Narrative

Table 1. Proposal

Project Number	2008-307-00
Project Name	Deschutes Basin Sockeye
Proposer	Confederated Tribes of Warm Springs Reservation of Oregon
Short Description	Development of a sockeye salmon population in Deschutes Basin
Province(s)	Columbia Plateau
Subbasin(s)	Deschutes River
Contact Name	Brad Houslet, Jeff Hogle, Jens Lovtang, Jen Graham, Cyndi Baker
Contact email	bhouslet@wstribes.org, jeff.hogle@wstribes.org, jlovtang@wstribes.org, jgraham@wstribes.org, cyndi.baker@wstribes.org

Information transfer:

A. **Abstract**

The anadromous form of sockeye salmon *Oncorhynchus nerka* is functionally absent and possibly extinct from the Deschutes River basin. Artificial barriers to fish movement including the Pelton Round Butte Hydroelectric Project (PRB Project) which was completed in 1964 (Nehlsen 1995), are among the factors contributing to sockeye extinction. The PRB Project is owned and operated by Portland General Electric Company (PGE), an Oregon corporation, and the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO). In 2005, the Federal Energy Regulatory Commission (FERC) granted PGE and CTWSRO (the Licensees) a new 50-year operating license (FERC License No. 2030-077). In 2004, a Settlement Agreement concerning the relicensing of the PRB Project was made by and among the Licensees and 21 other Parties. The Settlement Agreement includes provisions for a Fish Passage Plan to: 1) establish self-sustaining harvestable anadromous fish runs of Chinook, steelhead and sockeye above the PRB Project; and to 2) provide for safe, timely and effective upstream and downstream fish passage of adult and juvenile life stages of several fish species including sockeye (PGE et. al. 2004).

The goal of this sockeye development program is to develop and re-establish a self-sustaining harvestable anadromous sockeye run(s) above the PRB Project. The goal is included in the first requirement of the Settlement Agreement and supports requirements of the FERC license. Goal achievement is a shared responsibility among the CTWSRO, PGE and the Oregon Department of Fish and Wildlife (ODFW) because CTWSRO and PGE are co-licensees and CTWSRO has co-management authority with ODFW regarding fish and wildlife in the Deschutes River Basin (Fies et. al. 1996). Within the Deschutes watershed, CTWSRO, PGE and ODFW conduct *O. nerka* investigations both cooperatively with and independently of one another in the basin and this project like others has been developed to accommodate and support information and data sharing.

Completion of fish passage improvements at the PRB Project in 2009 has accommodated testing of fish passage facilities. Results will contribute to conclusions regarding sockeye development or re-establishement. Sustainable populations of resident *O. nerka* persist in Lake Billy Chinook (LBC) and Suttle Lake and offer an opportunity to restore an anadromous sockeye population (Thiede et al. 2002). Such restoration would focus on wild, indigenous sockeye population(s) in these systems, potentially enhancing genetic fitness of these populations (CTWSRO 1999).

The study objectives are designed to address some of the needs in the upper Deschutes River basin for many details of *O. nerka* ecology and life-history. Such details are necessary to inform fisheries management decisions. Information needs for LBC and Suttle Lake *O. nerka* include: genetic data marker analysis to assess population relatedness within the Deschutes River and Columbia River basins;, outmigration timing and relative abundance; outmigrant survival to the Selected Water Withdrawal (SWW) facility; population size and age structure; recruitment; growth rates; spawning escapement; spawning distribution; and smolt-to-adult return (SAR) rates.

Objectives for the study include:

1) Determine the genetic structure of *O. nerka* in the Deschutes and Metolius river basins;

2) Determine outmigration timing and abundance of *O. nerka* from Suttle Lake;

3) Determine movement of *O. nerka* from Suttle Lake to SWW facility;

4) Compare *O. nerka* SAR rates between Suttle Lake and LBC;

5) Determine *O. nerka* population size and distribution in LBC;

6) Determine spawner escapement of *O. nerka* in the Metolius River for the LBC population;

7) Develop quarterly and annual reports; and

8) Development of a sockeye reintroduction plan

Descriptions of sockeye development investigations in the Deschutes River basin by the participating agencies/entities including CTWSRO study objectives for this Deschutes Basin sockeye project are described in Table 3. This information will be useful to document *O. nerka* life-history characteristics and population changes in response to operation of the new SWW and fish transfer facility at the PRB Project as well as to facilitate development of a model to guide fisheries managers in sockeye re-establishment and management.

B. Technical and/or scientific background

Sockeye development efforts are reliant on the connectivity of upper- and lower Deschutes sub-basins through successful fish passage, maintenance and improvement to habitat, as well as on informed adaptive management decision processes. License articles for the FERC license 2030-077 for the PRB Project stipulate restored connectivity as an objective for basin restoration.

Sockeye salmon display more life history patterns than any other member of the genus *Oncorhynchus* (Burgner 1991). Based on differences in juvenile life history, reproductively isolated populations of sockeye salmon can be grouped into three basic "ecotypes". The "lake-type" ecotype, is anadromous and spends about half its life in a nursery lake before migrating to sea. The "sea-type" ecotype is also anadromous but rears in freshwater only weeks or months as it moves downstream to the sea; by definition, it is not found in lakes. The "kokanee" ecotype is nonanadromous and found only in lakes (Wood 2007, Wood et al. 2008)).

Given the lack of both genetic and life-history information about Deschutes River sockeye population combined with the complex life-history seen in other sockeye populations, sockeye development in the Deschutes River basin represents a challenge. Initially, better understanding of population structure and life-history details will be key to sockeye development success and will be a focus of the CTWSRO investigations described in the above objectives.

Historically, two Oregon lakes in the Columbia River Basin had sockeye salmon, Suttle Lake in the Deschutes River Basin and Wallowa Lake in the Snake/Grande Ronde River Basin. The Wallowa Lake population is extinct. Due to a lack of genetic and life-history information for the Deschutes River Basin population, the population status is unknown. In September 1994, NMFS initiated a status review of sockeye salmon in Washington, Oregon, and California. This review was conducted by a Biological Review Team (BRT) formed specifically for this purpose. The BRT identified six sockeye salmon Evolutionarily Significant Units (ESUs), one provisional ESU and two "other population units" one of which was the "Deschutes River, Oregon". The BRT concluded this sockeye salmon population unit "is clearly in danger of extinction if not already extinct". The BRT also concluded that the historic run of sockeye that migrated up the Deschutes River from the Columbia River to spawn in Suttle Lake were a separate ESU. However, the BRT was uncertain if remnants of this ESU existed based on a lack of genetic and life-history information. The majority of the BRT believed that it was not possible to identify a remnant component of this historic population. A minority of the BRT believed that the extensive transplant history of non-native sockeye salmon above Round Butte dam accounts for the current anadromous *O. nerka* in the basin, and as descendents of transplants, these sockeye salmon are not an ESA issue (Gustafson et. al. 1997).

