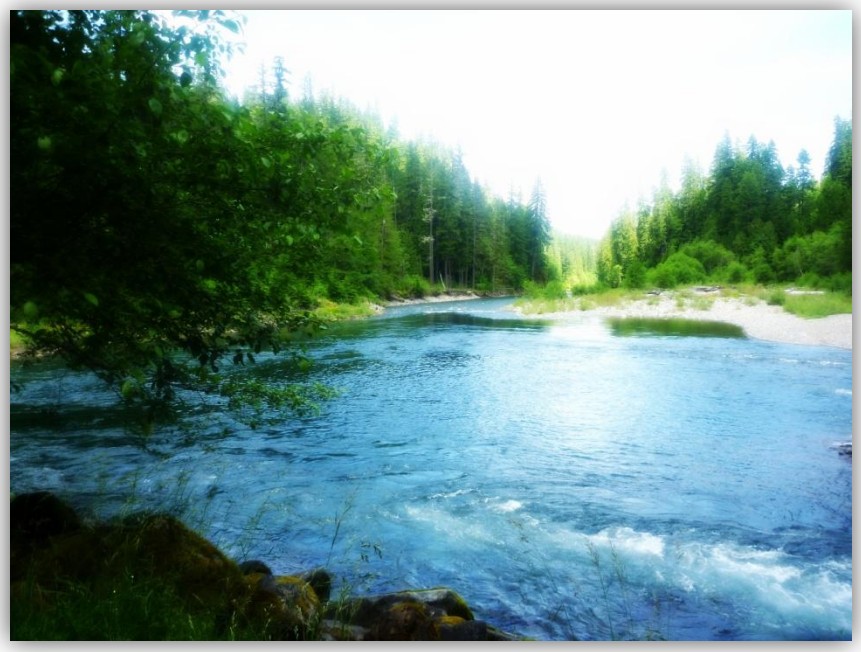
U.S. Fish and Wildlife Service

Clackamas River Bull Trout Reintroduction

FY 2010-11 Progress Report



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On the cover: *Confluence of the Clackamas River with the Collawash River, Oregon. Photo by M. Koski, USFWS.*

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FY2010-11 PROGRESS REPORT

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FY2010-11 PROGRESS REPORT

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Abstract – Bull trout were extirpated from the Clackamas River Basin in the 1960's. The extirpation resulted from environmental and fishery management problems that, at the present time, have been largely mitigated. The overall goal of the Clackamas bull trout reintroduction project is to re-establish a self-sustaining bull trout population of 300-500 spawning adults in the Clackamas River by 2030 that contributes to the conservation and recovery of bull trout in the Willamette Basin and to overall recovery criteria outlined in the Service's 2002 Draft Bull Trout Recovery Plan. During FY 2010 – 2011 the reintroduction project required a significant amount of planning and coordination between U.S. Fish and Wildlife Service programs and other agencies. The Columbia River Fisheries Program Office (CRFPO) contributed staff time and resources for this project by providing technical assistance during project permitting and development of the implementation strategy; leading the Monitoring and Evaluation (M&E) Committee and development of the M&E strategy; and monitoring the juvenile bull trout translocated to the Pinhead Creek habitat patch. As a result of the cooperative efforts between the CRFPO, the Service's Oregon Fish and Wildlife Office (OFWO) and other agencies, the project was successfully permitted and implementation and M&E strategies were developed to be experimental in nature and technically sound. A cooperative approach was developed between the CRFPO and OFWO whereby the CRFPO agreed to chair the M&E committee, leading the development of the M&E plan and committee activities. While the CRFPO did not detect any juvenile bull trout in the Pinhead Creek habitat patch, the protocol for assessing occupancy and distribution was established and observations were made about suitable habitat. While the project is anticipated to run for at least 20 years, 2011 marked the start of implementation, monitoring and evaluation activities that will shape future years' actions in an effort to successfully re-establish a bull trout population in the Clackamas, as well as to inform other bull trout recovery projects elsewhere in their range.

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Project Background

Bull trout (*Salvelinus confluentus*) is a species of char native to the Pacific Northwest and currently occurs in Oregon, Washington, Idaho, Montana, and Nevada. Bull trout require 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), over-harvest (Shively et al. 2007), and the introduction of non-native species (e.g., Leary et al. 1993). Consequently, bull trout populations have declined across their native range (Rieman et al. 1997). In addition, it is anticipated that the effects of climate change will further limit habitat and increase isolation between local populations (Rieman et al. 2007). By November 1, 1999 (64 FR 58910), all bull trout were listed as threatened by the U.S Fish and Wildlife Service ("Service") under the Endangered Species Act (ESA).

Consistent with the Service's 2002 Draft Bull Trout Recovery Plan (USFWS 2002), this project will attempt to reintroduce bull trout in a portion of its historic range where it has been extirpated, but where causes for extirpation have been largely mitigated. 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). Based on extensive surveys (e.g., Eberl and Kamikawa 1992; Zimmerman 1999), bull trout are believed to be presently extirpated from the Clackamas River subbasin, with the last verified sighting occurring in 1963 (Shively et al. 2007). Reestablishment of bull trout in the Clackamas River as an experimental population under section 10(j) of the ESA (76 FR 35979), will help to achieve distribution in the Clackamas River core habitat and will increase abundance of adult bull trout in the Willamette River Core Area. Thus, the overall goal of the Clackamas bull trout reintroduction project ("Project") is to re-establish a self-sustaining bull trout population of 300-500 spawning adults in the Clackamas River by 2030 that contributes to the conservation and recovery of bull trout in the Willamette Basin and to overall recovery criteria outlined in the Service's 2002 Draft Bull Trout Recovery Plan (U.S. Fish and Wildlife Service 2002; U.S. Fish and Wildlife Service et al. 2011).

While reestablishing bull trout to an area of its native range would be an accomplishment for the Project, a second goal and true success will be achieved if we can use information gained from this 10(j) experimental population reintroduction (whether bull trout are ultimately reestablished or not) to inform (future) potential bull trout reintroduction efforts in other parts of its historic range. The Columbia River Fisheries Program Office (CRFPO) has been involved in the planning and development of the experimental Project since approximately 2002. Initially, the primary role of CRFPO was to provide document reviews and technical assistance when appropriate. In FY 2010 and FY 2011, the CRFPO increased its involvement in the Project, at the request of the Regional Office, to provide our technical expertise and ensure that the project was scientifically sound. The CRFPO has since worked with the Project's lead office, the Oregon Fish and Wildlife Office (OFWO), to focus on planning and implementing the Monitoring and Evaluation Program (M&E Program) for this effort. However, the CRFPO has also been involved in other aspects of the project, including providing technical assistance to the Project's Implementation Program and during the regulatory permitting process; and leading the

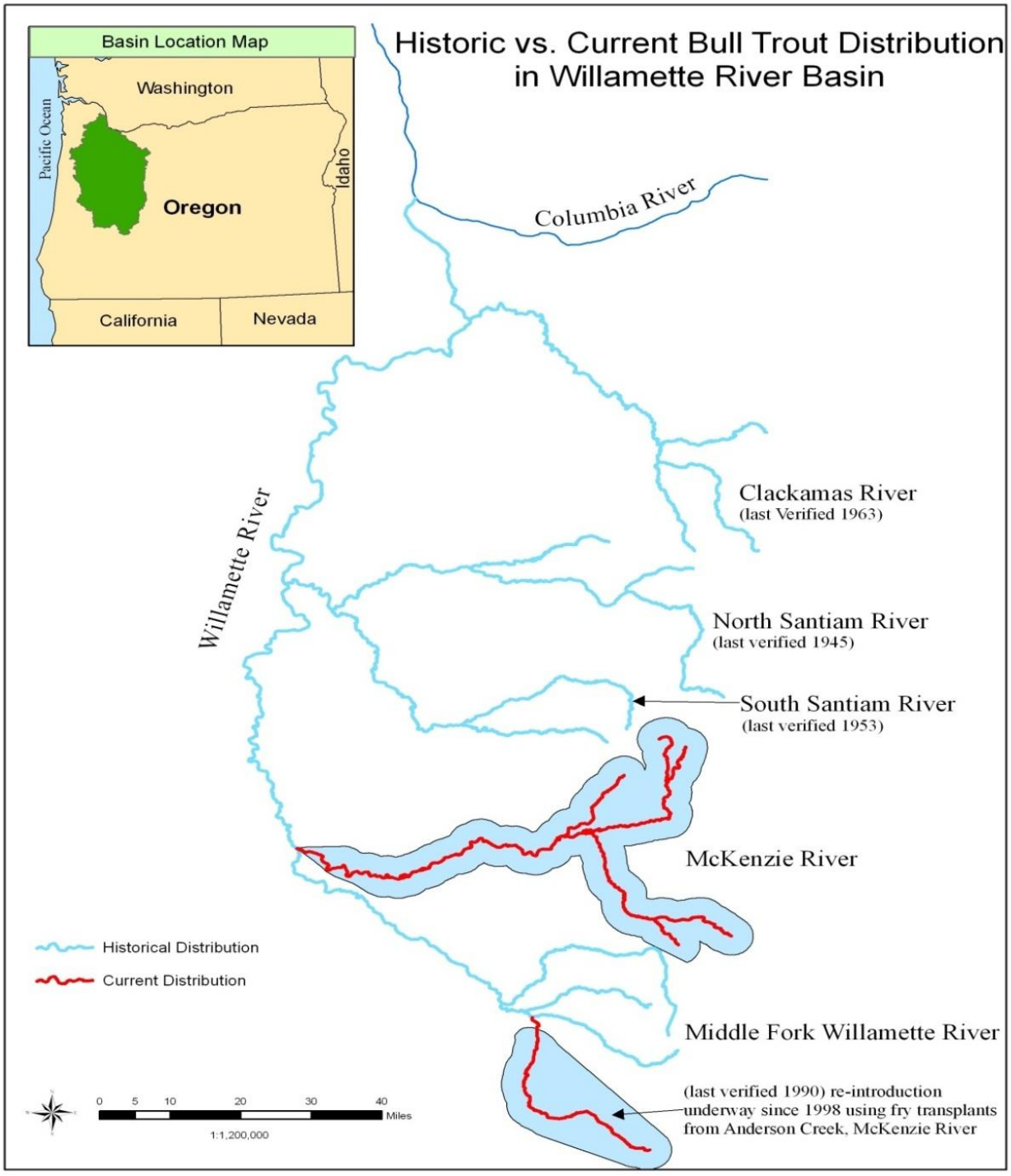

Figure 1. Historic and current bull trout distribution in the Willamette River Basin.

monitoring of translocated juvenile bull trout. Various partners (e.g, the U.S. Forest Service [USFS] and the Oregon Department of Fish and Wildlife [ODFW]) also participate in or lead specific monitoring aspects (e.g. adult radiotelemetry) of the Project. Thus, the Project objectives relative to CRFPO participation are as follows, and are described in further detail in the Methods section, below:

1. Coordinate the M&E Committee during all phases of the reintroduction project (e.g., lead development of the M&E Plan, lead M&E meetings, etc.).

2. Monitor the occupancy and distribution of juvenile bull trout that are translocated to or naturally spawned in the upper Clackamas basin.

3. Provide technical expertise and assistance in all aspects of the reintroduction project (including implementation), where needed (e.g., assist in the Section 7 consultation with the National Marine Fisheries Service (NMFS), review documents for scientific rigor, etc.).

Current Status of the Project

After several years of planning, bull trout were collected from the Metolius River basin and translocated to the upper Clackamas River basin, starting on June 30, 2011. Fifty-eight subadult and adult bull (all implanted with PIT and radio tags) trout were released in the Big Bottom area on the mainstem Clackamas River (Figure 2) between June 30 and July 15, 2011. Fifty-eight juvenile bull trout (all implanted with PIT tags) were released in Pinhead and Last creeks between June 30 and July 21, 2011. For details on 2011 Project implementation and monitoring activities led by partners, please refer to Barry and Clements (2012).

Methods

Objective 1 – M&E Committee Activities and Coordination

The complexity of the Project necessitated the division of planning efforts into two separate (but often overlapping) categories: implementation (i.e., collecting donor stock and transporting to the Clackamas, pathogen screening, and logistics for organizing crews, etc.) and monitoring and evaluation (i.e., defining priority monitoring questions, determining how to obtain the answers, and organizing on-the-ground monitoring of juveniles, subadults, adults and progeny (if any)). This section describes a) coordination between CRFPO and OFWO to develop the implementation and M&E committees, and b) development and initiation of the M&E program.

a) CRFPO and OFWO Coordination - Up through 2009, staff at the OFWO led the feasibility assessment (Shively et al. 2007) and preliminary development of the reintroduction project. In late 2009, OFWO requested the assistance of CRFPO to review details pertaining to project implementation, monitoring, and evaluation. After several coordination discussions (Appendix A), the CRFPO and OFWO developed a cooperative approach agreement and it was decided that OFWO staff (Chris Allen) would chair an Implementation Committee and that CRFPO staff (Marci Koski) would chair a Monitoring and Evaluation Committee to

