North Umpqua Hydroelectric Project

SA 19.2 Study Plans:
Long-Term Monitoring and Predator Control

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Prepared by
The Settlement Agreement Section 19.2
Technical Working Group and Stillwater Sciences
for the
Resource Coordination Committee

This Plan is hereby approved by the following RCC parties:

David E. Crouch 10/29/06
Bureau of Land Management Date

Stephanie Burchfield 10/24/06
NOAA Fisheries Date

David A. Harms 10/18/2006
Oregon Department of Fish and Wildlife Date

Dennis Bebby 10/18/2006
Oregon Department of Environmental Quality Date

Ronald C. Kohl 10/18/2006
Oregon Department of Water Resources Date

10/18/06
PacifiCorp Date

Craig A Russ 10/18/06
US Fish and Wildlife Service Date

John J. Sloan 10/19/06
US Forest Service Date

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1 INTRODUCTION

The Settlement Agreement (SA) for the Relicensing of the North Umpqua Hydroelectric Project requires PacifiCorp to fund a Long Term Monitoring and Predator Control study and program (SA Section 19.2). The purposes of this measure are: 1) to monitor and evaluate the success of the anadromous fish reintroduction in the North Umpqua River upstream of Soda Springs Dam; and (2) to formulate and implement a study plan, implementation plan, and monitoring and adaptive management plan concerning the potential predation of anadromous salmonid juveniles by nonnative predator species in Soda Springs Reservoir.

When the New License becomes final, PacifiCorp will establish a segregated, interest-bearing account into which it will deposit $100,000 per year during each year of the term of the New License (SA Section 19.2.1). The SA also specifies that if the New License is not final by 2004, then PacifiCorp will establish a segregated account in 2004, into which it shall deposit $20,000 per year until the New License becomes final, which was conducted in 2004 and 2005 prior to the license becoming final in October 2005. The SA authorizes the Resource Coordination Committee (RCC) to determine how funds are spent each year to implement this measure, under the guidance provided in SA Schedule 19.2.1 (Appendix 1). In 2004, the RCC formed the SA 19.2 Technical Work Group (TWG, Appendix 2), which developed this study plan over several years (Appendix 2) and will oversee the work performed under it.

The objective of the predator control study is to assess whether existing populations of predator-sized brown and rainbow trout residing in Soda Springs reservoir could consume a substantial proportion of juvenile anadromous fish produced upstream of the reservoir (Stillwater Sciences 2000) prior to fish passage provisions at Soda Springs Dam. The predator control study, combined with the long-term monitoring plan, is intended to evaluate the success of the anadromous fish re-introduction upstream of Soda Springs Dam. Over the entire term of the Long Term Monitoring and Predator Control Program, an overarching principle is that the greater portion of the fund will be used for long-term monitoring purposes.

This plan will be reviewed annually by the SA 19.2 TWG and revised when necessary by the TWG and the RCC. It is anticipated that the plan will evolve and respond to efficiencies and limitations as they are recognized, and will incorporate improved technologies as they develop. The goal is to maximize effort efficiency as pertinent questions and adaptive management concerns are addressed, while creating a database useful for hypothesis testing and long-term comparisons.

This study plan is intended to provide the anticipated location, schedule, and general methodology of tasks. Potential methods and costs are described in more detail in Appendix 3 and 4, respectively. Detailed work plans should be developed for each task prior to implementation to better describe scope, methods, costs, schedules, and responsibilities.

2 STUDY AREA

Soda Springs Dam is located at RM 70 on the North Umpqua River. Construction of the dam occurred between 1951 and 1952. Soda Springs Dam is a 23.5-m (77-ft) high arch concrete dam, and the resulting reservoir is 31.5 surface acres with limited access, which extends 1.9 km (1.2 miles) upstream of the dam. The maximum depth is 15 m (50 ft), with water levels fluctuating up to 3 m/day (9 ft/day), and typically 0.6–2 m/day (2–6 ft/day). Upstream fish passage and screens at Soda Springs Dam will be constructed by year 5 of the New License becoming final, and functioning effectively by the seventh anniversary of the new license. Upstream fish passage will provide access to at least 6.6 miles of anadromous spawning and rearing habitat in the North Umpqua River and Fish Creek. Upstream fish passage will not be provided at the Slide Creek Dam because little spawning habitat is available between Slide Creek Dam and Toketee Falls, which is located 1.5 miles upstream.