Currently, two *O. nerka* populations are present above the dams: one in Suttle Lake that spawns in Link Creek (the lakes inlet stream), and another in LBC, that spawns in the upper Metolius River (Gustafson et. al. 1997) for which there remains no definitive genetic analysis.

Given current genetic analyses capabilities to establish relationships among fish populations for ESU boundary establishment for anadromous salmon (ISRP/ISAB 2009), it is now possible to determine the relationship of these two populations to one another as well as to other *O. nerka* populations. Specifically, genetic analysis will consist of using single nucleotide polymorphism (SNP) assays (and/or microsatellite variation). Objective 1 will address this issue. If unique, in addition to being a key for successful Deschutes River Basin sockeye development, this population will rank high in conservation priority on a species range-wide basis (Wood 2007). From a gene purity standpoint, it will be desirable to develop an anadromous run of sockeye from the native *O. nerka* that have evolved within the Deschutes River Basin rather than introducing a separate gene pool to the basin (ODFW & CTWS 2008).

One or both of the *O. nerka* populations upstream of the PRB Project may be resident remnants of the historic Suttle Lake sockeye population (Thiesfeld et al. 1999; K. Kostow, Analyst, Columbia River Management, ODFW, pers. comm.) If this is the case it is most likely that the population would be a Suttle Lake remnant given its: 1) stocking history compared to LBC (Gustafson et. al. 1997); 2) upper position in the watershed; 3) and the fact that there appears to be some degree of reproductive separation between the two spawning groups of *O. nerka* in the upper Metolius watershed. For example, potential thermal barriers on Lake Creek may have prevented upstream migration for about 80 years so LBC *O. nerka* could not contribute to the gene pool of the Suttle Lake group (Nehlsen 1995). Conversely, the Suttle Lake *O. nerka* may have moved downstream contributing to the gene pool of the LBC group. Given results for a series of three screwtraps operated in the Metolius River watersheds (2009 data), it appears Suttle Lake outmigrants have a limited contribution to LBC *O. nerka* populations (CTWSRO, unpublished data; Eric Shultz, Data Specialist, PGE, pers.comm). This data showed that a majority of Suttle Lake outmigrants may not survive to Monty Campground at the inlet of LBC on the Metolius River (Map – Figure 1). Among the reasons for outmigrant mortality is loss in a series of Lake Creek water diversions and dis-tributaries. Loss of Suttle Lake fish to unscreened diversions may greatly affect the success of anadromous sockeye reintroductions to the historical nursery area of Suttle Lake. Objectives 2 and 3 will address these issues.

Regardless of gene purity, outmigrants captured from Suttle Lake and LBC will be enumerated and differentially marked and returning adults will be enumerated to determine SAR rates for each group. CTWSRO will mark all captured Suttle Lake outmigrants and PGE personnel will mark LBC outmigrants at the SWW fish transfer facility. Objective 4 will address this issue. The number of *O. nerka* that pass through the SWW will depend on parameters such as *O. nerka* population size and spawner escapement above the PRB Project. Objectives 5 and 6 will address this issue. Marked adults returning to the Pelton Fish Trap known to have originated from the upper Deschutes River Sub-basin could then be passed upstream to spawn naturally or moved to Round Butte Hatchery for propagation, and subsequent release upstream. (ODFW & CTWS 2008). The development of a sockeye reintroduction plan is being paid for by PGE and facilitated by CTWSRO and ODFW (Objective 8).

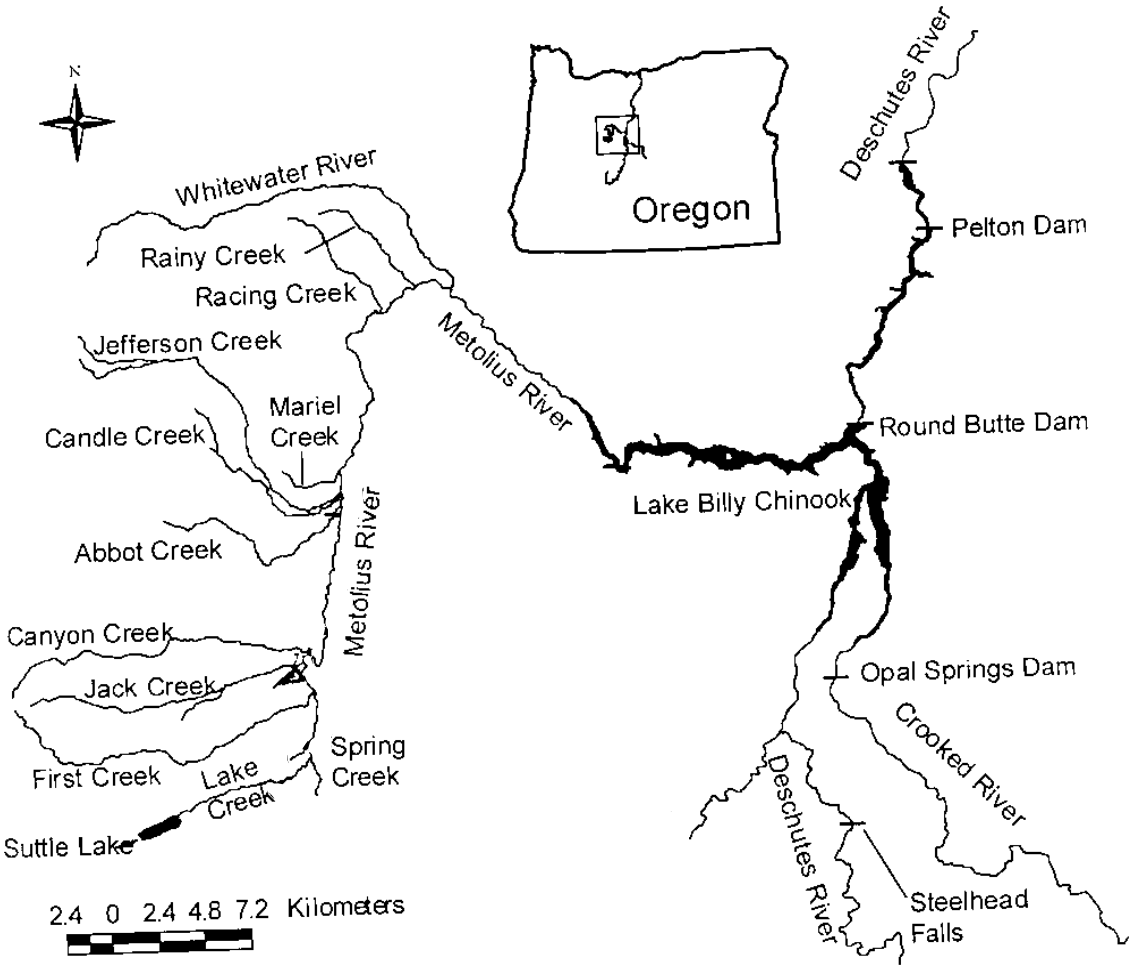

Figure 1. Study area map showing Deschutes/Metolius River basin detail including Lake Billy Chinook and Suttle Lake.