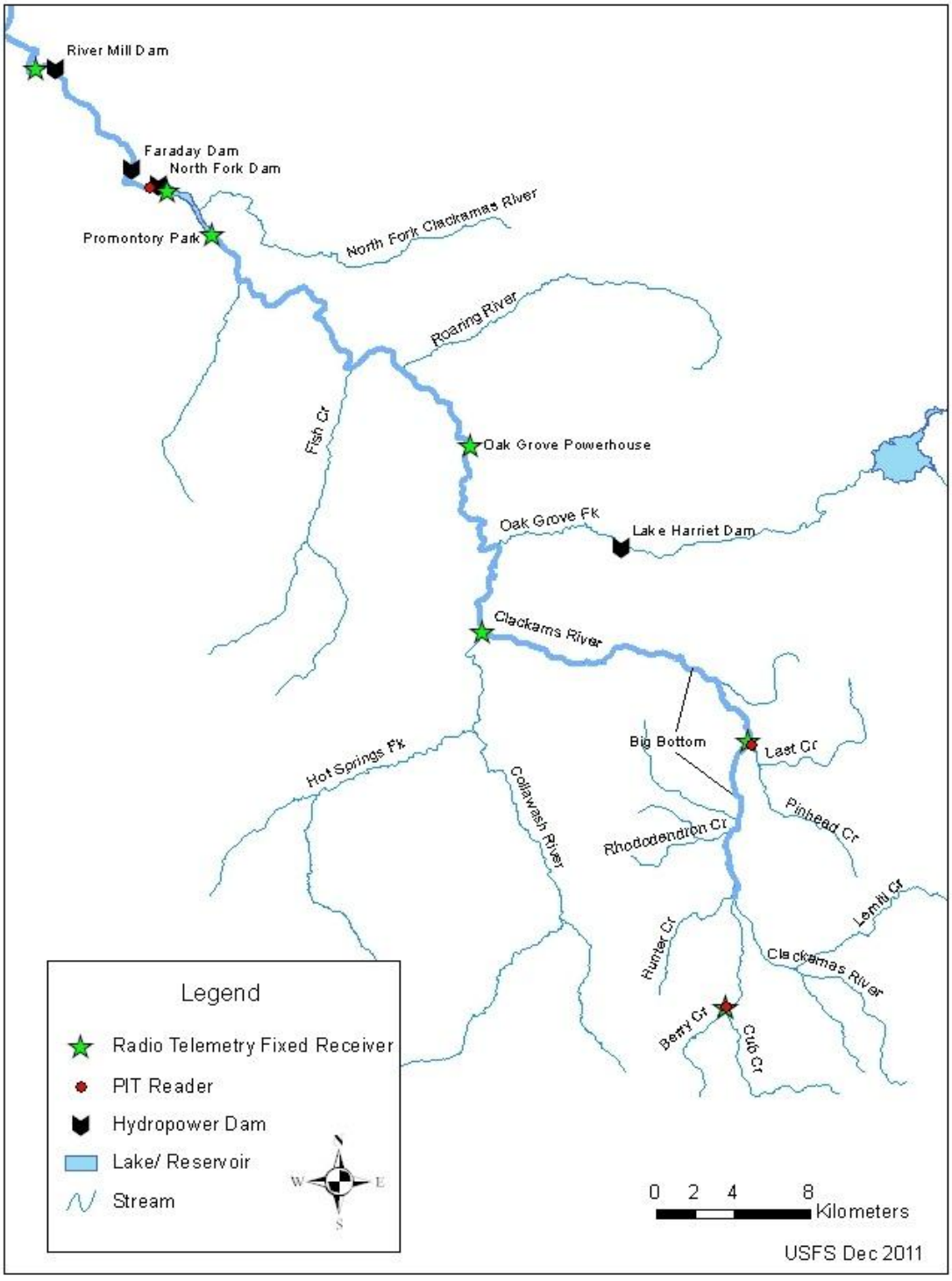

Figure 2. Location of automated radio telemetry and PIT tag monitoring sites within the study reach of the Clackamas River.

facilitate efficient coordination between the many agencies and organizations involved with the Project (Figure 3). As Chair of the M&E Committee, CRFPO coordinated with OFWO staff to brief managers in the Regional Office (RO) as well as managers of other agencies (e.g., ODFW, USFS) (Appendix A). Chairing the M&E Committee required CRFPO to lead the development and finalization of the Project's M&E Plan (part of the IM&E Plan), and coordinate M&E committee activities such as facilitating meetings (Appendix A), identifying assigning M&E tasks, and generating products.

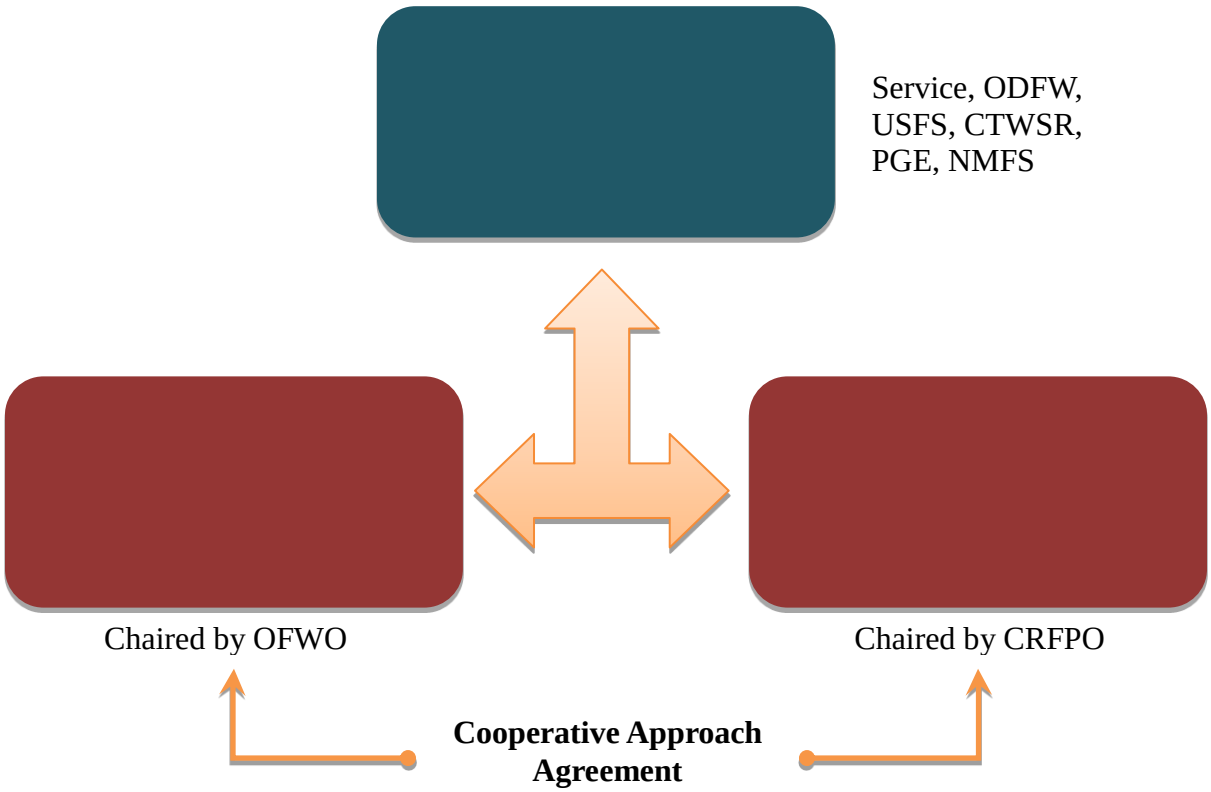

Figure 3. Clackamas bull trout reintroduction coordination committees.

b) M&E Program Development and Initiation – The tasks of the M&E committee during 2010 and 2011 generally consisted of three activities: developing the M&E strategy; identifying funds, equipment and personnel to implement the M&E program; and implementing the M&E program itself:

- M&E strategy development: A robust monitoring and evaluation program is required to determine the level of success of the implementation strategy, and to inform changes in the implementation strategy, if necessary. First, the M&E program had to be developed in conjunction with the implementation strategy. We determined the priority questions for this experimental reintroduction, then determined how we would monitor the reintroduction to get answers to those priority questions. The implementation strategy considered priority questions (e.g., are translocated subadult and adult bull trout moving

into High Vulnerability Zones), designed a method of implementation conducive to answering the question (e.g., identifying key locations for fixed station receivers and determining download and mobile tracking occurrences), and the M&E program identified ways to measure bull trout response (e.g., regular mobile tracking of radio-tagged fish and collection of movement data from fixed stations). The M&E program was designed to collect information that would inform us about the success of the reintroduction project, and provide information that may apply to bull trout reintroduction programs elsewhere in their range.

- M&E funding and equipment: Monitoring the Project requires several years' of ongoing funding and the use of technical equipment to detect bull trout throughout the Clackamas Basin. Particularly between November and December 2010, the CRFPO assisted in identifying equipment needed for FY 2011 implementation and M&E activities (see meetings in Appendix A), and provided information about where some equipment (e.g., PIT tags, receivers, etc.) could be purchased or borrowed. On April 21, 2011, CRFPO staff gave a presentation to Fisheries managers (including Terry Rabot) at the Regional Office to 1) provide an overview of the M&E strategy, and 2) reiterate the necessity of ongoing M&E program funding. The CRFPO requested $30,000 from the Fisheries Program to cover the costs of juvenile bull trout monitoring activities in FY 2011, including data management. Additionally, the CRFPO entered three FONS funding requests for the Clackamas River reintroduction project into FIS for FY 2011 funding:

  - Cross-Program Coordination (2010-161; $25,000 to support staff time)
  - Effectiveness of BT Reintroduction (2011-188; $30,000 to support juvenile M&E)
  - Impacts to Listed Spp M&E (2011-189; $15,000 to support monitoring adult bull trout)

Objective 2 – Monitoring Juvenile Bull Trout

While there are several components to the M&E strategy for the project, the CRFPO took responsibility for a portion of the required monitoring. One of the priority questions identified in the final IM&E Plan (USFWS 2011) concerns the general distribution of juvenile bull trout translocated to the upper Clackamas basin:

> B2. Do juveniles remain in the habitat patches they are outplanted to in the short-term or do they move relatively quickly out or into other habitat patches?
> a. If they stay, how are juveniles distributed within habitat patches?

To assess this, juvenile bull trout were monitored in two ways: 1) the use of PIT-tags and antennae array reader stations, and 2) ground-based surveys. Upon collection from the Metolius basin and prior to release in the Clackamas River, all bull trout between 70 and 150 mm in total length were PIT tagged by ODFW using 12 mm half-duplex tags. All PIT tags were placed in the body cavity of fish. One fixed PIT tag antenna array was placed at the mouth of Pinhead Creek, the habitat patch where juvenile bull trout were released, with the array stationed just above the confluence of the creek drainage and the mainstem Clackamas River. An additional fixed PIT tag antenna array was placed on Cub Creek just downstream of its confluence with Berry Creek. These two PIT tag antenna arrays were placed to identify any PIT-tagged bull trout

either leaving or entering those two habitat patches (i.e., Pinhead and Cub/Berry) (Figure 4).

The goal of the ground-based surveys was to document occupancy and distribution of translocated juveniles. Monitoring juvenile persistence within the Clackamas basin utilized an approach based on RMEG's patch occupancy protocol (USFWS 2008). However, in this case, we planned to continue surveying even if we determined a patch to be occupied; i.e., we planned to continue to survey all identified sampling locations in the habitat patch to answer questions about distribution and detection probability. The modified steps we took include the following:

1) Habitat patch identification. Six habitat patches have been delineated in the Upper Clackamas Subbasin, based on access to suitable habitat, stream size, and maximum temperature (Shively et al. 2007). The entire Pinhead Creek watershed was designated as one potential patch. A total of 58 juvenile bull trout were outplanted to two locations in Pinhead Creek: 1) on Pinhead Creek approximately 5 km from the confluence with the Clackamas River; and 2) on Last Creek, approximately 0.5 km from its confluence with Pinhead Creek and 2.1 km from the Clackamas River.

2) Utilize a Generalized Random Tessellation Stratified (GRTS) design to generate sampling sites within the patch. The GRTS design generated numerous potential survey sites (i.e., 50 m reach, with an average density of one reach per 500 m of stream) in a specific order. The top 70 GRTS sites generated for the Pinhead habitat patch were mapped.

3) Conduct reconnaissance surveys to evaluate the viability of selected sample sites. If any of these sites were ineligible (e.g., the site is dry, less than 1 m wide, over 18% gradient, etc.), the next site that was generated by the GRTS design was evaluated. This process was repeated until 21 eligible sites required for sampling were selected.

4) Select a field protocol to apply at each site. Sampling was conducted using a Smith-Root model LR24 backpack electrofisher. Electrofisher settings were subject to modification depending on conditions (i.e. water temperature, water depth, conductivity, flow, and fish response). Each 50 m reach was sampled from the downstream to upstream boundary, and no blocknets were used. A crew of three worked together (two netters and one electrofisher) to complete a single pass per reach.

5) Sample each site for juvenile bull trout (activities covered under CRFPO's ESA 10(a)(1)(A) recovery subpermit issued pursuant to Regional Blanket Permit TE-702631). All salmonids encountered were captured and identified; length (FL) and mass (g) were documented. All fish captured were released alive within the sampled reach.

6) Estimate probability of presence if all random sites are sampled and bull trout are not found. The probability of presence was estimated using the procedure of Peterson and Dunham (Peterson and Dunham 2003). A bull trout a priori detection probability of 30% was assumed for all sampled sites. A posteriori detection probability was calculated by dividing the number of reaches sampled in which bull trout were detected by the total number of reaches sampled.

Habitat characteristics at each sampling location were also recorded to make inferences about which habitats are preferred for spawning, rearing, and/or migration by fish that remain in the system. After the completion of fish sampling, habitat measurements were collected to qualitatively characterize or quantify habitat parameters from the study reach, including stream width, depth, cover (LWD, undercuts, canopy), habitat type (riffle, pool, run), substrate (silt, gravel, cobble, boulder, bedrock), gradient, and number of pools (Archer et al. 2004). Temperature and conductivity readings were gathered and recorded at each survey site.

Transects were flagged along the creek's thalweg at every 10 m mark from 0 to 50 m. Channel dimensions were then measured along each of the six designated transects within the sampling reach. For each transect, measurements were completed for the current wetted width, bank full width, maximum depth along the transect line, and depth recordings at a ¼, ½, and ¾ distance across the wetted width. Within each reach, the number and type of large woody debris (LWD) was categorized and counted. Only pieces of wood directly within the channel or within one meter of the water's surface were considered. Wood was classified into 4 categories: LWD >10 cm in diameter and >3 m in length, LWD >60 cm in diameter and >10 m in length, root wads, and LWD piles (aggregates of > 4 pieces of wood together) were quantified within each reach. The number, type and size of undercut banks were measured along both sides of the sampling reach. Undercuts were defined as areas under boulders, banks, wood, or bedrock along the stream bank that were > 5 cm deep, > 10 cm in length, and > 5 cm in height (Kershner et al. 2004). Only undercuts within 0.5 meter of the stream surface were considered. The reach was sub-divided into habitat units (pool, riffle, or run). The sum of estimated habitat unit lengths equaled the length of the sample reach (50 m). Within each of these units, the percentage of substrate composition was estimated. Substrate was classified as: sand/ silt/ clay (fines), gravel (pea sized), cobble (softball-sized), boulder (basketball-sized), and bedrock. Total substrate composition in each habitat unit equaled 100%. Finally, the gradient of each sampling site was measured using a hand-held clinometer. With both surveyors standing level with the water's edge, the person sighting the gradient measured against the person standing downstream. Gradient was measured for the top and bottom halves of the reach; these measurements were recorded and averaged.