To evaluate the need to control brown trout populations after fish passage is provided, predation studies will be focused on Soda Springs Reservoir, where the most predation is expected to occur. Brown and rainbow trout will also be monitored: (1) in the North Umpqua River upstream of Slide Creek Dam, (2) the lower 3.2 miles of Fish Creek (Figure 1, Table 1), and (3) in the Soda Springs bypass reach.

To determine baseline conditions and changes to anadromous fish abundance and species composition over time, long-term monitoring efforts will include the same study area, but will also include the upper portion of the North Umpqua River downstream from Soda Springs Dam (Table 1, Figure 1), and Boulder, Copeland, and Calf creeks.

Table 1. Study reaches in which monitoring will occur (see Figure 1).

Study reach length (mi)	Study reach description
7.4	Upper wild and scenic reach of the North Umpqua River (from Calf Creek upstream to Soda Springs powerhouse)
3.3	Copeland Creek (reach typically accessible to steelhead)
2.0+	Calf Creek (reach typically accessible to steelhead)
1.5	Boulder Creek (reach typically accessible to salmon)
0.3	Soda Spring bypass lower reach (downstream of gage pool)
0.2	Soda Springs bypass upper reach (gage pool tailout to dam)
1.2	Soda Springs reservoir (from dam face upstream to Medicine Creek bridge)
0.4	Slide Creek full-flow reach (from Medicine Creek bridge to Slide Creek powerhouse)
0.5	Slide Creek bypass lower reach (powerhouse to Fish Creek confluence)
1.5	Slide Creek bypass upper reach (Fish Creek confluence to Slide Creek Dam)
3.2	Fish Creek bypass lower reach (mouth to major obstacle at RM 3.2)
	Note: Monitoring in Fish Creek may be extended upstream of the obstacle at RM 3.2 if fish are able to pass the obstacle.

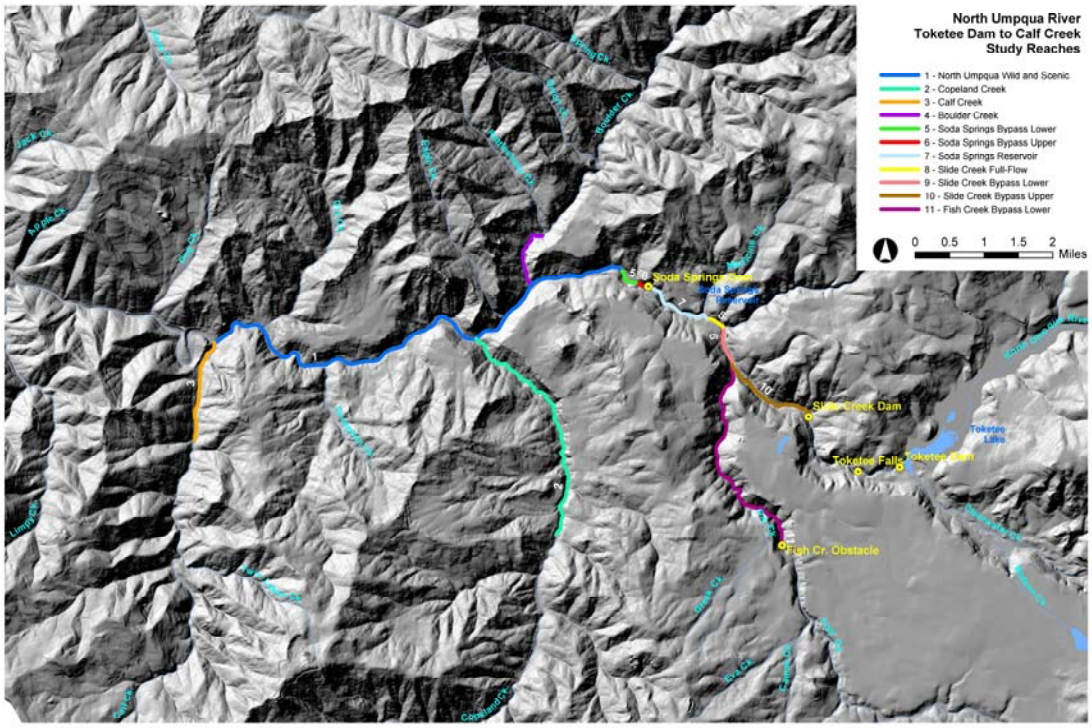

Figure 1. Vicinity where most SA 19.2 monitoring activity will occur.