C. Rationale and significance to regional programs

While many anadromous *O. nerka* populations have been extirpated by degradation of migration corridors and lack of passage over dams, (Lee et al. 1997) resident populations of *O. nerka* have persisted. Resident forms have produced anadromous offspring (Rieman et al. 1994), and sockeye runs have been successfully established using *O. nerka* derived from sockeye which had been landlocked for 15 generations (Bocking and Gaboury 2003). This evidence provides a rational for restoration of the Suttle Lake and LBC sockeye populations and supports restoration of anadromous *O. nerka.* The significance of actions to support restoration relates to species status as a focal species in the Deschutes Subbasin Plan for their ecological and tribal value and potential for re-introduction through passage facility development in LBC (NWPCC 2004, ODFW and CTWSRO 1990). The key to restoring sockeye to the Deschutes watershed is establishment of fish passage to and from the Middle Deschutes River Assessment Unit. The Deschutes Subbasin Plan addresses the need to provide suitable habitat and restore connectivity to spawning and rearing areas. Connectivity will occur in the Pelton Round Butte Habitat Complex where species historically present upstream of the PRB Project will be restored through total or partial transportation of downstream migrating juveniles and upstream transportation of adult fish. In the Metolius Habitat complex, fish passage will be restored at all artificial barriers (NWPCC 2004).

In 2004, a Settlement Agreement companion to the PRB Project (FERC Project. No. 2030) and committed to by PGE; CTWSRO and 21 other Parties (e.g., Federal; State; Fish Agencies; Non-Governmental Organizations; and Local parties) contained a Fish Passage Plan requiring the Licensees to: 1) establish self-sustaining harvestable anadromous fish runs of Chinook, steelhead and sockeye above the PRB Project; 2) provide for safe, timely and effective upstream and downstream fish passage of adult and juvenile life stages of several fish species including sockeye; 3) implement a three-phase fish passage program, and 4) conduct effectiveness monitoring, annual work plans, and a phased approach that includes: analysis of self-sustaining harvestable anadromous fish runs with the use of life cycle models and evaluation of passage efficiencies and survival estimates for the different life history stages of each species; and evaluation of spawning and rearing and movement of re-introduced fish species (PGE et. al. 2004).

Re-development of Deschutes River sockeye salmon perpetuates and adds to a diverse community of fish in the Columbia River Basin and increases treaty right fishing opportunities. For time beyond memory or record, aboriginal people of CTWSRO have harvested sockeye salmon. This Deschutes Basin Sockeye Project will address critical uncertainties about the potential for re-establishment and continued monitoring after re-development, with a large cost share from partnering state and federal agencies as well as private organizations.

D. Relationships to other projects

Sockeye re-development is a collaborative, cost shared effort between multiple agencies and funding sources. Currently the Bonneville Power Administration (BPA) funds multiple sockeye and kokanee projects (Table 2), including work with agencies (*e.g.*, ODFW, PGE, USFWS) that are not currently BPA funded (Table 3).

Genetic analyses of tissue sampled from Columbia River sockeye stocks will be used (200890700, Genetic Assessment of Columbia River Stocks) for genetic baseline and SNP markers development. The PIT tag information collected from adult sockeye at the Pelton Trap (Deschutes River - RM 161) will inform BPA projects (200851800, Upstream Migration Timing) and (200850300, Factors Limiting the Abundance of Okanagan and Wenatchee Sockeye Salmon); and provide data necessary to determine if trapped fish at the Pelton Dam are strays from other Columbia River basin sockeye stocks or a separate and unique population. Project 200850300 may also be helpful in further development of hydroacoustic smolt abundance estimation methodologies. BPA project (200201600, Evaluate Pacific Lamprey Status in the Lower Deschutes River) will share mainstem Deschutes River water temperature data if needed, and (200830100, Deschutes River Habitat Restoration Project) will complete projects beneficial to sockeye such as riparian zone plantings in migratory corridors.

E. Project history (for ongoing projects)

New Project

Table 2. Relationship to existing projects and programs

Funding Source	Project #	Project Title	Relationship (brief)
BPA	199404700	Lake Pend Oreille Kokanee Mitigation	This project does similar work to monitor Kokanee populations. They will assist in training staff and share technical expertise.
BPA	199501100	Chief Joseph Kokanee Enhancement	This project does similar work to monitor Kokanee populations. They will be able assist with technical expertise.
BPA	200740200	Snake River Sockeye Captive Propagation	Information gathered from this consortium of sponsors will be used as additional resource for technical expertise about sockeye population development and monitoring.
BPA	200890700	Genetic Assessment of Columbia River Stocks	Collected *O. nerka* tissue samples (project objective 1) will be used in genetic baseline development.
BPA	200850300	Sockeye Studies: Factors Limiting the Abundance of Okanagan and Wenatchee Sockeye Salmon	Complimentary project information will be exchanged on methods, results, and act as technical support.
BPA	200851800	Upstream Migration Timing	These projects will share information about PIT tag detections at mainstem Columbia River dams and in the Deschutes subbasin.
BPA	200831100	Natural Production Management and Monitoring	Shared personnel time and field equipment.
BPA	200830100	Deschutes River Restoration	Will complete habitat improvement projects which will be beneficial to sockeye such as riparian zone plantings in migratory corridors.
BPA	200201600	Evaluate Pacific Lamprey Status in the Lower Deschutes River	Will make water temperature data available for the mainstem Deschutes River.

Table 3. Relationship of Deschutes Basin Sockeye project objectives and on-going *O. nerka* investigations in the Deschutes and Metolius River basins among FERC licensees (CTWSRO & PGE), fisheries co-managers (CTWSRO & ODFW) and others.

Narrative Objective No.	**Brief Description**	**Lead Agency/Agencies**	**Coordinating Agency/Agencies**
1	Collect genetic samples and analyze	CTWSRO	PGE, ODFW
2	Monitor *O. nerka* outmigrant timing and abundance from Suttle Lake	CTWSRO	PGE, USFS, ODFW
3	Monitor movement of *O. nerka* from Suttle Lake to SWW	CTWSRO	PGE, USFS, ODFW
4	Compare *O. nerka* SAR rates between Suttle Lake and Lake Billy Chinook	CTWSRO, PGE	PGE, ODFW
5	Determine *O. nerka* population size and distribution in LBC	CTWSRO	ODFW, PGE
6	Determine spawner escapement of *O. nerka* in Metolius River basin for LBC population	CTWSRO	PGE, ODFW, USFS
7	Develop quarterly and annual reports	Project dependent	CTWSRO, PGE, ODFW
8	Facilitate the development of a sockeye reintroduction plan	PGE	CTWSRO, ODFW
NA[1]	Monitor *O. nerka* recruitment timing and abundance from Metolius River basin to LBC	PGE	
NA[1]	Monitor *O. nerka* outmigrant timing and abundance from LBC through SWW passage facility at PRB	PGE	

[1]NA (Not Applicable) items are being conducted by PGE and ODFW without assistance from CTWSRO.