Objective 3 – Technical Assistance

In the earlier planning phases of the Project, CRFPO committed to providing technical assistance and analytical support for implementation, monitoring, and evaluation activities. The Project contains three basic components: a) Project permitting; b) Project implementation (e.g., collecting donor stock and moving fish to the Clackamas); and c) Project monitoring and evaluation. The CRFPO provided technical assistance and support for each one of these processes by contributing to and reviewing planning documents, and by participating in numerous meetings and conference calls to refine Project details. In FY 2010 and 2011, CRFPO provided technical assistance for the following aspects of the Project permitting and implementation (CRFPO involvement in reintroduction monitoring will be discussed in Objective 2):

a) Project Permitting - because of the potential affects to several listed species, including bull trout in the Metolius basin and anadromous salmonids in the Clackamas basin, permits were required by both the State of Oregon and the federal government prior to the collection and translocation of any fish:

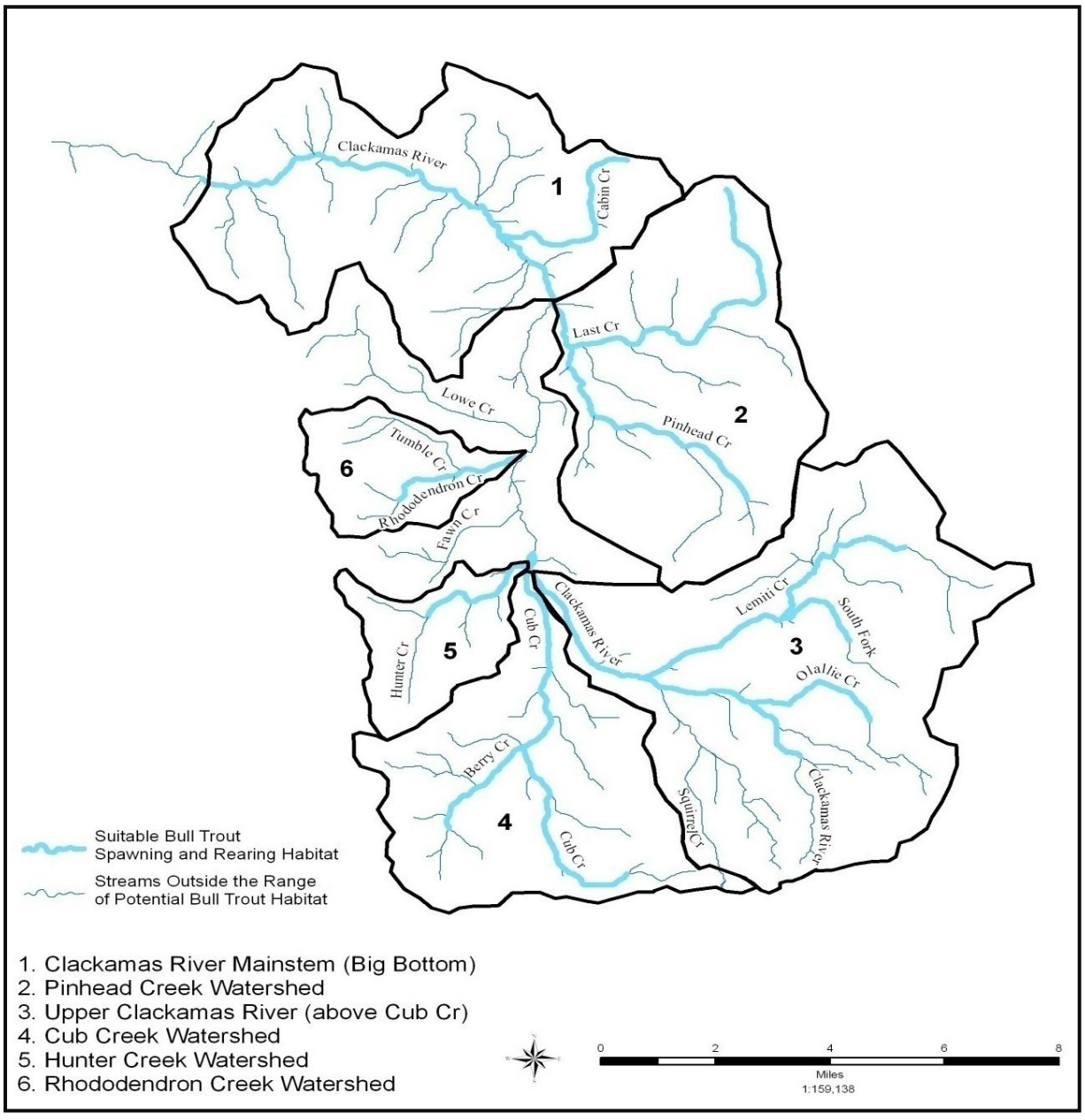

Figure 4. Suitable bull trout spawning and rearing habitat patches in the upper Clackamas River Subbasin (Shively et al. 2007).

- Establishment of ESA 10(j) non-essential experimental population: Prior to moving any bull trout to the Clackamas, the Service had to designate that any population of bull trout

re-established in the Clackamas River as a result of the Project would be a 10(j) non-essential experimental population under the Endangered Species Act. While the population is not essential to the continued existence of bull trout, it may contribute to their recovery. This population is legally treated as a "species proposed to be listed". To accomplish this, a proposed rule and draft Environmental Assessment (EA) was published in the Federal Register on Dec. 9, 2009 (74 FR 65045) and made available for public comment.

Prior to publishing the final rule, the Service had to address public comments received on the proposed rule and draft EA. NMFS and Portland General Electric (PGE), in particular, had considerable concerns regarding the potential impacts of the Project. On Jan. 26, 2010, the Service (OFWO and CRFPO) met with PGE to discuss their forthcoming comments on the proposed 10(j) rule and accompanying draft EA. PGE expressed support of the reintroduction project, but had two concerns: 1) how will the Project affect listed anadromous salmonids in the basin (which are still declining) and potentially affect the terms of a relicensing settlement agreement, and 2) how will Project success be defined and measured? The Service recognized that there were unanswered questions about the potential effects of a reintroduction, and committed to work with PGE to address concerns raised during the project development process. Subsequently, the Service received a 36-page comment letter (Feb. 8, 2010) and supplemental comments (Sept. 13, 2010) from PGE stating legal and biological concerns about the Project impacts. From then on, PGE attended several ESA section 7 consultation meetings with NMFS to ensure their concerns were addressed during the consultation process (see section 7 consultation below). CRFPO attended all of these meetings (Appendix A) and assisted OFWO in working with PGE to resolve their concerns as much as possible. Additionally, CRFPO reviewed the 10(j) Final Rule and EA during January and February 2011 and provided comments to OFWO prior to publication in the Federal Register.

- <u>ESA Section 7 consultation with NMFS for effects on listed salmonids</u>: Reintroducing bull trout into the Clackamas River has the potential to adversely affect other ESA-listed fish in the basin, including steelhead and other anadromous salmonids, due to increased predation risk and competition from bull trout. As such, the Service underwent an ESA section 7 consultation with NMFS, part of the National Oceanic and Atmospheric Administration (NOAA). This would allow a certain amount of incidental take of listed anadromous salmonids in the basin as the result of Project implementation. The CRFPO reviewed the Nov. 10, 2010 draft Biological Asssessment (BA) and provided comments to OFWO on Nov. 23, 2010. The final BA was sent to NMFS on Dec. 9, 2010, which initiated the consultation process with NMFS.

  Prior to and during the consultation, CRFPO participated in numerous meetings and phone conversations between March 23, 2010 and May 9, 2011 (Appendix A). Generally, most discussions revolved around questions and uncertainties regarding potential impacts of the Project on listed anadromous salmonids in the Clackamas River and in the PGE hydroproject area in particular. NMFS was concerned that 1) the magnitude of the potential impact of bull trout on listed salmonids was currently

unknown and the M&E Program did not have a direct way to measure impacts to listed salmonids; and 2) if a significant impact was detected, how the Project would be altered to stop the impact was unclear.

To address NMFS' first concern regarding the uncertainty surrounding the magnitude of impact bull trout may have on listed steelhead and salmon, CRFPO performed a series of bioenergetics simulations to estimate how many smolt adult and subadult bull trout would eat under various physical, dietary and environmental scenarios. Three primary scenarios were modeled for both adult bull trout (550 mm total length) and subadult bull trout (350 mm total length): 1) a "worst case scenario" where bull trout ate at their maximum consumption rate ($p = 1$) all year, eating only (100%) listed salmonids; 2) a "moderate scenario" where bull trout ate at a limited consumption rate depending on the time of year ($0.3 \leq p \leq 0.6$), eating only (100%) listed salmonids; and 3) a "more realistic scenario" where bull trout ate at a limited consumption rate (as above), but also ate a limited amount of listed salmonids (varying between 35 – 75% of their diet depending on the time of year). Further, each of these scenarios were run using two thermal regimes (warm and cool), depending where in the reservoir bull trout may be located. Fish Bioenergetics 3.0 (Hanson et al. 1997) with consumption parameters modified for bull trout (Matt Mesa, unpublished data) was used to estimate the potential growth of bull trout under each of these scenarios, then the number of smolt it would take to achieve that amount of growth was calculated. This number of smolts was multiplied by 60 to reflect the total number of smolts consumed by a single years' translocated subadult and adult bull trout, assuming no mortality. Simulations started on June 15 and went through one year, with peak migration periods occurring in the fall and spring. Vertical thermal profiles of North Fork Reservoir, energy density values for bull trout and prey items, and estimates of prey composition were obtained from Lowery and Beauchamp (2010) and Beauchamp (pers. comm. May 13, 2011). Bull trout weights were calculated using the length-weight relationship of bull trout collected from the Metolius Basin between 2008 and 2010 (ODFW, unpublished data); weights for Chinook and coho salmon as well as steelhead trout were calculated using length-weight regressions from Pearsons and Busack (2010).

The CRFPO also assisted OFWO in providing information to address NMFS' second concern concerning how the Project would be altered should a significant negative impact to listed anadromous salmonids in the Clackamas River be detected. The CRFPO worked with OFWO and NMFS to develop the Stepwise Impact Reduction Plan (SIRP), initially drafted on April 29, 2010 as a document called "Potential Impacts to Juvenile Anadromous Salmonids: Draft Scenarios, Triggers, Resulting Management Actions". The SIRP lists triggers for the implementation of management actions to address effects of bull trout on listed salmon and steelhead based on observations of both bull trout (e.g., individuals staging for a given length of time in a High Vulnerability Zone) and the population condition (i.e., trend and abundance) of listed stocks. The SIRP went through numerous revisions during the consultation process. The CRFPO attended several meetings to discuss the triggers and responses outlined in the SIRP (Appendix A), and reviewed and provided feedback on several versions of the document.

While direct impacts to listed anadromous salmonids are difficult to measure in real time (part of NMFS' primary concern), population conditions of listed stocks can be assessed to determine if a SIRP trigger has been reached. Currently, population trends and abundances of listed anadromous salmonids in the Clackamas are estimated based on the number of smolts outmigrating through the PGE hydroproject area and returning later to spawn. However, this estimate has had to be corrected due to fish being passed over the spillway at North Fork Reservoir. PGE provided CRFPO with an analysis of spill corrected juvenile outmigrant numbers at North Fork dam on the Clackamas River (Ackerman 2009) in early 2011. CRFPO (Wilson) reviewed the analysis (March 8, 2011) and concluded that the corrected outmigrant estimates may be more accurate than the uncorrected estimates, but the assumptions and metrics used may not adequately provide evidence to support the correction. As part of the M&E Program, CRFPO will continue to look at PGE smolt counts to assist in determining whether a SIRP trigger has been reached.

b) Project Implementation – once the Project was properly permitted, bull trout could be collected, tagged, transported, and released into the upper Clackamas basin. This process had several aspects:

- Implementation Strategy: First, an implementation strategy was developed. The strategy addressed questions regarding the experimental design of the Project: what life stage(s) of bull trout would be best to translocate, how many of them should be translocated each year, what habitat patches they should be placed in, and repetition of efforts each year. CRFPO participated in several meetings and discussions about the details of project implementation (Appendix A), especially in relationship to the monitoring program (e.g., determining how we can learn from an experimental approach to the reintroduction strategy).

  While CRFPO contributed to discussions regarding all issues stated above for Project implementation, we also provided technical guidance regarding the possible approaches the Project could take. For example, CRFPO reviewed and provided extensive comments on documents such as the draft Disposition Plan (comments provided to OFWO on August 30, 2011) for bull trout that required removal from the Clackamas River, the Implementation section of the Implementation, Monitoring and Evaluation Plan (IM&E Plan), and drafted guidance (e.g., a document outlining a series of sequential questions to guide translocation efforts, walking through the number of life stages to be used, which life stages will be used, details relating to those life stages, strategies for monitoring those life stages, and evaluating population success). Additionally, CRFPO performed a Principal Components Analysis (PCA) using SAS 9.1 (SAS Institute Inc. 2010) to determine the level of similarity between habitat patches in the upper Clackamas basin, based on primary tributary maximum temperature, minimum summer width, gradient, basin size, and percent of the basin considered to be in the High Cascades (as opposed to the Western Cascades) flow regime (unpublished data from ODFW and USFS). Juveniles would be seeded in two habitat patches per year, but those two patches had to be identified first. To maximize the probability of reintroduction success, it was decided that the two chosen patches should vary as much as possible across habitat attributes

(even though it was assumed that all six patches contained habitat suitable to bull trout). The PCA determined which patches were most similar in habitat attributes, thus providing information that helped determine which two habitat patches to seed each year.

- Implementation Funding: After the implementation strategy was developed, funding needs and resources had to be identified that could support the Project by supplying equipment and funding personnel. Because long-term funding has yet to be established, funding needs will likely have to be identified and funds sought annually, particularly during the first phase (years 1-7 of the reintroduction). During FY 2010 and 2011, CRFPO participated in discussions to identify resource and equipment needs and potential funding sources (Appendix A) and reviewed funding requests (e.g., FY 2009 Deferred Allocation Funding Request for $150,000 from the Recovery Fund, reviewed April 8, 2010). For the Project to be implemented in 2011 (i.e., fish translocated to the Clackamas), a total budget of $338,000 for FY 2011 was identified to support the ODFW coordinator position and field crew, pathogen screening, equipment purchases, and USFS personnel (for both implementation and M&E activities).

- Implementation Activities: Finally, implementation activities had to be initiated with the coordination of several agencies working together to collect, tag, transport and release fish into the upper Clackamas River basin. Collecting and translocating donor stock is expected to occur for at least the first phase of the Project. The implementation strategy may be refined based on what is learned (see monitoring section below) about the most effective way to reintroduce bull trout in the Clackamas River. While most of the implementation participation of CRFPO involved helping to shape the implementation strategy, we did assist in implementation activities by lending two electronarcosis units to ODFW staff for adult and subadult bull trout tagging surgeries performed at the Round Butte facility during the donor collection efforts.