A general description of project objectives, sampling locations, schedule, and methods are described below for long-term monitoring and predator control study. The organization of tasks is structured based on SA Schedule 19.2.1. The location, schedule, and methods are based on feasibility, and were considered the most likely to produce reliable results within the time and budget allocated. The methods used may vary from those described here, but they will be reviewed and approved by the TWG annually to ensure that overall study objectives are met.

3 LONG-TERM MONITORING

Following construction of fish ladders and screens, anadromous fish will be able to access reaches upstream of Soda Springs Dam. The goal of the long-term monitoring is to describe pre- and post-passage conditions upstream and downstream of Soda Springs Dam so that comparisons can be made to evaluate the success of the re-introduction, and to monitor juvenile fish production from reaches upstream of Soda Springs Dam. General methods are described here, and more detail on each methodology is provided in Appendix 3.

3.1 Pre-passage conditions: Years 1 through 7 (2005–2011)

3.1.1 Y1–7 determining baseline conditions

Describe pre-passage baseline fish population conditions in reaches upstream of Soda Springs Powerhouse following habitat manipulations and increases in bypass flow.

Locations: Soda Springs bypass, Slide Creek full-flow, Slide Creek bypass, Fish Creek bypass reaches.

Schedule: 2008–2010, after 2+ years of higher instream flows, during summer low-flow period (e.g., September).

Methods: Direct observation snorkel surveys will be used to conduct abundance estimates (relative abundance and species composition). Surveys will be conducted at night because night surveys generally provide greater probability of observation, especially in colder water temperatures, with species known to be nocturnal (e.g., brown trout). Prior to conducting snorkel surveys, habitats units within the reaches will be classified (e.g., pool, riffle, run), habitat unit boundaries will be delineated on base maps, and habitat unit characteristics will be measured and recorded. In order to compare trends in reaches over time, a subset of habitat units (index units) will be selected from within each of the reaches and sampled using multiple dive passes. The strength of using multiple dive passes is that variance can be calculated, allowing statistical comparisons of relative abundance and species composition between surveys over time.

3.1.2 Y1–7 estimating pre-passage juvenile fish production

Estimate pre-passage juvenile salmon, steelhead, and trout production in the upper Wild and Scenic Reach of the North Umpqua River, and in Boulder, Copeland and Calf creeks.

Locations: Upper Wild and Scenic Reach of the North Umpqua River (from Calf Creek to Soda Springs Powerhouse); Boulder, Copeland, and Calf creeks; and the Soda Springs bypass reach.

Schedule: Annually (as funding allows), with at least three consecutive years between 2006 and 2010 preferred.

Methods: Rotary screw traps (RST) will be used to assess juvenile fish production in the Soda Springs bypass reach, Calf and Copeland creeks. Potential RST locations (in order of priority) include:

- Downstream end of Soda Springs Bypass Reach (upstream of the powerhouse).
- Calf Creek.
- Copeland Creek (Note: A large woody debris [LWD] enhancement project is scheduled for summer 2006).

Sampling using RSTs was considered preferable to conducting population estimates using direct observation surveys (similar to methods being used to assess juvenile coho salmon carrying capacity in EF Rock Creek) because it estimates outmigrants (i.e., fish assumed to contribute to the anadromous population) not including resident fish; low observation probability of age-0+ fry, steelhead, especially in cold water temperatures and relatively high base flow; difficulty in scheduling surveys between storm events when water clarity (underwater visibility) is suitable.