F. Proposal biological/physical objectives, work elements, methods, and metrics

Study Area

The focus of this study is LBC and Suttle Lake of the upper Metolius River watershed on the eastern slope of the Cascade Mountains in Central Oregon (Figure 1). Historically, sockeye spawned in Suttle Lake and Link Creek, the Suttle Lake inlet, and reared in Suttle Lake (Nehlsen 1995). LBC is the reservoir pool formed by the 110m tall Round Butte Dam (Deschutes rkm 177). The reservoir submerged the confluence of three major rivers, forming three reservoir arms which are the Metolius (19 km), Deschutes (14 km), and Crooked (10 km) rivers (Nehlsen 1995). Surface area of the reservoir is more than 1,619 ha at full pool (Burger, 2007). The Metolius River originates from large springs at the base of Black Butte, and flows north and east approximately 45 km before entering LBC. Summertime base discharges are primarily spring-fed, as several large springs are located in rivers and tributaries. Spring-fed stream temperatures in the basin are cold, ranging from 4° to 9°C. Blue Lake (rkm 80) at the top of the Metolius Basin feeds via Link Creek into Suttle Lake (rkm 76), the largest natural lake in the basin. Suttle Lake discharges into Lake Creek which joins the Metolius River (rkm 64).

Objective 1: Determine the genetic structure of *Oncorhynchus nerka* in the Deschutes and Metolius river basins.

Currently there is no genetic baseline for sockeye salmon in the Columbia River Basin. Baseline genetic structure of kokanee in LBC and Suttle Lake will be documented using modern SNP assays (and/or microsatellite variation) to establish the genetic structure of existing *O. nerka* population(s) before adult *O. nerka* are allowed to pass upstream of the PRB Project. The LBC and Suttle Lake genetic baseline could then be analyzed in the context of broader spatial scales (Columbia River, west coast) to determine whether variation among individuals is similar to what appears at the local scale (K. Kostow, Analyst, Columbia River Management, ODFW, pers. comm.). A genetic baseline for Columbia Basin sockeye will be developed through BPA funded project (http://www.nwcouncil.org/fw/projectselection/accord/200890700.pdf).

In 1997, the majority of a NOAA Biological Review Team (BRT) believed that it was not possible to identify a remnant component of the Deschutes River basin historical sockeye population (Gustafson et. al. 1997). However, given advances in genetic analysis techniques the technology now exists (ISRP/ISAB 2009) to identify the unique genetic components of this species.

BPA project (200890700, Genetic Assessment of Columbia River Stocks) will develop a sockeye genetic baseline including samples collected through this Deschutes Basin Sockeye project. They will also develop SNP markers for sockeye. This information will provide information necessary to influence or inform effective management of sockeye populations of interest or at risk (ISRP/ISAB 2009) such as ESA listed Snake River-Redfish Lake sockeye (Federal Register Vol 56, No. 224, p 58618). Baseline development may also allow us to identify straying to the Pelton fish trap on the Deschutes River.

WE 157: Collect *O. nerka* genetic tissue samples from the Metolius River Basin

Tissue sample collection from *O. nerka* for genetic analysis will continue at the; 1) Suttle Lake outlet during smolt spring outmigration; 2) LBC inlet as fish gather just prior to the Metolius River spawning run; 3) the Pelton Dam adult fish trap during July – August adult returns. A maximum one hundred tissue samples will be collected at each site.

At Suttle Lake, to avoid sampling a single family group, genetic tissue collection will be equally apportioned during the duration the outmigration season. Collected kokanee will be anesthetized with MS-222, measured for total length, weight, and sampled for genetic material. A small piece of fin tissue will be preserved. Kokanee will be allowed to recover until equilibrium is regained then released at the capture location. At LBC sampling will be conducted three times per year in conjunction with a mark--recapture first-event (objective 6, WE 157) (Table 4). Sampling events will occur mid-August, late-August and mid-September. Tissue samples will come from the fish collected by ODFW for disease analysis. At the Pelton Dam adult fish trap samples will be collected from all returning adults at the trap.

Each sample will be stored individually in vials containing 200 proof, non-denatured ethanol. Vials will be supplied by the Columbia River Inter-Tribal Fisheries Commission's (CRITFC) Hagerman Genetics Laboratory in Hagerman, Idaho. Once tissue is preserved in vials, the vials will be sent to the CRITFC lab for analysis.

Table 4. Sample site/reach, time of sampling, and number of samples to be collected, the Metolius River and Deschutes River basins.

Sample Site or Reach	Date	Number of Samples to be Collected
Lake Billy Chinook (Metolius River mouth)	Mid-August	33
	End-August	33
	Mid-September	34
Suttle Lake outlet (Lake Creek smolt trap)	February to June	100
Pelton Dam Adult Fish Trap	July-August-September	100*
Suttle Lake	October-November-December	100

*This will likely require multiple years.

WE 159: Transfer genetic tissues to CRITFC Hagerman Lab

Genetic tissues will be transferred to Hagerman lab for genetic analysis to determine if there is a difference among geographic origins and for the development of a sockeye genetic baseline and SNP markers as proposed in the BPA project 200890700 narrative. Methods are available at: http://www.nwcouncil.org/fw/projectselection/accord/200890700.pdf.

WE 162: Determine genetic structure of *O. nerka* in the Metolius and Deschutes River basins
Genetic analysis will be conducted by personnel of the CRITFC's Hagerman genetics laboratory.

In 2009, 99 tissue samples were collected both at the Suttle Lake outlet and LBC inlet sites. Due to the small number of trapped adults, only thirteen samples were collected at the Pelton Trap. To date, 99 samples from *O. nerka* juveniles at the Suttle Lake outlet have been sent to the Hagerman laboratory for analysis. Another 99 samples have been collected from adult fish at the LBC Metolius River inlet, and a contract for analysis is pending with the laboratory.

Objective 2: Determine outmigration timing and abundance of *O. nerka* from Suttle Lake.
Presently, the number of Suttle Lake *O. nerka* outmigrants is not known. Juvenile *O. nerka* were documented emigrating from Suttle Lake spring 1997 (n=411) when an inclined fish trap was installed downstream of Suttle Lake Dam (USFS, unpublished data); and again in spring 2009 where they were collected at (n=1273) a rotary screw trap at the same location (CTWRSO, unpublished data). Although capture efficiencies were not calculated to produce an abundance estimate, it was estimated that upwards of 20,000 wild *O. nerka* smolts move downstream from the historical nursery area each year.