Results

Objective 1 – M&E Committee Activities and Coordination

This section describes products as a result of: a) coordination between CRFPO and OFWO to develop those committees; and b) the activities of the M&E Committee, including M&E strategy design.

a) CRFPO and OFWO Coordination – After numerous coordination meetings (Appendix A), the OFWO and CRFPO Cooperative Approach was finalized on March 23, 2010 (Appendix B). The document defined the roles of OFWO and CRFPO staff in the Project. The approach specified that OFWO and CRFPO, along with various Project partners, "must work cooperatively to 1) define success for the Project (both overall and at specific benchmarks); 2) establish an implementation, monitoring, and evaluation strategy that allows for adaptive management of the Project to increase the chances of success; and 3) address administrative responsibilities and logistical details." The approach further assigned OFWO (Chris Allen) to chair the Implementation Committee, and CRFPO (Marci Koski) to chair the M&E

Committee. As such, CRFPO was directed to lead the development of a scientifically sound M&E plan and provide guidance to the Implementation Committee.

CRFPO staff (Marci Koski) led the M&E Committee by facilitating meetings to discuss needs and details related to the M&E program (Appendix A), identified and assigned tasks to M&E subcommittee members (Appendix C), and written and distributed meeting notes and products (e.g., the M&E Plan and related documents, described below). It is anticipated that CRFPO staff will continue this role into the future as the Project is implemented and that M. Koski will continue to coordinate with partners to refine M&E program needs in all three monitoring aspects of the project (donor population health, bull trout reintroduction effectiveness, and impacts to listed salmonids), and will be responsible for coordinating annual reports and other products.

b) M&E Program Development and Initiation -

- M&E strategy development: The development of the M&E plan took approximately two years, starting with an initial version drafted in June 2009. Several meetings with the M&E Committee, as well as core M&E Committee members (Appendix C), resulted in the development of a list of prioritized M&E questions (Oct. 2010) and a list of corresponding actions (Dec. 2010) (Appendix D). Once these priorities were identified, the details of the M&E plan were completed and integrated into a final Implementation, Monitoring, and Evaluation Plan in June 2011 (USFWS 2011).

  Briefly, the Project's M&E plan focuses on 1) ensuring that the project does not negatively impact the donor population; 2) monitoring the effectiveness of the bull trout reintroduction in the Clackamas basin; and 3) evaluating the effects of the reintroduction on listed anadromous salmonids in the Clackamas basin. Data collected from monitoring activities will be used to inform further implementation actions, management of the bull trout population in the future, and other (potential) bull trout reintroduction efforts. The reintroduction strategy may change depending upon the perceived success of each life stage, habitat use, and/or reproductive success. Additionally, the Project may be altered depending upon observed impacts to listed anadromous salmonids in the basin (e.g., see the Stepwise Impact Reduction Plan (SIRP), USFWS 2011). Observations such as the location of adult bull trout and estimated smolt population numbers will be used to determine if early warning targets or trigger points outlined in the SIRP have been reached. Further information can be found in the Clackamas River Bull Trout Reintroduction Implementation, Monitoring, and Evaluation Plan.

  Bull trout were initially reintroduced to the Clackamas on June 30, 2011 at a public release event attended by all partnering agencies and local media. Since that time, all translocated bull trout were tracked using PIT tags/antennae and radio telemetry. Of note, ten of the 58 juveniles translocated to Pinhead and Last Creeks were detected emigrating from Pinhead to the Clackamas mainstem in the first two weeks following their release. Subadults and adults were detected throughout the upper Clackamas from above Big Bottom to North Fork Reservoir. However, no individual bull trout occupied any of the "High Vulnerability Zones" for more than two hours, and collectively spent only 5 hours 28 minutes in these zones between June 30, 2011 and Dec. 15, 2011.

Further results of implementation and M&E activities can be found in ODFW's annual report to the USFWS (Barry and Clements 2012).

Additionally, the Fisheries Program requested that the CRFPO produce a short video describing the M&E strategy for the Service's booth at the American Fisheries Society (AFS) Annual Meeting in Seattle (Sept. 4-8, 2011). The video was finalized on August 26, 2011, was featured at the Service's AFS booth along with other videos about Fisheries Program projects, and was posted on the Service's youtube channel (www.youtube.com) under the Pacific Region's playlist.

- M&E funding and equipment: In the winter of 2010-2011, CRFPO provided assistance with identifying needed equipment, supplies and funding (Appendix A). While none of the FONS funding requests were specifically granted, the Fisheries Program provided CRFPO with $20,000 to perform juvenile bull trout monitoring activities in the Clackamas during August 2011 (see Objective 3).

Objective 2 – Monitoring Juvenile Bull Trout

The small number of juvenile bull trout that were translocated (n=58) from the Metolius basin to the Pinhead Creek habitat patch in 2011 provided an opportunity to begin to examine how the bull trout occupancy approach, currently being employed (USFWS 2008), functioned in low density populations. Ground surveys in Pinhead Creek occurred between 8/30/2011 and 9/9/2011. Seventy-one sites were surveyed to attain 21 eligible sites. Electrofishing effort totaled 5,833 seconds with an average 277 seconds per reach. No bull trout were found in any of the reaches sampled (Figure 5, Appendix E). However, a total of 37 coastal cutthroat trout (*Oncorhynchus clarki clarki*, "CCT") were found in 13/21 (62%) of sites surveyed (Figure 5, Appendix E). No other salmonids were encountered. At low summer flows, the Pinhead Patch contains approximately 85,000 m^2 of spawning and rearing habitat (see Shively et al. 2007). Thus, if all the juvenile bull trout stayed in the patch and there were no mortalities, the density of juvenile bull trout would have been approximately $7x10^{-4}$ bull trout/m^2. In this case, because no bull trout were captured, detection probability would have been < 5% and a minimum of 28 GRTS reaches would need to be sampled to achieve an 80% certainty of absence (see USFWS 2008). Alternatively, juvenile bull trout may have left the patch through dispersal (see Barry and Clements 2012) or mortality and the patch may not have been occupied.

Habitat data was collected in all reaches (Appendix F). Additional comments were recorded for each reach, describing information not captured by the data types collected. The most frequent habitat type was riffles (91% of sites) and the most common substrate type was sand (44% of sites). Undercutting was found at all sites and ranged from 0.3% to 95% of the bank. Water temperature ranged from 6°C to 11°C averaging 8°C. Fifty one of the 71 GRTS reaches (71.8%) were dry. Thus, although the Pinhead Patch is approximately 6,918 hectares when fully wetted (see Shively et al. 2007), only 1,951 hectares (1,656 hectares that are connected) appear to be wetted at summer low flows. Fortunately, this area would still be considered large enough to support spawning and early rearing for a bull trout population (see USFWS 2008).

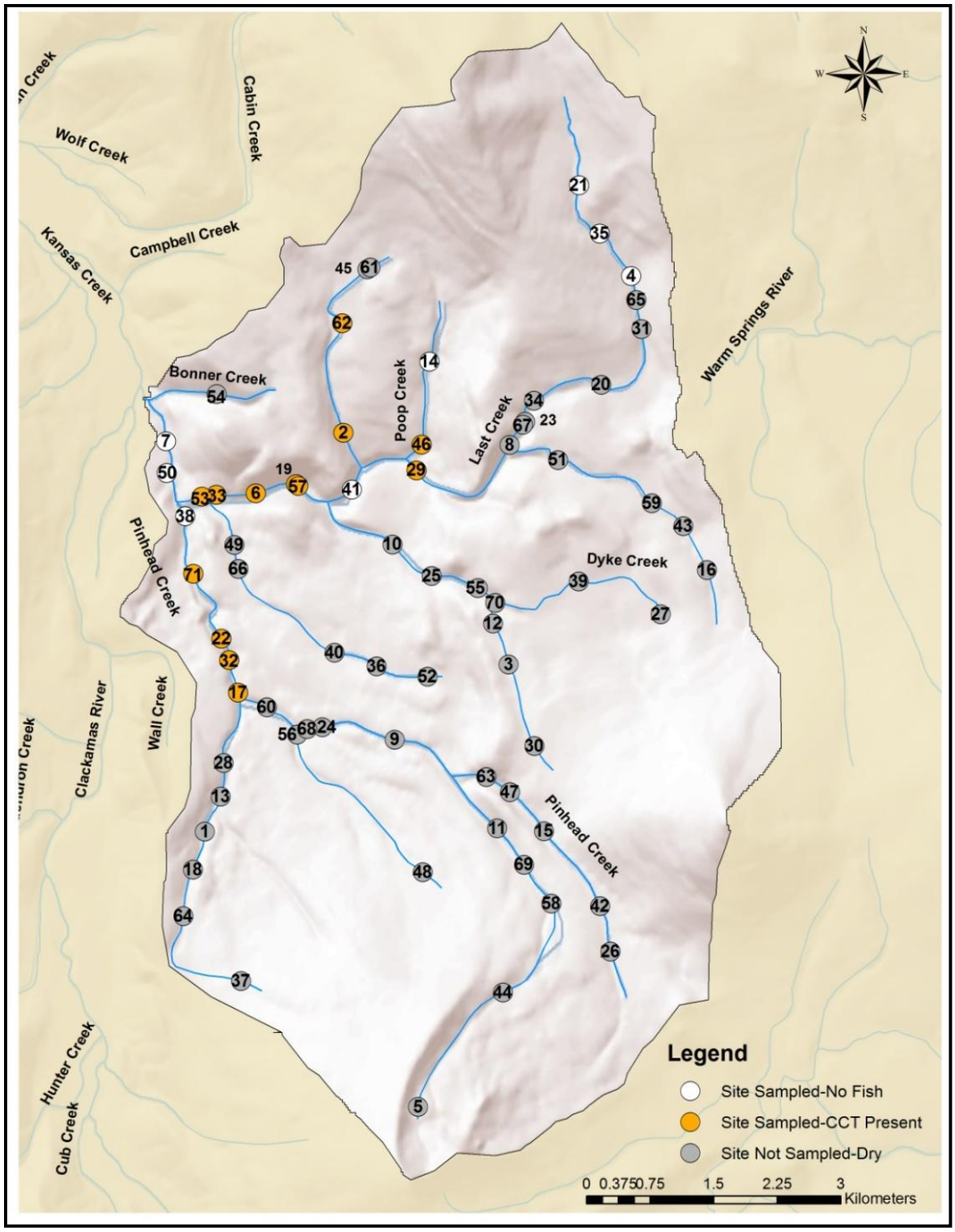

Figure 5. Sites sampled in Pinhead Creek 2011.

Objective 3 – Technical Assistance

As a result of attending and contributing to planning meetings and discussions, and reviewing and providing technical assistance, the CRFPO assisted in producing the following:

a) Project Permitting:

- Establishment of ESA 10j, non-essential experimental population: The final rule that established a non-essential 10(j) experimental population of bull trout in the Clackamas was published in the Federal Register on June 21, 2011 (76 FR 35979) with a final EA.

- ESA Section 7 consultation with NMFS for effects on listed salmonids: The section 7 consultation with NMFS was initiated on Dec. 9, 2010, when the final BA was transmitted from OFWO to NMFS on Dec. 9, 2010. The final SIRP, dated May 13, 2011, was sent to NMFS as an amendment to the Service's BA.

  CRFPO completed a series of bioenergetic simulations on May 19, 2011, that resulted in an estimate of the number of smolts that could be eaten by bull trout under three primary scenarios (Table 1, Appendix G). Based on the results of the bioenergetics modeling, NMFS had a better understanding of the potential impact of bull trout on steelhead trout, as well as coho and Chinook salmon populations in the Clackamas River. The implausibility of the other two scenarios actually occurring and the relatively low total number of listed salmonids consumed in the "more realistic" scenario alleviated many of NMFS' concerns about the Project's potential impact to listed anadromous salmonids in the Clackamas River. The consultation was concluded on June 27, 2011 with the completion of NMFS' non-jeopardy Biological Opinion (BiOp) (NMFS 2011).

Table 1. Estimated total number of smolts eaten yearly by 60 bull trout (from bioenergetics modeling scenarios). Only the warm (or high) thermal scenarios are shown here. The total number of estimated smolts eaten by bull trout are individually divided by steelhead trout, coho salmon and Chinook salmon, which are 13%, 47%, and 40% of the listed anadromous salmonids in North Fork Reservoir, respectively (Lowery and Beauchamp 2010).

Scenario	# Smolts Eaten by Subadults	# Smolts Eaten by Adults	Total # Smolts Eaten by BT	Total # Steelhead Consumed	Total # Coho Consumed	Total # Chinook Consumed
Worst Case	4,937	10,529	**15,466**	2,011	7,269	6,186
Moderate	448	1,418	**1,866**	243	877	746
More Realistic	173	552	**725**	94	341	290

b) Project Implementation:

- Implementation strategy: The CRFPO provided review and technical support for several planning documents developed for the Project's implementation strategy. Among these is a document of sequential questions to guide translocation efforts (December 14, 2009, Appendix H), contributions to and review of the Implementation Plan (part of the final IM&E Plan), and review of the Disposition Plan (reviewed August 30, 2011, finalized April 16, 2012).

  Part of the implementation strategy included a PCA performed by CRFPO during July 2010 that generated relationships between each patch and habitat characteristic dimensions within the Upper Clackamas River subbasin. Component loading is a measure of how much a particular variable (gradient, basin size, etc.) corresponds with the component. Dimension (or principal component) 1 is mostly a measure of summer stream width and basin size (both have high positive loadings), as well as gradient (high negative loading) (Figure 6). Dimension 2 has large loadings of maximum temperature and percent of the watershed in the high cascades (Figure 6). Together, these two dimensions account for about 72% of the variance between the streams.

  Based on where each basin falls relative to each dimension axis (Figure 6), Cub and Berry creeks (both in the same patch) appear to be similar in that both have higher summer temperatures (i.e., both fall near each other on the dimension 2 axis) whereas Pinhead and Last creeks (also in the same patch) are also fairly similar but have lower summer temperatures. Rhododendron and Hunter patches are similar based on gradient (dimension 1) but are not particularly close to each other regarding temperature. While the Upper Clackamas patch appears to be distinct, the basin acreage that was used is fairly large and includes the Upper Clackamas and Lemiti drainages; data was not available for the Upper Clackamas above its confluence with Lemiti Creek. Therefore, the uniqueness of the Upper Clackamas may be incorrect in this particular analysis.

  The identification of habitat patches to initially receive translocated juveniles was based partially upon the results of the PCA by choosing patches that were on opposite ends of a PCA axis. Dimension 2 (which is characterized by maximum temperature and high cascade flow regime), indicated that Pinhead and Last Creek (both in the Pinhead patch) and Cub and Berry Creeks (also in a single patch) vary in maximum temperature and flow regime, but are similar relative to stream width and basin size, as well as gradient.

- Implementation funding: In FY 2010, CRFPO provided approximately 0.25 FTE in coordination and planning activities (~ $25,000), and approximately 0.3 FTE in FY 2011 (~ $33,000) for continued coordination, planning, and M&E Program activities (see Objective 2 for more information on CRFPO contributions to coordination and the M&E Program). Staff time contributed by CRFPO to the Project was not included in addition to the identified budget total of $338,000.