The number of rotary screw traps to be deployed will be decided by the TWG, based on suitable locations, and available staff, equipment, and funding. Traps will be operated at each location continuously during the first year. During subsequent years, traps will be operated when juvenile and fry are present based on the results from the first year of monitoring. Traps will be checked daily, and the number, species, weight, and length of all fish captured will be recorded. A sub-sample of fish (Chinook, coho, and steelhead) will be marked and released upstream of outmigrant traps to estimate trap efficiency, and allow the estimation of production. Fry and juvenile production estimates will be conducted for each trap using a stratified mark-recapture method adapted from Darroch (1961) and Arnason (1973) which allows calculation of confidence interval around the estimate, for comparisons between estimates using Darroch Analysis with Rank Reduction (DARR 2.0; Bjorkstedt 2005) or similar software.

For the North Umpqua River's Upper Wild and Scenic Reach and Boulder Creek, redd counts from spawning surveys and intragravel permeability may be used to estimate fry production. Fry-to-juvenile production estimates from Soda Springs bypass reach, and Calf and Copeland creeks (where juvenile production will be measured using RST) will be used to adjust estimates for juvenile production.

3.1.3 Y1–7 conducting pre-passage spawning ground surveys

Estimate the number of returning spring Chinook salmon, coho salmon, and steelhead spawners in the upper Wild and Scenic Reach, Boulder, Copeland, and Calf creeks.

Locations: The North Umpqua River between Calf Creek and Soda Springs Powerhouse; Boulder, Copeland, and Calf creeks; Soda Springs bypass reach.

Schedule: Annually, starting in 2006. Sample every 7–10 days mid-September through January; sample every 7–10 days February through late May (as conditions allow between storms). Please note that detection and identification of steelhead and coho salmon redds in the upper Wild and Scenic Reach may be problematic and may not provide useful results. A decision regarding whether to conduct spawning surveys for steelhead and coho in the upper Wild and Scenic Reach will be determined by the TWG and the RCC.

Methods: Oregon Department of Fish and Wildlife (ODFW) protocols will be matched as closely as possible to provide protocols consistent with long-standing data sets (e.g., Forest Service). Record the relative location of each live fish, redd, and carcass in regards to position in the reach, and indicate whether live fish are actively spawning. Mark carcasses, and record the species, sex, hatchery/wild. The start and end points of the surveys will be identified on a map. Surveying will be integrated to the extent possible with ongoing ODFW and Forest Service surveying.

Surveys in Soda Springs bypass reach, Copeland, Calf, and Boulder creeks will be surveyed by wading. Surveys in the upper Wild and Scenic Reach will be conducted using boats (e.g., kayak, cataraft). A dry suit should be worn during surveys for safety and to facilitate direct observation of holding (and spawning) habitat.

Coho salmon and steelhead surveys will likely take 3-5 days (approximately every 10 days) to complete for a two-person crew. The Wild and Scenic reach of the North Umpqua will take one day with a crew of three to survey.

3.2 Interim conditions: Years 8 through 20 (2012-2024)

3.2.1 Y8-20 monitoring downstream migration.

Monitor the downstream migration of juvenile fish produced upstream of Soda Springs Dam.

Locations: Soda Springs Dam (juvenile bypass system, spillway, release valve, ladder), downstream end of Soda Springs bypass reach (i.e., RST).

Schedule: Year-round (at least once/week).

Methods: Enumerate juvenile salmonids using fish monitoring equipment at the juvenile bypass system (e.g., video, PIT tag antenna), the fish ladder (e.g., video, PIT tag antenna), the spillway, and at the downstream end of Soda Springs bypass reach (i.e., RST). The feasibility of installing PIT tag antennas at the juvenile bypass system, fish ladder, and spillway will be evaluated in cooperation with construction design engineers, and will be built into the design to the extent feasible.

Monitoring at each location and at the downstream end of Soda Springs Bypass Reach will provide an estimate of production upstream of Soda Springs Dam and the proportion of fish using each route under various conditions. Monitoring will be coordinated with the predation control study to estimate predation.

3.2.2 Y8-20 conducting annual spawning ground surveys.

Estimate the number of returning spring Chinook salmon, coho salmon, and steelhead spawners in the North Umpqua River upstream of Soda Springs Dam and compare to the number of spawners in reaches below Soda Springs Dam.