WE 157: Collect temporal distribution and relative abundance data
To determine the relative timing and abundance of juvenile *O. nerka* emigrating from Suttle Lake, a smolt trap will be placed in Lake Creek, below the Suttle Lake dam. The trap will be operated from mid-February through mid-June, four to seven days a week (96-168 hr/week) depending on number of outmigrants captured. *O. nerka* outmigrants will be enumerated on days the trap is checked, and a sub-sample of at least 30 fish will be measured for length (TL and/or FL) on a weekly basis.

WE 162: Analysis of temporal distribution and relative abundance data
The length-frequency distribution of all *O. nerka* outmigrants will be graphed and age class categories of Age-0, Age-1+ and greater than Age-1+ will be inferred. *O. nerka* catch per sample date will be graphed to document timing of outmigration based on age class and as a measure for the total population. Dates associated with 25, 50, 75 and 100% of the proportion of outmigrating *O. nerka* caught in the trap will be determined.

Relative abundance of *O. nerka* will be calculated on the basis of fish/trap day (the number of fish caught in the number of days that the trap is fished between trap-checks) and reported by age class and as a measure (%) of the total population. Relative abundance will be graphed and described.

WE 162: Develop an abundance estimate of juvenile *O. nerka* emigrating from Suttle Lake
The number of fish captured by the trap represents only a portion of the total juvenile *O. nerka* emigrating from Suttle Lake. Total juvenile *O. nerka* outmigration estimates will be determined on a weekly basis for *O. nerka* using mark-recapture methodology described by Carlson et al. (1998).

Objective 3: Determine movement of *O. nerka* from Suttle Lake to SWW.
Presently, it is not known to what extent Suttle Lake *O. nerka* contribute to abundance in LBC. Fate of *O. nerka* outmigrants from Suttle Lake is unknown but likely includes emigration to the Metolius River and eventually into LBC and the SWW. Rotary screw trap data at Allingham (rkm 61) and Monty (rkm 23) campgrounds (operated by PGE) indicate that some of the 2009 outmigrants from Suttle Lake moved through Lake Creek and into the Metolius River; 37 and 2 *O. nerka* smolts were caught in the Allingham and Monty campground traps, respectively (Eric Shultz, Data Specialist, PGE, pers.comm.).

WE 158: PIT tag *O. nerka* outmigrants from Suttle Lake
A subset of juvenile *O. nerka* (≥85mm and in good condition) will be tagged using 12 mm full-duplex passive integrated transponder (PIT) tags. Fish will be anesthetized with a bath containing 70mg tricaine methanesulfonate (MS-222) L^{-1} buffered with sodium bicarbonate to a pH of 7 and kept in a bath for 90s after losing equilibrium (Summerfelt 1990). PIT tags (12mm, BioMark, Inc, Boise, ID) will be inserted using a scalpel to make a 2mm incision posterior to the pectoral fins along the midventral line (Prentice 1990). Fish will be held in a 5-gallon bucked with an aerator until equilibrium is restored.

WE 159: Upload PIT tag tagging and release data to the PITAGIS database
Managed from Portland, Oregon the Columbia Basin PIT Tag Information System (PTAGIS) is a Fisheries Data Project of the Pacific States Marine Fisheries Commission (http://www.ptagis.org).

The following two work elements describe a PIT tag study involving two release groups of 400 PIT tagged fish each. The study will compare emigration success of the two groups to the SWW facility as well as assess capture efficiencies for two Metolius River smolt traps. Fish for the study will be captured at the Lake Creek smolt trap at the outlet of Suttle Lake. One group will be released into the Metolius River near the Lake Creek mouth and the other group will be released into the Metolius River at Monty Campground near the Metolius River mouth. These release locations are downstream of Lake Creek where *O. nerka* outmigrant losses may be high due to suspected juvenile passage challenges. Each of the following two work elements describe one release group of 400 PIT tagged fish each for a total of 800 PIT tagged fish for the study.

WE 156: Determine the contribution of Suttle Lake outmigrants PIT tagged and released from the Lake Creek mouth to the downstream screwtraps at Allingham and Monty campground as well as to the SWW facility
PIT tag approximately 400 Suttle Lake *O. nerka* outmigrants from the Suttle Lake outlet smolt trap on Lake Creek and release them into the Metolius River below the Lake Creek mouth. These PIT tagged fish will then face potential capture and subsequent PIT tag interrogation at two downstream Metolius River smolt traps located at Allingham and Monty campgrounds as well as the SWW facility. This study will provide information to determine smolt trap efficiencies for juvenile *O. nerka* at the Allingham and Monty campground sites as well as emigration success via LBC to the SWW facility.

WE 156: Determine the contribution of Suttle Lake outmigrants PIT tagged and released from Monty Campground near the Metolius River mouth to the SWW facility

PIT tag approximately 400 Suttle Lake *O. nerka* outmigrants from the Suttle Lake outlet smolt trap on Lake Creek and release them into the Metolius River near its mouth at the Monty Campground. These PIT tagged fish will then face potential capture and subsequent PIT tag interogation at the SWW facility. This portion of the PIT tagging study will provide information to determine emigration success via LBC to the SWW facility.

Emigration success between the two PIT tagged groups of *O. nerka* will be compared to establish the potential value of direct Metolius River releases of yearling *O. nerka* trapped at the Suttle Lake outlet. An estimate of losses in Lake Creek will lend to recommendations regarding whether it is reasonable to maximize trapping each year at the Suttle Lake outlet for release below Lake Creek or Pelton for migration until the problems in Lake Creek are resolved.

Objective 4: Compare SAR rates between Suttle Lake and Lake Billy Chinook.

Uniquely maxillary clip a significant number of *O. nerka* yearlings captured at the Suttle Lake outlet then release them below the PRB Project's Pelton Dam. PGE will be responsible for uniquely marking and releasing LBC *O. nerka* yearlings at the SWW facility. This will produce Suttle Lake origin adults and get at SAR questions in a way that will allow comparison between Suttle Lake and LBC *O. nerka* populations. Resulting data will provide insight to the relative contribution to sockeye run development for both the Suttle Lake and LBC populations. The sample sizes of these marked fish released below Pelton Dam should be large, because the number of returnees will be a very small fraction of the number tagged and released. This would be a multi-year SAR study with future analysis involved.

WE 157: Collect *O. nerka* at Suttle Lake outlet screw trap or smolt trap for marking and release

Use trapped surplus fish not needed for objectives 2 and 3 above. Fish collected from LBC at the SWW will be marked and released by PGE.