- Implementation activities: The CRFPO loaned two electronarcosis units to ODFW staff at the Round Butte fish holding facility to immobilize fish for surgery. These units were

used on adult and subadult bull trout collected as donor stock for translocation to the Clackamas River. A total of 58 adults and subadults were implanted with both radio tags and PIT tags during these surgeries; these fish were released in the Clackamas River starting June 30, 2011, with transfers continuing for several additional weeks.

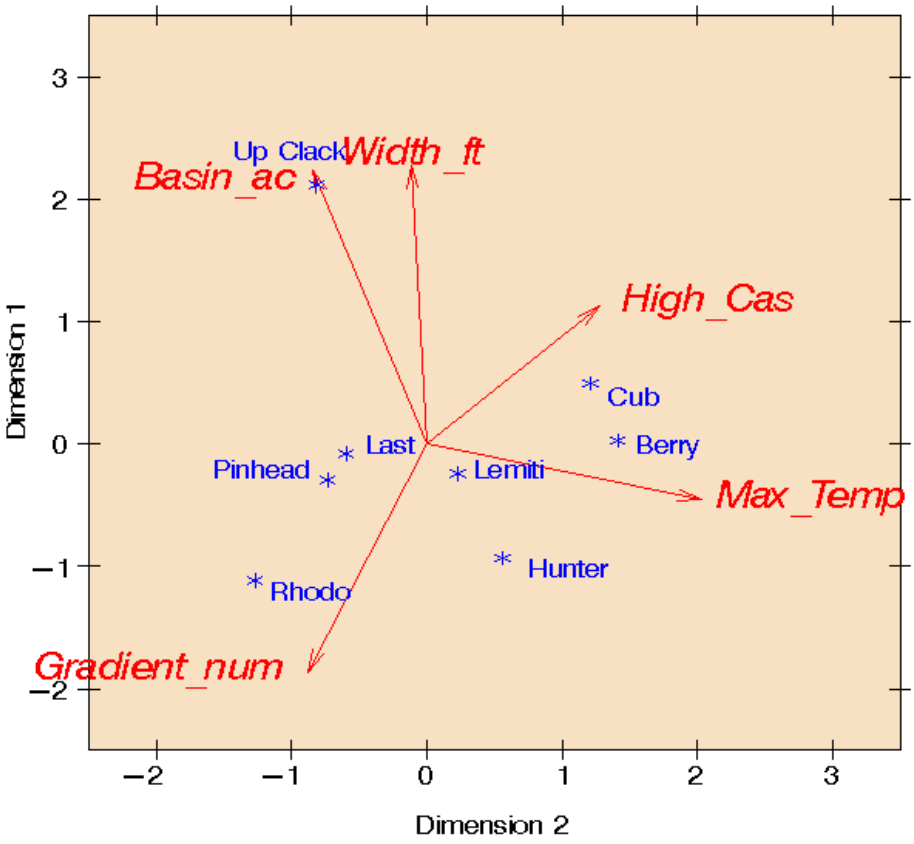

Figure 6. Principal Components Analysis of habitat attributes in the upper Clackamas River subbasin bull trout patches. We considered maximum water temperature ("Max_Temp"), minimum summer stream width ("Width_ft"), stream gradient ("Gradient_num"), basin area (in acres, "Basin_ac"), and the percent of the basin that fell within the High Cascade (vs. West Cascade) flow regime ("High_Cas"). Names of individual habitat patches are shown in blue (note that Pinhead and Last are in the same patch, as are Cub and Berry; Lemiti is also part of the Upper Clackamas patch).

Summary

The CRFPO made significant contributions to the Clackamas bull trout reintroduction project during FY 2010 – 2011, that included providing technical assistance during 1) Project permitting (i.e., establishing the 10(j) bull trout population in the Clackamas and completing the section 7 consultation with NMFS), and 2) Project implementation (i.e., developing the implementation strategy and assisting with identifying equipment and funding needs). A Cooperative Approach agreement was developed between OFWO and CRFPO, whereby CRFPO staff chaired the M&E Committee and led the development of the M&E Plan, including identifying necessary equipment and funding. Further, the CRFPO conducted activities to monitor whether juvenile bull trout occupied the Pinhead patch during August 2011. No bull trout were detected; however, information was obtained about suitable habitat and refining occupancy sampling protocol during these surveys.

Acknowledgements

During FY 2010 – 2011, the following agencies contributed their expertise and resources towards planning, implementing and monitoring the Clackamas reintroduction project: Oregon Department of Fish and Wildlife, U.S. Forest Service, the Confederated Tribes of the Warm Springs Reservation, National Marine Fisheries Service, Portland General Electric, and the U.S. Geological Survey. We are grateful for the time and efforts of everyone on the M&E Committee.

Literature Cited

Ackerman, N. 2009. Estimating spill corrected juvenile outmigrant numbers at North Fork Dam on the Clackamas River. Portland General Electric. Portland, Oregon. 10 pp.

Archer, E. K., B. B. Roper, R. C. Henderson, N. Bouwes, S. C. Mellison and J. L. Kershner. 2004. Testing common stream sampling methods for broad-scale, long-term monitoring. General Technical Report. United States Department of Agriculture, Forest Service, Rocky Mountain Research Station. RMRS-GTR-122.

Barry, P. M. and S. Clements. 2012. Clackamas River Bull Trout Reintroduction Annual Progress Report for 21 June 2011 - 15 December 2011. Oregon Department of Fish and Wildlife Salem, Oregon. Contracts 13420-AJ030 (USFWS) and 11-CS-11060600-003 (USFS). 22 pp.

Eberl, J. and D. Kamikawa. 1992. Upper Clackamas River bull trout survey. Mt. Hood National Forest, Oregon.

Fraley, J. J. and B. B. Shepard 1989. "Life history, ecology, and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River system, Montana." Northwest Science 63: 133-143.

Hanson, P. C., T. B. Johnson, D. E. Schindler and J. F. Kitchell. 1997. Fish Bioenergetics 3.0. University of Wisconsin - Madison Center for Limnology and University of Wisconsin Sea Grant Institute. Madison, Wisconsin.

Kershner, J. L., E. K. Archer, M. Coles-Ritchie, E. R. Cowley, R. C. Henderson, K. Kratz, C. M. Quimby, D. L. Turner, L. C. Ulmer and M. R. Vinson. 2004. Guide to effective monitoring of aquatic and riparian resources. General Technical Report. U.S. Department of Agriculture, Rocky Mountain Research Station. Fort Collins, Colorado. RMRS-GTR-121. 57 pp.

Leary, R. F., F. W. Allendorf and S. H. Forbes 1993. "Conservation genetics of bull trout in the Columbia and Klamath river drainages." Conservation Biology 7: 856-865.

Lowery, E. D. and D. A. Beauchamp. 2010. Baseline food web assessment of the Upper Clackamas River Basin prior to reintroduction of bull trout. U.S. Geological Survey, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fisheries Sciences at the University of Washington, Report No. WACFWRU-010-02. Seattle, WA. 78 pp.

NMFS. 2011. Biological Opinion on the U.S. Fish and Wildlife Service Proposal to Reintroduce Bull Trout to the Clackamas River, OR, Consultation Number 2010/06535. National Marine Fisheries Service. Portland, Oregon. 76.

Pearsons, T. N. and C. A. Busack. 2010. PCD Risk 1: A tool for assessing and reducing ecological risks of hatchery operations in freshwater. Washington Department of Fish and Wildlife. Olympia, Washington.

Peterson, J. T. and J. Dunham 2003. "Combining inferences from models of sampling efficiency, detectability, and suitable habitat to classify landscapes for conservation of threatened bull trout, *Salvelinus confluentus*." Conservation Biology 17: 1070-1077.

Rieman, B. E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce and D. Myers 2007. "Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin." Transactions of the American Fisheries Society 136(6): 1552-1565.

Rieman, B. E., D. C. Lee and R. F. Thurow 1997. "Distribution, status, and likely future trends of bull trout within the Columbia River and Klamath River basins." North American Journal of Fisheries Management 17: 895-909.

Rieman, B. E. and J. D. McIntyre 1995. "Occurrence of bull trout in naturally fragmented habitat patches of varied size." Transactions of the American Fisheries Society 124: 285-296.

SAS Institute Inc. 2010. SAS Version 9.1.3 for Windows. SAS Institute, Inc. Cary, North Carolina.

Shively, D., C. Allen, T. Alsbury, B. Bergamini, B. Goehring, T. Horning and B. Strobel. 2007. Clackamas River Bull Trout Reintroduction Feasibility Assessment. Published by USDA Forest Service, Mt. Hood National Forest for the Clackamas River Bull Trout Working Group. Sandy, Oregon.

U.S. Fish and Wildlife Service 2002. Chapter 5, Willamette River Recovery Unit, Oregon. U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon**:** 96 pp.

U.S. Fish and Wildlife Service. 2008. Bull Trout Recovery: Monitoring and Evaluation Guidance. Report prepared for the U.S. Fish and Wildlife Service by the Bull Trout Recovery and Monitoring Technical Group (RMEG). Portland, Oregon. 74 pp.

U.S. Fish and Wildlife Service. 2011. Stepwise Impact Reduction Plan, Amendment to the 12/10/2010 Biological Assessment on the Reintroduction of Bull Trout to the Clackamas River. U.S. Fish and Wildlife Service. Portland, Oregon. 8 pp.

U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife and U.S. Forest Service. 2011. Clackamas River Bull Trout Reintroduction Implementation, Monitoring and Evaluation Plan. U.S. Fish and Wildlife Service. Portland, Oregon. 63 pp.

Zimmerman, M. P. 1999. Upper Clackamas River basin bull trout surveys, 1998–1999. Oregon Department of Fish and Wildlife. Clackamas, Oregon.

Appendix A: Key Information, Decisional and Coordination Meetings

Meeting Date	Offices Present	Primary Discussion Topics and Outcomes
1. Technical Assistance: a) Reintroduction Permitting		
Jan. 26, 2010	OFWO, CRFPO, PGE	• **10(j) Rule:** Discussed forthcoming comments on the proposed 10(j) rule (Dec. 9, 2009) and accompanying draft EA. PGE expressed support of the reintroduction project, but had two concerns: 1) what does the project mean to listed anadromous salmonids in the basin (which are still declining), and 2) how is Project success defined and measured? Results: OFWO recognizes that there are unanswered questions about the potential effects of a reintroduction; the Service is willing to work with PGE to address concerns during the project development process.
Sept. 2, 2010	OFWO, ODFW, CRFPO, USFS, TU	• **Clackamas Subbasin Fish Management Plan:** Oregon Fish and Wildlife Commission Meeting – proposal to amend the Clackamas subbasin fish management plan and reintroduce bull trout was passed, with one year of support from the Confederated Tribes of the Warm Springs Reservation.
Mar. 23, 2010	OFWO, CRFPO, ODFW, NMFS	• **Section 7 Pre-Consultation:** Met to discuss agency roles, and how the Project would be implemented, and its potential effect to listed salmonids. NMFS needs assurances of long-term M&E, and actions that would be taken if the Project's impacts were too great. Also expressed concern about the introduction of adults. CRFPO is leading development of M&E program. Off-ramps are being developed by the Service. Implementation strategy still needs to be defined, along with how to assess potential effects on listed salmonids.
April 30, 2010	OFWO, CRFPO, PGE, NMFS	• **Section 7 Pre-Consultation:** Met to discuss Project information needs, timing, locations and feasibility associated with assessing interactions between bull trout and salmon/steelhead relative to PGE's hydroproject and Settlement Agreement. Also outlined potential impact scenarios that would trigger management or mitigation measures on the Service's part from the bull trout reintroduction. The Service is refining an exit strategy for the Project, and ways to assess impacts (e.g., effective tagging, bioenergetics modeling, etc.).
June 17, 2010	OFWO, CRFPO, DC, NMFS	• **Section 7 Pre-Consultation:** Continued discussions about Project implementation and monitoring. NMFS and PGE support moving fry only; want an improved risk assessment with predation studies and bioenergetics analysis of worst-case scenarios. The Service is drafting a decision framework for assessing risk to listed salmonids, and will take NMFS and PGE's concerns and recommendations into consideration when developing Project details.

Meeting Date	Offices Present	Primary Discussion Topics and Outcomes
Jan. 21, 2011	OFWO, CRFPO, NMFS	● **Section 7 Consultation:** Discussed adequacy of the BA for consultation, and the consultation timeline. NMFS needs information on measuring survival of salmonids in NF reservoir, the benefits of moving all three life history phases, clarification on the adaptive management strategy. NMFS will talk with Science Center staff for their input on the Project. Result: the Service will provide more details, including metrics used to assess impacts, and M&E specifics.
Feb. 15, 2011	OFWO, CRFPO, NMFS	● **Section 7 Consultation:** NMFS was prepared to determine that the Project jeopardizes the listed stocks in the Clackamas based on stock health, life history stages proposed (adults), and deficiencies in the M&E program (i.e., difficult to measure impacts on listed salmonids). Result: NMFS will provide information on an allowable level of take; the Service will continue to elucidate a decision framework about off-ramps and triggers.
Mar. 4, 2011 (conference call)	OFWO, CRFPO, NMFS	● **Section 7 Consultation:** Further discussion was had about triggers that would alter or stop the Project; triggers should be based on both bull trout and prey populations, and should include early warning signals. If NMFS is going to call jeopardy, they need to provide evidence of why. Result: the Service will continue to refine Project triggers and off-ramps.
Mar. 15, 2011	OFWO, CRFPO, NMFS	● **Section 7 Consultation:** NMFS again asked the Service if the Project can be reduced the first years and then ramp up once some information about potential impacts to listed salmonids is obtained. The Service has already reduced the project (e.g., number of adults). Results: the Service produced a first draft of the Stepwise Impact Reduction Plan (SIRP) that will be reviewed by NMFS.
Mar. 31, 2011	OFWO, CRFPO, NMFS	● **Section 7 Consultation:** NMFS is trying to gain clarification on the current trend of listed stocks in the Clackamas, and determine whether partnering agencies support the Project. Result: the Service requested that NMFS write up remaining questions for the Service so that they can be researched and answered. NMFS will determine in one week whether or not the consultation needs to be elevated to senior managers.
May 9, 2011	OFWO, CRFPO, ODFW, NMFS	● **Section 7 Consultation:** Reviewed the draft SIRP with NMFS, and discussed monitoring – will upload data 2 times per week during peak migration periods. BO completion target is May 27. CRFPO (Koski) to run "worst case" bioenergetics simulations for NMFS.