Locations: Slide Creek full-flow reach, Slide Creek bypass reach, lower Fish Creek bypass reach, Soda Springs bypass reach, upper Wild and Scenic Reach of the North Umpqua River, and Boulder, Copeland, and Calf creeks. If initial surveys indicate that anadromous fish get past the possible barriers at RM 3.2 and 4.0, the extent of anadromy will be determined through surveys within the Fish Creek watershed, and subsequent years will incorporate these areas in the annual spawning ground surveys.

Schedule: Annually starting in 2011. Sample every 7–10 days mid-September through January; sample every 7–10 days February through late May (as conditions allow between storms). Please note that detection and identification of steelhead and coho salmon redds in the upper Wild and Scenic Reach may be problematic and may not provide useful results. A decision regarding whether to conduct spawning surveys for steelhead and coho in the upper Wild and Scenic Reach will be determined by the TWG and the RCC.

Methods: Oregon Department of Fish and Wildlife protocols will be matched as closely as possible. Surveys in the Slide Creek, Fish Creek, and Soda Springs bypass reaches can be conducted by wading. Surveys in the Slide Creek full-flow reach will likely require a boat (kayak or cataraft). A dry suit should be worn during surveys for safety and to facilitate direct observation of holding (and spawning) habitat.

Record the location of each live fish, redd, and carcass on a map of the reach, and indicate whether live fish are actively spawning. Mark carcasses, and record the species, sex, hatchery/wild. The extent of the surveys will be identified.

Surveys will likely take 2–3 days to complete for a two-person crew. Fish Creek will likely require 1 full day to complete.

3.3 Post-passage conditions: Years 21 through 35 (2025-2039)

3.3.1 Y21-35 determining benchmark conditions

Describe fish population conditions in reaches upstream of Soda Springs Powerhouse subsequent to fish passage to compare with baseline conditions.

Locations: Soda Springs bypass, Slide Creek full-flow, Slide Creek bypass, Fish Creek bypass reaches.

Schedule: Annually (as funding allows).

Methods: Direct observation snorkel surveys will be used to conduct abundance estimates (relative abundance and species composition). Surveys will use methods comparable to surveys conducted during pre-passage conditions (Section 3.1.1, Appendix 3). Surveys will be conducted in index reaches established during pre-passage conditions surveys to compare changes during implementation of the new license.

3.3.2 Y21-35 estimating post-passage juvenile fish production

Estimate juvenile production of steelhead, salmon and trout in the North Umpqua River in the Upper Wild and Scenic Reach, Boulder, Copeland and Calf creeks.

Locations: North Umpqua River in the Upper Wild and Scenic Reach; Boulder, Copeland, and Calf creeks; Soda Springs bypass reach.

Schedule: Fish rotary screw traps annually as funding allows for periods of at least three consecutive years at a time.

Methods: Rotary screw traps will be used to assess juvenile fish production using methods comparable to those conducted during pre-passage conditions (Section 3.1.2, Appendix 3). Juvenile fish production in the upper Wild and Scenic Reach and Boulder Creek will be conducted using adjusted redd survey data as in Section 3.1.2..

3.3.3 Y 21-35 conducting post-passage spawning ground surveys

Estimate the number of returning spring Chinook salmon, coho salmon, and steelhead spawners in the upper Wild and Scenic Reach, Boulder, Copeland, and Calf creeks, Slide Creek full-flow reach, Slide Creek bypass reach, lower Fish Creek bypass reach, and Soda Springs bypass reach.

Locations: The North Umpqua River upper Wild and Scenic Reach; Boulder, Copeland, and Calf creeks; Soda Springs bypass reach. Slide Creek full-flow reach, Slide Creek bypass reach, lower Fish Creek bypass reach, and Soda Springs bypass reach

Schedule: Annually. Sample every 7–10 days mid-September through January; sample every 7–10 days February through late May (as conditions allow between storms). Please note that detection and identification of steelhead and coho salmon redds in the upper Wild and Scenic Reach may be problematic and may not provide useful results. A decision regarding whether to conduct spawning surveys for steelhead and coho in the upper Wild and Scenic Reach will be determined by the TWG and the RCC.
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Methods: Spawning habitat surveys will be conducted using methods comparable to those conducted during earlier surveys (Section 3.1.3, Section 3.2.2, Appendix 3).