WE 157: Transport fish from Suttle Lake outlet trap to Deschutes River release site below Pelton Dam

PGE will transport the fish.

Objective 5: Determine *O. nerka* population size and distribution in LBC.
Hydroacoustic surveys have been conducted on LBC intermittently since 1996. Each survey has utilized the same 48 systematically-located survey transects to monitor the number and distribution of *O. nerka* in LBC (Thiesfeld et al 1999, Thiede et al 2002, Burger 2007, Nealson 2008). Metolius River arm was divided into 20 transects (M1 – M20), Deschutes River arm into 16 transects (D1–D16) and Crooked River arm into 12 transects (C1-C12). The same survey transects will be used in this proposed study.

WE 157: Locate and GPS survey transects prior to surveys (only needs to be done once, then can be used for future surveys)
Use maps and boat to locate and then travel to transect markers. Obtain GPS coordinates for each marker using Trimble XT handheld rover or similar for accurate and precise measurements. Have GIS department input data into GIS library. Boat navigation during surveys can then be conducted by GPS for future surveys instead of placing flashing lights for each survey. This will save money because placing and then retrieving flashers takes most of a day each.

WE 157: Conduct Hydroacoustic surveys in LBC
The specific objectives of future LBC hydroacoustic studies include:
1) Determine the abundance and distribution of the LBC *O. nerka* stock, both for the reservoir as a whole and for each of the three individual arms (Metolius, Deschutes, and Crooked River Arms).
2) Provide an estimate of the size class distribution of limnetic fish species in LBC.
3) Estimate the vertical (depth) distribution of limnetic fish observed during the survey.

Hydroacoustic surveys will be conducted two times per year as follows: 1) after juvenile recruitment into the reservoir (May/June) and 2) after spawning escapement (November). Sampling will commence after nightfall such that all transects will be surveyed during the hours of darkness, over a two or three night period, preferably during a period with no moon.

An HTI *Model 241 Portable Split-Beam Echo Sounder System* operating at a frequency of 200 kHz will be used to conduct LBC mobile hydroacoustic *O. nerka* population assessment (Torkelson 2000).

WE 162: Analyze hydroacoustic data
Fish lengths will be estimated from the individual fish mean target strength measurements based on the relationship described by Love (1971). The HTI EchoScape (or EchoView) data entry and editing program (HTI, Seattle, WA) will be used to process the acoustic echo data.

WE 156: Develop method to verify hydroacoustic population numbers
Validation of hydroacoustic targets to determine species will be conducted using mid-water trawl methods developed by Rieman (1992) and Maiolie et al. (2008) conducted concurrently with hydroacoustic surveys. This will also allow apportionment of the hydroacoustic fish population estimates into *O. nerka* age-classes including age 0+, 1+, 2+, and 3+ when possible (season dependent). Fish ages will be determined by scale analysis (Ambrose 1992). This work may be contracted out.

Objective 6: Determine spawner escapement of *O. nerka* in the Metolius River for the LBC group.

O. nerka congregate at the head of the Metolius Arm of LBC in the late summer prior to ascending the Metolius River to spawn (D. Ratliff, Senior Aquatic Biologist, PGE, pers. comm.). To estimate spawning escapement of *O. nerka* migrating from LBC into the Metolius River mark-recapture/resight techniques were used in 1996-2000 and 2005-2009 (Thiesfeld et. al. 1999, Thiede et. al. 2002, Gauvin et. al. 2009). These surveys have been performed to generate estimates of the spawning population, potential egg deposition, growth, fecundity, and maturity rates and ultimately to forecast future age class strength and population abundance. Prior to 2007, population estimates were derived from standard mark-recapture analysis (Gauvin et. al. 2009) using the Chapman modification of the Petersen estimators (Seber 1973). However, an assumption of this method was being violated in that the method assumes no loss of marks which, in fact, was occurring (e.g. tagged fish were losing tags between mark and resight events). In 2007, to improve methodological inconsistencies and shortcomings (Jens Lovtang, CTWSRO Fisheries Management Supervisor, pers. comm.), CRITFC scientists developed a model to incorporate tag loss into the abundance estimate (Galbreath and Hyun 2008). CTWSRO has adopted the CRITFC model for future Metolius watershed mark-recapture/resight spawner abundance estimates. This year and in the future, CRITFC will continue model development and refinement, and the CTWSRO and CRITFC will continue to assess Metolius *O. nerka* tagging and survey procedures to improve spawning escapement estimation.

WE 157: Estimate *O. nerka* spawner escapement in the Metolius River Basin.

Mark-Recapture/Resight methods (Galbreath and Hyun 2008, Gauvin et. al. 2009) will be used, and the study will be conducted cooperatively among CTWSRO, PGE and ODFW.

WE 162: Calculate Metolius River *O. nerka* spawner escapement

Spawner escapement will be estimated using the full-likelihood model (Galbreath and Hyun 2008). This model incorporates tag loss and fish abundance.

Objective 7: Develop quarterly and annual reports.

Objective 8: Facilitate the development of a sockeye reintroduction plan.

WE 191: Reintroduction Plan Coordination and Development

The sockeye reintroduction plan is being funded by PGE. The CTWSRO and ODFW will work with Clearwater BioStudies, Inc. (Canby, OR) to develop the plan. The basis of the plan will be similar to the Reintroduction and Conservation Plan for Anadromous Fish in the Upper Deschutes River Sub-basin, Oregon, Edition 1: Spring Chinook and Summer Steelhead (ODFW and CTWSRO 2008). In fact, the Edition 1 plan specifically references a second plan by stating, "a more refined and specific plan for this species (sockeye) is under development by the Fish Managers in coordination with members of the Fish Committee. Greater specificity on future efforts to reintroduce sockeye to areas above PRB will be provided in a Second Edition of the Reintroduction Plan".

Our specific role in the development of the plan is to:

- Collaborate and communicate with co-managers and other agencies participating in data collection and natural resource management (*e.g.* USFS, USFWS, NOAA-F) to ensure quality control.
- Assist with plan development by providing data, insight, and editing.
- Participate in various forums (e.g., PRB Project Fish Committee, co-management meetings) to ensure a unified effort.

The first draft of the plan was submitted January 2010.