Meeting Date	Offices Present	Primary Discussion Topics and Outcomes
1. Technical Assistance: b) Reintroduction Implementation and Agency Coordination		
Nov. 9, 2009	OFWO, CRFPO, USFS, ODFW, USGS, U-of-W, NMFS, Grd Rnd, CTWSRO, PGE	● **Implementation and M&E Meeting:** Nearly all stakeholders met to refine the implementation strategy, define M&E goals, discuss agency roles, and discuss funding. Permitting still needs to be completed (10j rule, NEPA, CTWSRO Tribal Council review, NMFS section 7, ODFW Fish and Wildlife Commission). Result: Existing draft IM&E plan needs more definition and consensus on implementation and M&E components, as well as prioritization of M&E questions. Need to approach this from an experimental approach and consider the adaptive management aspects of the project.
Dec. 15, 2009	OFWO, CRFPO, Abernathy, ODFW, USFS	● **Implementation and M&E Meeting:** Discussed primarily the use of differing life history stages, and discussed priority monitoring actions based on those life history stages. Koski and Whitesel walked through their "sequential questions" document to guide the discussion. Result: three alternatives for using varying life history stages will be written based on the conversation.
Jan. 7, 2010	OFWO, CRFPO, FWS-Bend, USFS, ODFW	● **Implementation Meeting:** Met to discuss several logistical aspects of Project implementation, including funding, disease screening protocols, donor stock collection, tagging and detection systems, fish transfer protocols, and fish release protocols.
April 15, 2010	OFWO, CRFPO, ODFW, USFS, NMFS, PGE	● **Manager's Meeting:** Chairs from the Implementation and M&E committees met with the managers to provide an update on Project status. Because administrative hurdles (permitting) had not been cleared, implementation will likely not occur in 2010. The Service will work with NMFS and PGE to address their concerns about the Project. PGE and ODFW are concerned about sustainable funding over the 20 year life of the Project; a stable funding source needs to be identified.
May 27, 2010	OFWO, CRFPO, ODFW	● **Implementation Meeting:** The Service met with ODFW to address their remaining concerns about the Project, including using older fish in the reintroduction, their proposed numbers, and impacts to listed anadromous salmonids. Also discussed the current status of permitting and section 6 funding for an ODFW coordinator position.
June 24, 2010	OFWO, CRFPO, USFS, USGS	● **Implementation and M&E Field Trip:** We drove up to the Clackamas basin and visited potential release sites in all six habitat patches. It was decided that juveniles would be released in two patches, to be determined by a PVA looking at habitat differences between patches (CRFPO will do). Stocking would be continued in those patches for two consecutive years, then shifted to two other

Meeting Date	Offices Present	Primary Discussion Topics and Outcomes
		patches. Release locations within patches were scouted and identified; also discussed the logistics of tagging and moving fish from the Metolius, and monitoring with PIT tag arrays/mobile readers.
July 21, 2010	OFWO, CRFPO, FWS-Bend, ODFW, PGE, USFS, NMFS	• **Implementation and M&E Meeting:** Technical meeting to refine details of implementation and monitoring strategies; prepare for fish transfers in spring / summer 2011. Result: determined final numbers and sizes of fish to be transferred (1000 juveniles 100-250 mm; 30 subadults 250-450 mm; and 30 adults 450-650 mm). Discussed collection periods for each life stage, and translocation details (which patches, how to seed, release locations). Monitoring: discussed occupancy surveys for juveniles and coordinating with PGE to use information they will be collected to monitor adults and subadults. Need to determine funding and agency responsibilities for monitoring activities.
Oct. 15, 2010	OFWO, CRFPO, RO, reps from stakeholder groups	• **Stakeholder Field Trip:** We took managers and staff from all stakeholder agencies (i.e., the RO, ODFW, USFS, NMFS, PGE, CTWSRO, USGS) on a guided tour of the upper Clackamas Basin to discuss Project implementation, and M&E strategies. We stopped at several potential release sites and compared habitat patches.
Nov. 30, 2010	OFWO, CRFPO, Abernathy, ODFW, USFS, CTWSRO, NMFS, PGE	• **Implementation Meeting:** The Implementation Committee was provided updates on administrative tasks (i.e., permitting), and given an update on the draft IM&E Plan along with prioritized monitoring questions and respective implementation needs and a preliminary schedule (Koski). Results of pathogen screening were discussed, along with future screening requirements. Agency roles and responsibilities were discussed for both the Implementation and M&E committees. Also presented were AIS protocols, Project funding needs and sources, and donor collection logistics.
Apr. 18, 2011	OFWO, CRFPO, Abernathy, FWS-Bend, ODFW, USFS, CTWSRO, PGE	• **Implementation Meeting:** Firmed up details for the oncoming field season. Reviewed agency roles and responsibilities, provided status of IM&E Plan, implementation timeline (June and July); donor collection, transfer locations and methods; and funding for personnel and equipment needs.
April 19, 2011	OFWO, CRFPO, ODFW, USFS, NOAA/NMFS	• **Manager's Meeting:** Provided Manager's Committee with Project update – status of permitting, implementation schedule, and primary monitoring components. Reviewed agency roles and responsibilities, and funding. Discussed the ESA consultation with NMFS, reviewing the BA and STEP, and timeline for completion.

Meeting Date	Offices Present	Primary Discussion Topics and Outcomes
2. M&E Committee: a) Committee Development and Intra-Service Coordination		
Sept. 21, 2009	CRFPO, OFWO	• **Coordination Meeting:** Initial meeting with OFWO to discuss current status of Project, and immediate needs. CRFPO provided extensive comments on the draft Implementation and Monitoring Plan, which was initially an appendix in the draft EA. CRFPO reiterated the need for a more detailed, stand-alone plan that emphasizes the experimental nature of the Project, complete with goals, objectives, methods, etc.
Jan. 21, 2010	CRFPO, OFWO	• **Coordination Conference Call:** Primarily discussed funding possibilities for monitoring needs. CRFPO proposed that C. Allen or M. Koski could coordinate Implementation and Monitoring programs such that an ODFW coordinator position would be unnecessary at this time, resulting in more funding for equipment. However, the budget needs to be fleshed out prior to CRFPO requesting funds for monitoring from the RO Fisheries program.
Feb. 3, 2010	CRFPO	• **Internal Briefing Meeting:** Met to brief Schaller on current Project status: remaining questions about life stages to be used, details of the implementation plan, proposed development of two committees (implementation and M&E), and potential impediments.
Mar. 20, 2010	CRFPO, OFWO	• **Coordination Meeting:** Met to discuss the cooperative approach document crafted to define roles of OFWO and CRFPO, and give an update on Project status. Also touched on how to move forward given PGE and NMFS comments on the proposed rule and draft EA.
June 22, 2010	CRFPO, OFWO	• **Coordination Meeting:** Discussed the current status of the IM&E Plan, and its incorporation into the BA. We decided to divide the M&E Program into two elements: 1) effectiveness of the bull trout reintroduction, and 2) the effect of the Project on other species. Also discussed working with PGE and ODFW to initiate PIT tag studies regarding salmon survival through the hydroproject, and bioenergetics modeling to estimate how much BT could potentially predate upon listed stocks. Started to refine M&E questions to shape the M&E Program.
Aug. 4, 2010	CRFPO, RO	• **Briefing Presentation:** Gave a brief presentation to the new Fisheries ARD (R. Hannan) outlining the reasons for the Project, the general implementation and M&E strategies, and current status.
Sept. 22, 2010	CRFPO, OFWO	• **Coordination Meeting:** Update on Project status (see permitting issues above). Also discussed IM&E Plan development, specifically

Meeting Date	Offices Present	Primary Discussion Topics and Outcomes
		funding for identified M&E budget needs. Briefly discussed the implementation design and M&E strategy.
Oct. 5, 2010	CRFPO, RO	• **Internal Briefing Meeting:** Met with managers at the RO to update them on the coordination between OFWO and CRFPO, as well as provide an update on the Project status. CRFPO provided a Project timeline (past and anticipated future benchmarks), the OFWO and CRFPO Cooperative Approach Agreement, and prioritized questions for the three aspects of the M&E Program (donor stock status, reintroduction effectiveness, and impacts to listed salmonids).
Oct. 29, 2010	CRFPO, OFWO	• **Coordination Meeting:** Discussed the need to be explicit in the BA and EA about what will be monitored by the Project regarding impacts to listed anadromous salmonids. Also discussed FY2011 funding – what is in place, and what is needed. CRFPO volunteered to monitor juveniles translocated to the Clackamas. Reviewed the prioritized M&E questions for monitoring donor stock, reintroduction effectiveness, and impacts to listed salmonids.
Mar. 8, 2011	CRFPO, OFWO	• **Coordination Meeting:** Discussed the details of monitoring each life stage that will be reintroduced to the Clackamas: advantages, disadvantages, potential level of impact on listed species, and likelihood of successful establishment.
2. M&E Committee: b) Reintroduction M&E Program (See also joint Implementation and M&E Meetings in section 1.a above.)		
Sept. 21, 2010	CRFPO, OFWO, Abernathy, ODFW, USFS	• **M&E Conference Call:** After reviewing the draft IM&E Plan, the M&E committee discussed the additional detail that was still missing from the monitoring section. Prioritization of things that the Project is required to do, vs. what would be interesting to do, should be clear. Elements for M&E should be divided into must do, plan to do, and hope to do categories.
Oct. 27, 2010	CRFPO	• **Internal M&E Meeting:** CRFPO staff met to discuss drafted priority questions for each of the three Project phases. Within each phase, donor stock monitoring, reintroduction effectiveness, and impacts to listed anadromous salmonids have to be addressed. Questions for each were refined.
Dec. 22, 2010	CRFPO, OFWO, ODFW, USFS	• **M&E Meeting:** Core M&E committee staff met to define agency roles and responsibilities. The primary questions that need to be addressed during phase 1 of the Project were reviewed, and corresponding Project components were discussed per handouts. Available funds, equipment and personnel (along with resource needs) were identified for each agency. ODFW committed to

Meeting Date	Offices Present	Primary Discussion Topics and Outcomes
		leading most of the on-the-ground monitoring, with assistance from the USFS; CRFPO will monitor juveniles with ground surveys and house a database for all Project data collected.
Jan. 6, 2011	CRFPO, OFWO, Abernathy, ODFW, PGE, USFS, CTWSRO	• **M&E Meeting:** The larger M&E committee met to discuss final details of the M&E portion of the IM&E Plan. Specific questions were asked of PGE regarding how lead Project agencies could work with PGE to effectively monitor impacts to listed salmonids, and to clarify comments that PGE had submitted on the M&E plan previously. Details were also refined for genetics monitoring, and juvenile monitoring ground surveys.
Feb. 1, 2011	Univ. WA, OFWO, CRFPO	• **Food Web Study Meeting:** Members of the Implementation and M&E committees met with Dave Beauchamp to discuss the results of his baseline food web study that was conducted in the Clackamas basin. It is undetermined whether this study will be repeated in the future; however, this information will be useful for preliminary bioenergetics modeling. Food web studies for juvenile rearing habitat should be conducted to get a sense of the "whole picture".

Appendix B: Clackamas Bull Trout USFWS Cooperative Approach

United States Department of the Interior

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Clackamas River Bull Trout Reintroduction
OFWO and CRFPO Cooperative Approach

March 23, 2010

The successful reintroduction of bull trout to the Clackamas River will require a coordinated approach from contributing U.S. Fish and Wildlife Service (Service) offices. Implementation of reintroduction activities and subsequent monitoring and evaluation are intimately linked, so Service teams must move together in a compatible fashion. The intent of this document is to: 1) clarify roles and responsibilities and enhance the coordination between the Oregon Fish and Wildlife Office (OFWO) and the Columbia River Fisheries Program Office (CRFPO); 2) increase the scientific rigor, merit, and appropriateness of the Clackamas River Bull Trout Reintroduction Project ("Project"); and 3) better position the Service to utilize the collective expertise of its personnel for the success of this project and the utility of reintroduction approaches for the recovery of bull trout.

The overall goal of the Project is to re-establish a self-sustaining bull trout population in the Clackamas River basin, making progress within specific time frames. To accomplish this goal, OFWO and CRFPO, together with the Oregon Department of Fish and Wildlife (ODFW), U.S. Forest Service (USFS) and other project partners, must work cooperatively to 1) define success for the Project (both overall and at specific benchmarks); 2) establish an implementation, monitoring, and evaluation strategy that allows for adaptive management of the Project to increase the chances of success; and 3) address administrative responsibilities and logistical details. This Project provides an opportunity to not only restore a native fish to its formerly-occupied habitat, but to learn from our successes and failures, and provide guidance to similar recovery efforts for bull trout and other fish species. This document outlines the roles of OFWO and CRFPO in accomplishing the above three objectives so that the Project can be implemented and maintained in an efficient and structured approach.

Administrative Tasks
Within the context of the three objectives above, the following administrative tasks must be completed before bull trout reintroduction in the Clackamas River can be fully initiated:

1. Issuance of a Biological Opinion from NOAA
2. Approval from CTWSRO Tribal Council to utilize bull trout from the Metolius River as donor stock
3. Approval by Oregon Fish and Wildlife Commission to modify the Clackamas Subbasin Plan
4. Annual Disease screening mandated by ODFW
5. Development of detailed Implementation, Monitoring, and Evaluation plan(s)
6. Publication of the final 10(j) rule for designating an experimental nonessential population
7. Completion of NEPA (finalization of EA and ROD)

Collectively, OFWO and CRFPO personnel have substantial technical and regulatory knowledge that can be utilized to accomplish the above tasks and achieve Project goals. Three committees have been formed to address project needs:

- Manager's Committee
- Implementation and Logistics Committee
- Monitoring and Evaluation Committee

The chairs of the Implementation and Logistics Committee and the Monitoring and Evaluation Committee will act as liaisons to convey information and issues of concern to the Manager's Committee. It is anticipated that OFWO personnel will initially chair the Implementation and Logistics Committee and CRFPO personnel will chair the Monitoring and Evaluation Committee. After one year (i.e., at a pre-determined annual date), each committee will decide to either retain the existing chair-person or elect a new one. These two committees will coordinate planning, implementation, monitoring, evaluation and reporting activities that are consistent with a pre-determined understanding of each office's roles and responsibilities. Project implementation and monitoring / evaluation are tied together in many aspects of this Project (e.g., adaptive management), and one must be considered before moving forward with the other. The OFWO Project Leader will chair the Manager's Committee, which is consistent with how this committee has operated in recent years.