4 PREDATOR CONTROL STUDY

The goal of the Predator Control Study is to determine if non-native predators (i.e., brown trout) in the vicinity of Soda Springs are likely to substantially reduce the success of anadromous fish re-introduction efforts. If results indicate a substantial reduction in re-introduction success due to non-native predators, a program will be considered to reduce the impacts of predators. General methods are described here, and more detail on each methodology is provided in Appendix 3. The predator control study work plan is provided in Appendix 5. Work in support of these tasks will begin in 2006 and be completed in 2007.

4.1 Evaluating pre-passage predator population using mark and recapture

Describe the number, species composition, size distribution, and growth rates of fish in Soda Springs Reservoir using a focused mark and recapture study. This task will be conducted in conjunction with the determination of consumption rates, described in Section 4.1.2.

Locations: Soda Springs Reservoir.

Schedule: The predator population estimate will be conducted in the spring coincident with determining pre-passage consumption rates. Field sampling for the combined population estimate/consumption rate estimates will consist of three separate 72-hour sampling efforts, each at least one week apart. Growth rates will be determined from recaptures collected in the spring during the population estimate and evaluation of consumption rates.

Methods: Various fish capture methods, including trap nets (e.g., Oneida), gill nets, angling, and electrofishing may be used to capture as many fish as possible during each sampling effort. Electrofishing and angling have been the most productive sampling methods to-date. Three sampling efforts will be conducted, with at least 1 week separating efforts to ensure redistribution and equal mixing of the population for mark/recapture statistical design. Each sampling effort will be conducted for a three-day period (i.e., approximately 72 hours). Sampling will concentrate on morning, evening, and night, when capture efficiency is greatest. For all methods, time of effort will be recorded to calculate CPUE (catch per unit effort, either soak time or angler-hours). Crews can alternate between gill netting, checking traps, and angling. Four 2-person crews will be required for continuous sampling, assuming 2 crews alternately work 12-hour shifts.

Species, length, and weight for each fish captured will be recorded. All captured trout will be scanned for PIT tags, and PIT tags will be inserted into all un-tagged fish greater than 65 mm fork length. All trout that are PIT-tagged will also be measured for length and weight, and a scale sample will be collected to determine size at age. A full-duplex PIT-Tag (12mm/134.2kHz) will be inserted into body cavity. For subsequent efforts, each fish will be scanned for a PIT tag immediately after capture, and fish that do not have PIT tags will be marked. Scales will be collected from all fish tagged and released, and from any sacrificed fish. Scales will be analyzed to assess age and growth of fish. Program MARK will be used to conduct size-specific population estimates.

4.2 Predicting consumption rates pre-passage

Determine consumption rates of brown and rainbow trout in Soda Springs Reservoir and describe the relationship between predator size and consumption rate. This task will be conducted in conjunction with the spring estimates of the predator population size described in Section 4.1.1.

Locations: Soda Springs Reservoir.

Schedule: Spring (March–June) 2006–2007, to coincide with predicted peak spring Chinook salmon outmigration.

Methods: To determine the potential consumption of piscivorous trout on Chinook salmon hatchery Chinook salmon will be experimentally released into Soda Springs Reservoir prior to fish passage provisions. The response (i.e., consumption rate) of the predator population will be directly measured. Three (3) experimental release groups of approximately 500, 2,000, and 8,000 batch-marked juvenile Chinook salmon will be used in each of 3 separate efforts to determine the relationship between prey density and predator consumption rates. After each release (smallest group first), 3 days (72 hours) of sampling will occur to capture fish, in conjunction with population estimate capture methods described in Section 4.1.1.

Consumption will be measured directly to determine (1) the size of predators that respond to anadromous salmonids prey, and (2) the densities of prey that elicit a response. Stomach sampling (gastric lavage) will be conducted on all fish captured to document diet, and consumption rate of fish in release groups. All stomach contents will be preserved (or placed on ice) for later analysis. The number of identifiable fish remains will be enumerated, and the live-lengths of all fish found in digestive tracts will be estimated. The proportion of fish in the diet will be determined by wet mass.