H. Facilities and equipment (* marks equipment that need to be purchased):

a. The personnel will be stationed out of the Warm Springs Office.
b. CTWSRO motor vehicles will be utilized (Objective 1-6).
c. *Boats (Objectives 1, 5 & 6)
    i. Large trawl boat
        1. *Trawl net
        2. *Electronics
            a. Radar
            b. Fish/depth finder
            c. Chart plotter
            d. VHS radio
    ii. Smaller motor boat
d. *Heated shop building/warehouse
    i. Boat storage
    ii. Workshop area - indoor work area for field projects (e.g. a warm, dry place for PIT tag antenna construction).
e. Hydroacoustic equipment will be a model 241 Portable Split-Beam Echo Sounder, operating at a 200 kHz frequency with a 15-degree vertically aimed transducer, mounted on the side of a boat and connected to a laptop computer. The analysis of the hydroacoustic data will be contracted to HTI inc. during the first 3 years and then performed by CTWSRO staff after training. HTI inc. performed the analysis in 2007 and 2008. Consistency in the data analysis is important in the near future while CTWSRO staff becomes familiar and trained in the analyses (Objective 5) (This equipment is currently supplied by ODFW).
f. *Hydroacoustic data analysis software and dedicated laptop computer (Objective 5).
g. Five feet diameter screw trap or other smolt trap placed at the outlet of Suttle Lake. The trap would be supplied by CTWSRO or ODFW (Objectives 2-4).
h. *Trimble XT GPS handheld rover (or similar) for collection of GPS coordinates (Objectives 1-6).
i. *Nets – seining and gill or trammel (Objectives 1 and 6)
j. *Personal Field gear (Objectives 1–6)
    i. PFDs
    ii. Mustang survival suit
    iii. Dry suit

iv. SPOT handheld unit – personal satellite locator and messenger for safety

k. *PIT tag Equipment

i. Handheld PIT tag scanners/readers (Objective 3)

I. References

Ambrose, J. J. 1992. Age determination. Pages 301-324 *in* L. A. Nielsen, and D. L. Johnson, editors. Fisheries Techniques, fourth edition. American Fisheries Society, Blacksburg, VA.

Bocking, R. C., and M. N. Gaboury. 2003. Feasibility of reintroducing sockeye and other species of Pacific salmon in the Coquitlam Reservoir, BC. LGL Limited, Burnaby, BC.

Burger, C. V., K. T. Scribner, W. J. Spearman, C. O. Swanton, and D. E. Campton. 2000. Genetic contribution of three introduced life history forms of sockeye salmon to colonization of Fraser Lake, Alaska. Canadian Journal of Fisheries and Aquatic Sciences 57:2096-2111.

Burger, M. 2007. Lake Billy Chinook Hydroacoustic Survey, November 16 and 17, 2006. Report by BioSonics, Inc. to Portland General Electric Company, Portland, OR.

Burgner, R. L. 1991. Life history of sockeye salmon (Oncorhynchus nerka). Pages 3-118 *in* C. Groot, and L. Margolis, editors. Pacific Salmon Life Histories. UBC Press, Vancouver, B.C.

Carlson, S. R., L.G. Coggins Jr., and C. O. Swanton. 1998. A simple stratified design for mark-recapture estimation of salmon smolt abundance. Alaska Fishery Research Bulletin 5(2):88-102.

Fies, T., M. Manion, B. Lewis, S. Marx. 1996. Metolius River subbasin fish management plan. Upper Deschutes fish district. Oregon Department of Fish and Wildlife. Bend, Oregon

Galbreath, P. F. and S. Hyun. 2008. Procedures for estimating tag loss rate and spawning escapement in a mark-recapture study of Metolius River kokanee *Oncorhynchus nerka*. Columbia River Inter-Tribal Fish Commission Technical Report 08-06, Portland, Oregon. (http://www.critfc. Org/tech/08-07report.html).

Gipson, R. D. and W. A. Hubert. 1993. Spawning-site selection by kokanee along the shoreline of Flaming Gorge Reservoir, Wyoming-Utah. North American Journal of Fisheries Management 13:475-482, 1993.

Gustafson, R.G., T.C. Wainwright, G.A. Winans, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-33, 282 p.

Hindar, K., B. Jonnson, N. Ryman, and G. Stahl. 1991. Genetic relationships among landlocked, resident, and anadromous brown trout, *Salmo trutta*, L. Heredity 66:83-91.

ISRP/ISAB (Independent Scientific Review Panel/Independent Scientific Advisory Board). 2009. Tagging Report: A comprehensive review of Columbia River Basin fish tagging technologies and programs. Northwest Power and Conservation Council. Available:

Lee, D. C., J. R. Sedell, B. Rieman, R. F. Thurow, and J. Williams. 1997. Broadscale assessment of aquatic species and habitats. US Forest Service, Pacific Northwest Research Station, Portland.

Lewis, S. L., and R. B. Lindsay. 1976. Population dynamics of kokanee salmon in Odell Lake, Annual Report. Oregon Department of Fish and Wildlife, Portland.

Love, , R. H. 1971. Dorsal-aspect target strength of an individual fish. Journal of the Acoustical Society of America 49:816-823.

Maiolie, M.A., G.P. Schoby, W.J. Ament, and W. Harryman. 2008. Kokanee and rainbow trout research efforts, Lake Pend Oreille, 2006. Annual Progress Report, IDFG 08-0006. Idaho Fish and Game, Boise ID.

Nealson, P.A. 2008. Hydroacoustic evaluation of kokanee (*Oncorhynchus nerka*) population size and distribution in Lake Billy Chinook, Oregon during December 2007. Hydroacoustic Technology, Inc. Project P2415B. Prepared for Portland General Electric Company, Portland, Oregon.

Nehlsen, W. 1995. Historical salmon and steelhead runs of the upper Deschutes River and their environments. Portland General Electric, Portland.

NWPCC (Northwest Power and Conservation Council). 2004. Deschutes Subbasin Plan. Available: http://www.nwcouncil.org/fw/subbasinplanning/deschutes/plan/ (January 2010).

ODFW and CTWSRO (Oregon Department of Fish and Wildlife and Confederated Tribes of Warm Springs, Oregon). 1990. Columbia basin system planning Salmon and Steelhead Production Plan; Deschutes River Subbasin. Northwest Power Planning Council and Columbia Basin Fish and Wildlife Authority. Portland, Oregon.

ODFW and CTWSRO. 2008. Reintroduction and conservation plan for anadromous fish in the upper Deschutes Sub-basin, Oregon: Edition 1. spring Chinook and summer steelhead. Bend, Oregon.

Prentice, E. F., T.A. Flagg, C.S. McCutcheon, D.F. Brastow, and D.C. Cross. 1990. Equipment, methods, and an automated data-entry station for PIT tagging. American Fisheries Society Symposium: 335-340.

PGE (Portland General Electric Company), CTWSRO (Confederated Tribes of the Warm Springs Reservation of Oregon), and others (twenty stakeholders including federal, state, county and local governments and non-profit entities. 2004. Exhibit D: fish passage plan *in* Relicensing settlement agreement concerning the relicensing of the Pelton Round Butte Hydroelectric project, FERC project no. 2030

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout. American Fisheries Society *in association with* University of Washington Press. ISBN: 0-295-98437-6.

Rieman, B. E. 1992. Status and analysis of salmonid fisheries; Kokanee salmon population dynamics – kokanee salmon monitoring guidelines. Project F-73-R-14, Subproject II, Study II. Idaho Fish and Game, Boise, Idaho.