OFWO: The OFWO will chair the Implementation and Logistics Committee, which will be responsible for the administrative, regulatory permitting, planning and logistical details of implementing the actual reintroduction. OFWO, as an Ecological Services field office, will be responsible for completing regulatory requirements associated with this project (e.g., any annual permitting required, as well as disease clearances, inter-agency coordination relative to implementation, etc.). As a lead office for this project, OFWO will also largely be responsible for obtaining other required approvals (i.e., items 1-7 above). The Implementation and Logistics Committee will be tasked with working out the logistical details of project implementation, such as determining staffing needs; which cooperating agencies will contribute to Project implementation and monitoring and in which ways; identifying specific locations and methodology of fish collection, marking, transport, and short-term holding (if necessary); and obtaining funding for project needs.

CRFPO: The CRFPO will chair the Monitoring and Evaluation Committee and will be responsible for leading the development of the Monitoring and Evaluation plan. As stated above, Project implementation (i.e., initial implementation as well as future reintroduction actions) is closely tied to monitoring and evaluation, such that the results of implementation actions will be used to guide subsequent reintroduction plans and tasks. CRFPO personnel will guide the Committee (which is comprised of members from several cooperating agencies such as ODFW and the USFS) in developing a scientifically sound plan (thus addressing item 5 above) and providing guidance to the Implementation and Logistics Committee for coordinating implementation logistics. The plan will emphasize an experimental approach (by definition and nature) to bull trout reintroduction so that, through monitoring and evaluation, we can determine why the reintroduction, or aspects of the reintroduction, worked or did not work. The goals of the plan will be two-fold: 1) to re-establish a viable population of bull trout in the Clackamas River Basin, and 2) use an experimental design that will inform both adaptive management and other reintroduction programs in the future (i.e., White Salmon). In doing so, the plan will outline an adaptive management framework through which the program will most likely achieve success. The Monitoring and Evaluation Committee will review results of monitoring efforts to determine the most appropriate subsequent actions for the reintroduction program, and will provide recommendations to the Implementation and Logistics Committee for implementing those actions.

It is anticipated that the OFWO and CRFPO will work together to accomplish specific tasks, including providing assistance in the duties of the Implementation Committee and the Monitoring and Evaluation Committee. Both are involved in different, yet overlapping, aspects of Project implementation, and thus must work together to reach consensus on how tasks will be accomplished. For example, while the CRFPO might take the lead in developing the Monitoring and Evaluation Plan, the OFWO would have input to the plan, and review and provide feedback on consistency with the NOAA BO, other agreements, and cost feasibility. Similarly, both the OFWO and the CRFPO will seek and provide supplementary funding to aid in monitoring and evaluation activities.

OFWO and CRFPO leads will coordinate and represent the ideas and conclusions of their respective committees as Project development progresses. Through their respective roles, Project success will be specifically defined; an Implementation, Monitoring, and Evaluation Plan will be developed and refined as the Project progresses; and annual logistical planning, interagency coordination and administrative tasks will be accomplished in a defined manner.

It is expected that the cooperative approach outlined above will facilitate and guide the working relationship between the OFWO and CRFPO for the duration of the Clackamas River Bull Trout Reintroduction Project. However, if a future modification to the cooperative approach is warranted it will be at the discretion of the OFWO and CRFPO project leaders.

Paul Henson, PhD
Project Leader, OFWO

Howard Schaller
Project Leader, CRFPO

Appendix C: Clackamas Bull Trout M&E Committee Members

M&E Committee Member	Agency	Contact Information
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* Indicates core M&E team members

Appendix D: Clackamas Bull Trout Reintroduction IM&E Prioritized Questions and Field Actions

There are three main questions that we will try to assess during the three phases of the reintroduction project:

1) Can the Metolius basin bull trout population continually be an appropriate donor stock for the Clackamas reintroduction;
2) Can a self-sustaining population of Clackamas bull trout be re-established by translocating fish from the Metolius basin; and
3) Does the reintroduction of bull trout have a significant negative impact on the recovery of listed salmonids also in the basin?

	Donor Stock Status (Implementation)	Clackamas Bull Trout Reintroduction Effectiveness (M&E)	Impacts to Listed Salmonids (M&E)
Phase 1: Years 1-7	D1. Does the donor stock population have the minimum threshold number of spawning adults required to continue donor stock removal? D2. Is the donor population disease-free?	B1. Do translocated adult and subadult bull trout remain in the upper Clackamas Basin (above River Mill Dam)? a. If yes, what is their seasonal distribution? b. If yes, is there evidence of spawning activity? If no, does changing the release timing/location provide a different result? B2. Do juveniles remain in the habitat patches they are outplanted to in the short-term or do they move relatively quickly out or into other habitat patches? a. If they stay, how are juveniles distributed within habitat patches? B3. Which translocated life stages are successful in contributing naturally produced progeny in the Clackamas River? a. Do adults and subadults produce progeny in years 1-3 (and beyond)? b. Do translocated juveniles mature to produce progeny in years 4-7? B4. Is the level of genetic variation in the donor population adequately represented by translocated fish (years 4-7)?	S1. Do adult and subadult bull trout occupy High Vulnerability Zones (HVZs) during smolt migration periods in which they could consume particularly high numbers of juvenile salmon and steelhead? a. If yes, does listed salmonid production during the freshwater phase decrease relative to historic estimates of freshwater productivity? b. If the freshwater productivity of listed salmonids decline, could bull trout be responsible for the magnitude of decline observed (i.e., bioenergetics analysis and life cycle modeling)?

	Donor Stock Status (Implementation)	Clackamas Bull Trout Reintroduction Effectiveness (M&E)	Impacts to Listed Salmonids (M&E)
Phase 2: Years 8-15	D3. Does the donor stock population have the minimum threshold number of spawning adults required to continue donor stock removal? D4. Is the donor population disease-free? D5. Are there any indications of deleterious impacts (genetic fitness or population abundance) to the donor population from removing individuals for translocation?	B5. What is the estimated population size of the reintroduced population? B6. Is the level of genetic variation in the donor population adequately represented by the Clackamas population? B7. What habitats do naturally produced and translocated bull trout utilize for spawning and rearing? B8. What life history strategies do naturally produced fish in the Clackamas exhibit? B9. How has the food web changed as a result of reintroducing bull trout into the Clackamas River basin?	S2. Do adult and subadult bull trout occupy areas in the PGE hydroproject during smolt migration periods in which they could consume particularly high numbers of juvenile salmon and steelhead? S3. What is the estimated level of bull trout predation on juvenile salmon and steelhead? S4. Are there potential indirect food-web effects of bull trout on salmon and steelhead?
Phase 3: Years 16 - 21	D6. Does the donor stock population have the minimum threshold number of spawning adults required to continue donor stock removal? D7. Is the donor population disease-free? D8. Were there long-term detrimental impacts (genetic fitness or population abundance) to the donor population from removing individuals for translocation?	B10. Is the level of genetic variation in the donor population adequately represented by the Clackamas population? B11. What is the effective population size and trend? B12. What is the structure of the Clackamas bull trout population?	S5. Do adult and subadult bull trout occupy areas in the PGE hydroproject during smolt migration periods in which they could consume particularly high numbers of juvenile salmon and steelhead? S6. What is the estimated level of bull trout predation on juvenile salmon and steelhead? S7. Are there potential indirect food-web effects of bull trout on salmon and steelhead?

Clackamas Bull Trout Reintroduction Summary of Design and Implementation Needs for FY 2011

PROJECT PHASE 1: Years 2011 – 2017

Project Component	Study Question Addressed	Time Frame
Implementation		
Monitoring of the donor population - Redd surveys throughout Metolius subbasin - Creel surveys in Lake Billy Chinook - Outmigrant screw-trap in Metolius River at Monty - Juvenile BT density monitoring at index reaches in spawning streams	D1	Ongoing annually, will continue throughout the life of the project
Disease screening for IHNV - Performed by the ODFW Fish Health Services labs in Madras or Corvallis - Will require 60 ripe bull trout adult (nonlethal) and 150 fry (lethal)	D2	Every year starting in 2009; adults – fall prior to translocation, fry – spring of translocation
Adult and subadult (>250 mm) collection from the Metolius basin (see also tagging, below) - Collected from Metolius arm of Lake Billy Chinook - Angling, collection at Round Butte Dam		May and June, starting 2011
Juvenile (<250 mm) collection from the Metolius basin (see also tagging, below) - Collected from the mainstem Metolius and tribs - Snorkel herding, seining, electrofishing		May and June, starting 2011
Hold fish prior to transport to the Clackamas basin - Adults and subadults: holding tanks at Round Butte Fish Isolation Facility - Juveniles: holding tanks at Round Butte Fish Isolation Facility		May and June, starting 2011
Transport fish to the Clackamas basin		May and June, starting 2011
Release fish in Clackamas basin - Adults and subadults: Big Bottom - Juveniles: Big Bottom and upper basin patches (1-6) rotationally, 500 in each of two patches per year		May and June, starting 2011 2011-2012: Pinhead and Cub/Berry 2013-2014: Rhodo and Upper Clack 2015-2016: Hunter and Big Bottom

Project Component	Study Question Addressed	Time Frame
Monitoring and Evaluation		
Half-duplex PIT tag all fish collected from the Metolius - Tag upon catch; use 23 mm tags for fish > 120 mm, use 12 mm tags for fish < 120 mm - Dorsal sinus for fish > 300 mm; body cavity for < 300 mm	B1.a-b, B2.a, S1	May and June, starting 2011 through all translocation years
Radio-tag all adults and subadults collected from the Metolius basin - Tag upon catch from Lake Billy Chinook - Maximize battery duration, using tag size dependent on fish size (2+ years battery life)	B1.a-b, S1	May and June, starting 2011 through 2012
Install fixed-station radio antennas in the Clackamas basin to track movements of adults and subadults (listed in order of priority): - Below River Mill Dam (1) - Head of North Fork Reservoir (2) - North Fork Reservoir collector (3) - Collawash confluence (4) - On Clack at Last Creek (5)	B1.a-b, S1	Install spring 2011, upload data every 7-10 days April – Dec. starting 2011 through life of batteries (may be less in winter depending on movement). During peak migration times (Apr. 15 – June 15 and Oct. 15 – Dec. 15) data will be uploaded 2 x/wk, with a minimum of 1 x/wk.
Install half-duplex PIT tag arrays in the Clackamas basin to track all translocated fish: - At mouths of patches 2-6 tributaries (Fork of Last/Pinhead, Fork at Upper Clack/Cub-Berry, Hunter, Rhodo) and in the downstream bypass of the hydrofacilities	B1.a-b, B2.a, S1	Install spring 2011, upload data every 7-10 days April – Dec. starting 2011 through life of batteries (may be less in winter depending on movement).
Look for evidence of spawning: - Assess radio and PIT tag data that may indicate fish moving to spawning habitat - Mobile tracking: ground and/or aerial tracking during spawning season (opportunistic observation of presence of redds or actively spawning fish)	B1.a-b	Mobile radio tracking: in conjunction with antennae maintenance, dependent on fish movement (aerial if necessary) Mid Aug – Oct, starting Fall 2011 – through end of Phase 1
Ground-based surveys to detect presence (survival) of juveniles and naturally produced progeny (electrofishing and/or night snorkeling and mobile PIT tag tracking) - GRTS (21 surveys of 50 m reaches per patch per RMEG guidelines) or census the two patches that juveniles were released in each year. - Based on locations of adults, may survey additional patches to survey for progeny	B2.a, B3.a-b	Summer of each year that juveniles are reintroduced, starting 2011 through end of Phase 1
Collect tissue samples for genetic analysis: - Fin clip all fish translocated from the Metolius - Collect fin clips from all unmarked BT found (during electrofishing or night snorkeling surveys) in the Clackamas to assess parentage (and determine which translocated life stage successfully reproduced depending on observed/assumed spawning behavior)	B3.a-b, B4	May – June, starting in 2011 with collection of fish to be translocated and during summer juvenile surveys in years 2 – 7 of Phase 1

Appendix E: Sites sampled and species found in Pinhead Creek 2011

Site	Sample Date	BT Present?	Other Species	Comments
1				Dry
2	9/2/2011	N	CCT, Cottids	
3				Dry
4	8/30/2011	N		
5				Dry
6	9/7/2011	N	CCT, Cottids	
7	9/6/2011	N	Cottids	Many undercuts and three braided channels in site, recorded undercuts along outermost banks
8				Dry
9				Dry
10				Dry
11				Dry
12				Dry
13				Dry
14	9/1/2011	N		Stream goes dry for 6 m in site
15				Dry
16				Dry
17	9/1/2011	N	CCT, Cottids	Braid in site
18				Dry
19	9/7/2011	N	CCT, Cottids	
20				Dry
21	8/30/2011	N		Beaver Dam in site
22	9/9/2011	N	CCT	
23				Dry
24				Dry
25				Dry
26				Dry
27				Dry
28				Dry
29	9/2/2011	N	CCT	
30				Dry
31				Dry
32	9/9/2011	N	CCT, Cottids	
33	9/7/2011	N	CCT, Cottids	Braided channel in site
34				Dry
35	8/30/2011	N		
36				Dry
37				Dry
38	9/8/2011	N	Cottids	High swift water, shocked along banks and side channels
39				Dry
40				Dry
41	9/2/2011	N	Cottids	
42				Dry
43				Dry
44				Dry
45				Dry
46	9/1/2011	N	CCT	
47				Dry
48				Dry
49				Dry
50	9/8/2011	N	Cottids	
51				Dry
52				Dry
53	9/8/2011	N	CCT, Cottids	
54				Dry
55				Dry
56				Dry
57	9/7/2011	N	CCT, Cottids	Braided in channel site
58				Dry
59				Dry
60				Dry
61				Dry
62	9/6/2011	N	CCT, Cottids	
63				Dry
64				Dry
65				Dry
66				Dry
67				Dry
68				Dry
69				Dry
70				Dry
71	9/8/2011	N	CCT, Cottids	