Using PIT tagging during mark and recapture efforts described in Section 4.1.1, individual growth rates will be measured. Growth rate data on the current trout population will provide a useful reference point in bioenergetics modeling (i.e., model calibration to empirical data), and a comparison with post-passage conditions (e.g., growth rates may increase for some life-stages with reintroduction of anadromous fish).

4.3 Predicting predation-related anadromous fish mortality pre-passage

Estimate impact of predation in Soda Springs Reservoir after reintroduction, based on pre-passage data.

Locations: Soda Springs Reservoir.

Schedule: 2007-2008 subsequent to field analysis

Methods: Size-specific estimates of predator population size and consumption rates will be used to estimate the number of juvenile salmonids likely to be consumed given the present population size, and various potential levels of production.

A bioenergetics model such as Fish Bioenergetics 3.0 (Hanson et al., 1997) will be used to estimate the number of juvenile salmonids likely to be consumed given the present population size, and various potential levels of production. Bioenergetics modeling uses the energy balance equation that consumption equals the sum of metabolism, waste, and growth:

$$C=M+W+G$$

where growth is used to calculate consumption. Bioenergetics modeling has been used successfully at other sites to make reasonable estimates of the potential total consumption of a piscivorous population (e.g., Beauchamp 1995; Baldwin et al. 2000; Ruzycki et al. 2003). The strength of bioenergetics modeling is that it integrates environmental and physiological factors that regulate production and growth of a predator population, and allows different scenarios to be evaluated to assess potential future conditions, or to account for uncertainty in the values used (e.g., if predator population size is larger, or smaller, than estimated). Bioenergetics modeling, when coupled with results from the functional response to different numerical releases of salmon, will provide a predictive tool to assess potential predation under various scenarios of anadromous smolt production, and of changes in the predator population (i.e., potential success of a control program). The bioenergetics model could also be used as a gaming tool for adaptive management of the predator control strategy subsequent to fish passage.

Comments: The TWG will require robust data, such as the data provided by a bioenergetics modeling approach, to determine if control measures are warranted prior to passage. The bioenergetics model would be useful in estimating the effects of predation from a known (or estimated) population of predacious brown and rainbow trout on a known (or estimated) number of juvenile fish migrating through Soda Springs Reservoir.

In addition, ongoing monitoring and updating simulations with the bioenergetics model will likely be needed to analyze predator population changes in response to reintroduction of anadromous fish upstream of Soda Springs Dam and predator control efforts. Post-passage survival of smolts through the reservoir can be directly measured by marking fish at a rotary screw trap upstream of Soda Spring Reservoir, and recapturing in the evaluation system on the juvenile bypass (fish screen evaluator).

4.4 Develop and implement predator control plan if warranted

If RCC agrees that predation may be a significant impact on the population, then options for long-term, small- or large-scale brown trout control will be considered. A pilot small-scale or large-scale brown trout control program may also be warranted. The RCC will decide whether data collected in anadromous fish pre-passage years provides sufficient information for making decisions on predator control methods to use after anadromous fish passage begins.

Locations: To be determined (Soda Springs Reservoir, Slide Creek Bypass Reach, Slide Creek full-flow reach).

Schedule: 2009. Pre-passage predation evaluation in Soda Springs Reservoir will be available by 2008, so the TWG/RCC can decide whether, and to what extent, the pilot scale testing is warranted.

Methods: To be determined.

Comments: Predator control options will be challenging in Soda Spring Reservoir because potential recruitment to the brown trout population from upstream is likely very high, and because a reduction in large brown trout may cause an increase in both smaller (yet piscivorous) brown trout, and large piscivorous rainbow trout. Predator control measures should be carefully tested prior to complete implementation. An ongoing monitoring program of the rate of predation mortality and response of the predator population to control measures will likely be warranted, with adjustments to the control program based on results.

4.5 Prepare final report

Produce a final report to the TWG and RCC per SA Schedule 19.2.1, including recommendations for addressing non-native predation.