Rieman, B. E., D. L. Myers, and R. L. Nielsen. 1994. Use of otolith microchemistry to discriminate *Oncorhynchus nerka* of resident and anadromous origin. Canadian Journal of Fisheries and Aquatic Sciences 51:68-77.

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, second edition. MacMillan Publishing, New York, NY.

Thiede, G. P., and coauthors. 2002. Lake Billy Chinook sockeye salmon and kokanee research study 1996-2000. Oregon Department of Fish and Wildlife, Bend, OR.

Thiesfeld, S. L., J. C. Kern, A. R. Dale, M. W. Chilcote, and M. A. Buckman. 1999. Lake Billy Chinook sockeye salmon and kokanee research study 1996-1998. ODFW, Bend, OR.

Torkelson, T.C. 2000. Model 241/243/244 Split-beam Digital Echo Sounder System: Operator's Manual, Version 1.8. Hydroacoustic Technology, Inc., Seattle, Washington, 121 pp.

Winans, G. A., S. Pollard, and D. Kuligowski. 2003. Two reproductive life history types of kokanee, *Oncorhynchus nerka*, exhibit multivariate morphometric and protein genetic differentiation. Environmental Biology of Fishes 77:87-100.

Wood, C. C., and C. J. Foote. 1996. Evidence for sympatric genetic divergence of anadromous and nonanadromous morphs of sockeye salmon (*ONCORHYNCHUS NERKA*). Evolution, 50(3), 1996, pp. 1265-1279.

Wood, C.C. 2007. Sockeye salmon ecotypes: origin, vulnerability to human impacts, and conservation value. Pages 1-4 *in* C. A. Woody, editor. Sockeye salmon evolution, ecology, and management. American Fisheries Society, Symposium 54, Bethesda, Maryland.

Wood, C. C., J. W. Bickham, R. J. Nelson, C. J. Foote, and J. C. Patton. 2008. Recurrent evolution of life history ecotypes in sockeye salmon: implications for conservation and future evolution. Evolutionary Applications:207-221.

J. Key personnel

THE CONFEDERATED TRIBES OF THE WARM SPRINGS RESERVATION OF OREGON

This project will be implemented by the CTWSRO Department of Natural Resources personnel.

Brad Houslet, Project Manager

Jeff Hogle, Fisheries Biologist

Education

M.S., Range and Water Resources, University of Wyoming, 1993
B.S., Range Management, University of Wyoming, 1990

Work Experience

Confederated Tribes of the Warm Springs Reservation of Oregon
Fisheries Biologist, 2009-Present
Lead biologist for multi-agency, collaborative re-development of native sockeye salmon stock.

US Fish and Wildlife Service, Vancouver, Washington
Fisheries Biologist, 2002-2009
Served with The Native Trout Program and the Hatchery Evaluation/Planning Team.

Recent Publications

Hogle J.S. 2008. New Zealand mudsnail surveys at lower Columbia River basin National Fish Hatcheries 2008. Columbia River Fisheries Program Office United State Fish and Wildlife Service. Vancouver, WA 98683.

Olson, D., **J. Hogle**, and S. Olhausen. 2007. Survival and contaminant analysis of juvenile spring Chinook salmon during herbicide treatment with 2,4-D and Diquat for control of noxious weeds in Drano Lake, 2006 Skamania County, Washington. Columbia River Fisheries Program Office United State Fish and Wildlife Service. Vancouver, WA 98683.

Zydlewski, J., J.R. Johnson, **J. Hogle**, J. Brunzell, S. Clements, M. Karnowski, C. Shreck. 2008. Seaward migration of coastal cutthroat trout (*Oncorhynchus clarki clarki*) from four tributaries of the Columbia River. *In* Movements of coastal cutthroat trout (*Oncorhynchus clarki clarki*) in the lower Columbia River: tributary, mainstem and estuary use. Completion Report for U.S. Army Corps of Engineers Project No. 123083. U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Jens Lovtang, Fisheries Biologist

Education

Oregon State University, M.S. Fisheries Biology, 2005
Humboldt State University, B.S Natural Resources Planning, 1995

Work Experience

Confederated Tribes of the Warm Springs Reservation of Oregon
Fish Production Biologist, November 2005 – Present
Current Duties: Oversee data collection, analysis, and reporting of the CTWSRO Fish Production Program, which includes monitoring of natural production of steelhead and spring Chinook salmon in reservation streams, and kokanee salmon in the Metolius River Basin. Participate in the cooperative management of the Warm Springs National Fish Hatchery.

Oregon Department of Fish and Wildlife, Corvallis, Oregon
Experimental Biology Aide, Gearhart Mountain Bull Trout project, July – August 2005
Experimental Biology Aide, Siletz River Fall Chinook Project, September - October 2005

Oregon State University, Corvallis, Oregon
Graduate Research Assistant (M.S. Candidate), January 2002 – June 2005

Portland General Electric, Madras, Oregon
Fish Technician, Pelton Round Butte Project April – November 1999

Deschutes National Forest, Sisters Ranger District, Sisters, Oregon
Seasonal Fisheries Biologist, 1996 – 1998

Recent Publications

Lovtang, J.C. 2008. Confederated Tribes of Warm Springs, Fish Production Program, 2007 Annual Report. Confederated Tribes of Warm Springs, Warm Springs, OR

Lovtang, J.C., M. Hill, R. Stocking, and B. Hodgson. 2008. Lake Billy Chinook / Metolius River 2007 Kokanee Spawning Population Studies. Tab 17 *in* Portland General Electric Pelton Round Butte Project, 2008 Annual Fisheries Workshop. Portland General Electric, Portland, Oregon.

Lovtang, J.C., 2008. Chinook Reintroduction / Fry Releases in the Metolius River Basin, 2008. Tab 12a *in* Portland General Electric Pelton Round Butte Project, 2008 Annual Fisheries Workshop. Portland General Electric, Portland, Oregon.

Confederated Tribes of the Warm Springs Reservation of Oregon and The United States Fish and Wildlife Service. 2007. Warm Springs National Fish Hatchery, 2007- 2011 Operational Plan and Implementation Plan. USFWS, Columbian River Fisheries Program Office, Vancouver, WA.

Lovtang, J.C., P. Galbreath, and S. Hyun. 2007. Using a Dual-Frequency Identification Sonar (DIDSON) to enumerate the spawning migration of Kokanee salmon into the Metolius River. Tab 19 *in* Portland General Electric Pelton Round Butte Project, 2007 Annual Fisheries Workshops. Portland General Electric, Portland, Oregon.

Lovtang J.C. 2005. Distribution, Habitat Use, and Growth of Juvenile Chinook Salmon in the Metolius River Basin, Oregon. FERC Number 2030. Portland General Electric, Portland, Oregon.