Appendix F: Habitat data from Pinhead Creek sites 2011

Site ID	2	4	6	7	14	17	19	21	22	29	32
Date Sampled	09/02/ 2011	08/30/ 2011	09/07/ 2011	09/06/ 2011	09/01/ 2011	09/01/ 2011	09/07/ 2011	08/30/ 2011	09/09/ 2011	09/02/ 2011	09/09/ 2011
Sampling Crew	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP, JL	BPS, CM, MP	BPS, CM, MP, JL
% Gradient	7.5	4.67	4	2.66	12.5	4	4	2.5	5.6	4	5
% Canopy Cover	70	90	75	40	95	60	75	45	40	80	60
BT Present?	N	N	N	N	N	N	N	N	N	N	N
# CCT	3	0	2	0	0	5	4	0	5	1	1
E-Fisher Volts	350	350	350	350	350	350	350	350	350	350	350
E-Fisher Duty Cycle (%)	16	14	16	16	14	14	16	14	16	16	16
E-Fisher Hz	24	24	24	24	24	24	24	24	24	24	24
E-Fisher Seconds	171	107	336	838	88	401	222	131	444	161	321
Temperature (°C)	9	11	9	7	7	6	8	9	7	7	6.5
Conductivity (µs)	30	20	60	60	30	60	60	10	60	60	60
Time Start	14:00	13:30	12:53	10:59	10:40	13:54	10:06	10:52	11:00	9:35	9:40
Time End	14:50	14:23	13:49	12:45	11:22	15:09	10:53	11:45	11:47	10:30	10:43
Reach Length (m)	50	50	50	50	50	50	50	50	50	50	50
# Pools in Reach	2	2	0	0	0	2	0	1	0	0	0
#LWD >3 m and > 10 cm	17	3	28	54	11	16	16	18	28	10	14
# LWD Piles	2	1	4	22	0	3	1	1	5	1	4
# Large LWD Pieces	2	0	6	14	0	2	0	1	2	0	2
# Root Wads	2	0	2	6	0	5	0	0	3	1	2
Mean Depth (m)	0.12	0.05	0.28	0.43	0.05	0.27	0.24	0.09	0.27	0.15	0.23
Mean Wetted Width (m)	1.7	1.3	8.1	45.7	1.5	10.4	8.5	1.4	11.7	2.8	10.3
Mean Bankfull Width (m)	2.9	3.5	9.4	46.6	2.0	11.0	9.2	2.8	11.9	3.9	11.5
% Undercut Banks	8.0	1.5	31.5	95.0	18.0	57.5	25.0	3.8	31.0	25.0	46.0

Site ID	33	35	38	41	46	50	53	57	62	71
Date Sampled	09/07/2011	08/30/2011	09/08/2011	09/02/2011	09/01/2011	09/08/2011	09/08/2011	09/07/2011	09/06/2011	09/08/2011
Sampling Crew	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP	BPS, CM, MP
% Gradient	6.3	4	2	6	3.5	4	2.5	4	3.33	2
% Canopy Cover	77	75	30	80	85	35	50	75	70	35
BT Present?	N	N	N	N	N	N	N	N	N	N
# CCT	1	0	0	0	4	0	2	2	1	5
E-Fisher Volts	350	350	350	350	350	350	350	350	350	350
E-Fisher Duty Cycle (%)	16	14	16	16	16	16	16	16	16	16
E-Fisher Hz	24	24	24	24	24	24	24	24	24	24
E-Fisher Seconds	285	104	305	281	232	219	291	345	155	396
Temperature (°C)	8	9	7	7	9	8.5	8	8	8	8
Conductivity (µs)	60	20	60	60	50	50	60	60	30	50
Time Start	14:08	12:27	10:28	11:00	11:49	13:00	9:17	10:53	9:44	14:50
Time End	15:20	13:09	11:46	12:00	12:37	13:46	10:13	12:21	10:22	15:53
Reach Length (m)	50	50	50	50	50	50	50	50	50	50
# Pools in Reach	0	1	0	0	0	0	0	0	1	1
#LWD >3 m and > 10 cm	45	6	25	21	15	16	10	17	15	12
# LWD Piles	4	1	7	4	2	1	2	3	4	3
# Large LWD Pieces	7	0	3	2	2	1	1	3	1	0
# Root Wads	4	0	3	2	1	2	1	3	1	0
Mean Depth (m)	0.23	0.10	0.46	0.20	0.07	0.50	0.29	0.24	0.05	0.32
Mean Wetted Width (m)	14.1	2.0	15.0	8.3	1.6	14.7	7.8	8.5	1.3	9.3
Mean Bankfull Width (m)	15.3	3.2	15.8	9.3	2.4	15.0	8.6	9.2	3.0	9.3
% Undercut Banks	41.5	0.25	65.0	27.0	8.0	79.0	28.0	15.0	3.0	88.0

Appendix G: Summary of Bioenergetic Simulation Scenarios

BT Life Stage[1]	Scenario Intensity[2]	Thermal Regime[3]	Start Length[1], mm	End Length[1], mm	Mass of Salmonids (all spp) Consumed, g, per year[4]	# of Listed Salmonids Consumed, per year[5]	No. of Bull Trout (no mortality)[6]	Total # of Listed Salmonids Eaten per Year[7]
Adult	Max consumption rate all year (p=1), eating 100% salmonids	High	550	1098	40571	351	30	**10529**
		Low	550	1026	30546	264	30	**7927**
Adult	Limited consumption rate (p = 0.3-0.6), eating 100% salmonids	High	550	699	5464	47	30	**1418**
		Low	550	670	4422	38	30	**1148**
Adult	Limited consumption rate (p = 0.3-0.6), eating limited % (35-75%) salmonids	High	550	689	2126	18	30	**552**
		Low	550	661	1688	15	30	**438**
Subadult	Max consumption rate all year (p=1), eating 100% salmonids	High	350	891	19024	165	30	**4937**
		Low	350	809	13422	116	30	**3483**
Subadult	Limited consumption rate (p = 0.3-0.6), eating 100% salmonids	High	350	462	1726	15	30	**448**
		Low	350	435	1372	12	30	**356**
Subadult	Limited consumption rate (p = 0.3-0.6), eating limited % (35-75%) salmonids	High	350	453	666	6	30	**173**
		Low	350	427	519	4	30	**135**

[1] Bioenergetics scenarios were performed for both adults and subadults. For the purposes of the Clackamas bull trout reintroduction project, subadult bull trout were 250 – 450 mm (the starting length is the average, 350 mm), and adult bull trout were 450 – 650 mm (the starting length is the average, 550 mm; no bull trout over 650 were collected for translocations). To calculate mass, a length-weight regression was calculated for bull trout collected in the Metolius Basin between 2008 and 2010 (M. Harrington, ODFW, unpublished data): mass, g = $(5*10^{-6})$*(length, $mm^{3.1016}$) (R^2 = 0.993). The calculated mass for subadults was 388.7 g, and 1579 g for adults. At the end of the simulation year, the mass of the grown bull trout was then converted back to length (i.e., end length).

[2] Three feeding scenarios at various intensities were considered for both adults and subadults. In the red scenario (the "Worst Case" scenario in Table 1), bull trout fed at their maximum consumption rate all year (p=1), and listed salmonids comprised 100% of their diet. In the blue scenario (the "Moderate" scenario in Table 1), bull trout fed exclusively on listed salmonids at variable rates throughout the year (p=0.3-0.6) based on prey availability; i.e., based on prey abundance and migration timing, bull trout probably feed at around p=0.3 for most of the year, except for during a two-week acute feeding period during the spring smolt migration (p=0.6) (D. Beauchamp, personal communication). In the green scenario (the "More Realistic" scenario in Table 1), consumption rate was determined as in the blue scenario, but bull trout fed on additional prey items such that listed salmonids comprised about 35% of their diet for most of the year, but 75% of their diet during the two-week acute feeding period (other fish and invertebrates made up the other portion of their diet) (D. Beauchamp, personal communication).

[3] Two thermal regimes were considered based on the location of bull trout if they were to stay in North Fork Reservoir year-round. In the "high" scenario, bull trout stayed in the upper 25% of the water column, and in the "low" scenario, bull trout stayed in the lower 25% of the water column. Water temperatures collected through 2008-2009 (D. Beauchamp, unpublished data) were averaged for the upper and lower 25% of the water column and interpolated for months were no data was available.

[4] The total mass of all listed salmonids a single bull trout consumed over the course of the year, based on the scenarios described above.

[5] The total mass of listed salmonids eaten by one bull trout in a single year was converted to number of listed salmonids consumed based on a pooled energy density (5200 J/g wet weight) for Chinook, coho, *O. mykiss*, and unidentified salmonids (Lowery and Beauchamp 2010).

[6] The implementation strategy for years 1 and 2 of the reintroduction program would use 30 adults and 30 subadults per year.

[7] The total number of listed salmonids consumed per year per bull trout was multiplied by the total number of either adult or subadult bull trout reintroduced, assuming no mortality. Table 1 further breaks this total number down for each listed species.

Appendix H: Sequential Series of Questions to Guide Translocation

December 14, 2009
CRFPO, M. Koski and T. Whitesel

Overall objective: Establishment of a self-sustaining (i.e., stable trend in adult abundance over a ten-year period and high level of genetic diversity) bull trout population in the Clackamas River basin within 30 years.

- A primary goal for this program should be to balance production and establishment of bull trout and increase our knowledge of accomplishing successful reintroductions. While reestablishing a bull trout population in the Clackamas basin is a priority, an experimental approach will enable us to learn and inform adaptive management decisions in the Clackamas River and bull trout recovery work range-wide. Monitoring the response of bull trout during program implementation is a necessary task to determine future management actions and evaluate the program's success.

1. Will **several life stages** be initially introduced (see 2), or will only **one life stage** be initially introduced (see 3)?

2. If **more than one life stage** is initially introduced…

    a. Which life stages will be selected for reintroduction, and why (justification)?
    b. How many of each life stage will be reintroduced, and why?
    c. How will monitoring (i.e., of survival, growth, distribution, movement, reproduction) of individuals in separate life stages be distinguished between different treatment groups, or from any progeny in subsequent years?
    d. For additional questions, see 3-8 below…

3. Which life stage will be introduced first and why (justification/pros and cons)? **Adults** (see 4), , **juveniles** (see 5), **fry** (see 6), **embryos** (see 7)?

4. If **adults** are to be initially reintroduced:

    a. How many will be taken from the donor population for reintroduction annually, and why?
    b. When will adults be removed from the population? Will they be held or directly outplanted, and why?
    c. When will the translocation occur (i.e., during what time(s) of the year), and why?
    d. Where will adults be placed in the Clackamas basin, and why?
    e. How will adults be marked, and for what purposes?
    f. Will genetic information be collected from adults prior to translocation?
    g. After translocation, how will the following questions be evaluated?

A) Did translocated adults remain in the Clackamas system? Where in the system did they go?
B) Did they survive?
C) Did they spawn? When? Is it possible to quantify spawning effort?
D) Were offspring produced? How will they be detected?
E) Did offspring survive?
F) Did offspring grow?
G) What is the genetic similarity of initial propagules?
H) What is the genetic similarity of offspring to the donor population?
I) What is the abundance of adults and their offspring?
J) Did offspring mature and spawn?

5. If **juveniles** are to be initially reintroduced:

a. How many will be taken from the donor population for reintroduction annually, from where, and why?
b. When will juveniles be removed from the population? Will they be held or directly outplanted, and why?
c. When will the translocation occur (i.e., during what time(s) of the year), and why?
d. Where will juveniles be placed in the Clackamas basin, and why?
e. How will juveniles be marked, and for what purposes?
f. Will genetic information be collected from juveniles prior to translocation?
g. After translocation, how will the following questions be evaluated?

A) Did translocated juveniles remain in the Clackamas system? Where in the system did they go?
B) Did they survive?
C) How long after translocation did maturation and subsequent spawning occur?
D) Did offspring survive? How will they be detected?
E) Did offspring grow?
F) What is the genetic similarity of the offspring?
G) What is the genetic similarity of offspring to the donor population?
H) What is the population abundance?

6. If **fry** are to be initially reintroduced:

a. How many will be taken from the donor population for reintroduction annually, from where, and why?
b. When will fry be removed from the population? Will they be held or directly outplanted, and why?
c. When will the translocation occur (i.e., during what time(s) of the year), and why?
d. Where will fry be placed in the Clackamas basin, and why?

e. How will fry be marked, and for what purposes?
f. Will genetic information be collected from fry prior to translocation?
g. After translocation, how will the following questions be evaluated?

A) Did translocated fry remain in the Clackamas system? Where in the system did they go?
B) Did they survive?
C) How long after translocation did maturation and subsequent spawning occur?
D) Did offspring survive? How will they be detected?
E) Did offspring grow?
F) What is the genetic similarity of the offspring?
G) What is the genetic similarity of offspring to the donor population?
H) What is the population abundance?

7. If **embryo baskets** are to be initially employed for reintroduction:

a. How many adults will be used to harvest and fertilize eggs, and why?
b. How many embryos will be placed into each basket, and why?
c. How many baskets will be installed in the Clackamas basin, and why?
d. When will egg baskets be installed at receiver sites, and why?
e. Where will the receiver sites be located, and why?
f. Will genetic information be collected from eggs (or their parents) prior to translocation?
g. After translocation, how will the following questions be evaluated?

A) Did embryos hatch?
B) Did fry survive?
C) How will fry survival be detected?
D) Is it possible to measure survival rates for subsequent life stages?

8. If fish have successfully reproduced, when could we expect to be able to detect offspring (i.e., is a 3-5 year window reasonable)?

9. If we do not expect to be able to detect reproduction (or even survival) of fish for 3-5 years, what will happen during this period? Will the original approach continue until adaptive management suggests moving to another strategy?

a. Will the same initial reintroduction scenario (i.e., 2-8) be employed during years 2-5?
b. If not, how will subsequent reintroduction scenarios be chosen?
c. What factors might change the reintroduction strategy during the initial 3-5 years (e.g., health of the Metolius donor population, funding, etc.)?

10. What monitoring (i.e., trapping/tagging) or marking methods will be employed to detect offspring (as opposed to original translocated individuals – all translocated marked, others not)? If all translocated individuals are marked and/or tagged, will naturally spawning individuals be marked or tagged at any point?

11. If no evidence of survival is observed after 3-5 years, what actions will be taken (i.e., what is the next strategy), or will the program be terminated?

    a. How will detection probability be evaluated? How will we know if fish left the system or died, as opposed to being present in low numbers?
    b. Based on detection probability, what is the level of confidence that will be used to conclude that translocation efforts did not succeed?

12. If no evidence of reproduction is observed after 3-5 years, but survival of originally stocked fish is evident, what actions will be taken?

13. After Phase 1 (the initial 7-year management and monitoring phase), what observations will trigger a change in the reintroduction period during Phase 2 of the program?

    a. Would another life stage be more appropriate for reintroduction? Which one(s)?
    b. Does the number of fish transferred need to be adjusted? How?
    c. Is the timing of release appropriate?
    d. Are the release locations suitable? Are fish leaving the release locations for other habitat?
    e. Is there appropriate spawning habitat?
    f. Are further translocations necessary (does the population appear to be established), or can fish transfer be suspended?

14. If a population appears to have been established (i.e., reproduction is evident and individuals are detected), how will success be evaluated?

    a. How will "success" be defined?
    b. How long will post-translocation monitoring efforts continue to ensure long-term success of the program (i.e., how will we know that the habitat can support a BT population beyond the 10-year goal)?
    c. How will a "stable trend in adult abundance" be measured and evaluated? How is a "stable trend" defined?
    d. What is a "high level of genetic diversity" and how will it be measured?

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