Schedule: 2010 for initial report, with follow-up report after fish passage. Evaluation of predation in Soda Springs Reservoir will be available by 2008 so the TWG and RCC can decide whether, and to what extent, predator control is warranted.

Ongoing monitoring of the level of predation mortality, and the response of predator populations to control measures, will likely be warranted, with adjustments to the control program based on results.

5 EQUIPMENT AND DATA MANAGEMENT FOR LONG-TERM MONITORING AND PREDATION CONTROL

Successful implementation of the long-term monitoring and predator control study plan will require several dedicated, relatively expensive pieces of equipment such as a work boat, nets, and traps. To complete all required work at the appropriate times, the program cannot rely solely on loaned and borrowed federal, state, and private company equipment. Equipment purchased and maintained with SA 19.2 funds will be the property of PacifiCorp unless other arrangements are made with ODFW or other TWG agencies. PacifiCorp will store equipment on the North Umpqua Hydroelectric Project, and it will be available for all SA 19.2 studies as a top priority. If such equipment requires repair, replacement, or maintenance as a result of use for unrelated work (either by PacifiCorp or TWG agencies), the agency performing the other use will be expected to pay for such repair, replacement, or maintenance. Any dispute related to equipment will be discussed among the TWG first, and the RCC if necessary.

The overall management of this program will be the responsibility of the ODFW Umpqua Fish District biologist funded under the SA, in close cooperation with PacifiCorp and the TWG. Program management will require storing and sharing of data, analyzing data, quarterly and annual reporting, and field work permitting.

5.1 Data

Notes, spreadsheets, and data summaries and databases will be stored at ODFW with copies of all electronic files forwarded at least quarterly to the TWG for review and back-up storage. All reasonable attempts will be made to collect and manage data in a consistent fashion to facilitate hypothesis testing and comparisons.

5.2 Analyses

Analyses will primarily be performed by ODFW, although any TWG member may perform their own analyses as well. All data analyses and conclusions will be provided to the TWG for critical review before being distributed to the RCC or a wider audience. This process will provide an opportunity for a critical review to minimize misinterpretation or invalid comparisons.

Specific contractors may be required to summarize and analyze data they collect as part of their contract. All data, spreadsheets, databases and analyses developed under a SA 19.2 contract will be made available to the TWG.

5.3 Reports

Quarterly updates will be prepared by ODFW for cooperating entities, along with an annual summary report and presentation prepared by ODFW and PacifiCorp for the TWG and RCC. Updates will include previous month's activities, data collection efforts, and a

brief data summary. The annual report and presentation will be provided to the TWG in February, and to the RCC in March (unless the TWG postpones further for revision). It will summarize the work completed during the previous season, relative to each of the objectives in this plan, and in context with what was known prior to that year's work. Annual reports will also contain recommendations of work priorities for future years. Any form of adaptive management instituted or recommended will be noted, along with an explanation of the reason for the need. A report format will be developed to promote consistency among years.

5.4 Permitting

Fish sampling and collection permits from ODFW (and possibly the National Marine Fisheries Service, NMFS) will be necessary to perform all intended study plan and long-term monitoring work. Requirements may include a 4(d) Scientific Research and Take Authorization Permit, Section 7, and an ODFW Scientific Taking Permit. ODFWs Umpqua Fish District will coordinate with USFS and PacifiCorp to obtain the annual permits. Annual permit reports and applications will be the responsibility of the Umpqua Fish District biologist funded under the SA.

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APPENDIX 1 – SA Schedule 19.2.1

Long-Term Monitoring Goals and Predator-Control Objectives

These statements of objectives are intended to guide implementation of the fund provided under Section 19.2 of the Agreement. An overarching principle is that the greater portion of the fund will be used for long-term monitoring purposes.

Long-Term Monitoring

Years 1 through 7 of New License (prepassage conditions):

- Determine baseline conditions in response to increased bypass flow in stream reaches upstream of Soda Springs powerhouse (trout species abundance and composition).
- Estimate juvenile fish production in the main-stem North Umpqua River in the upper Wild and Scenic Reach and Copeland and Calf creeks.
- Conduct spawning-ground surveys for spring Chinook and steelhead in the upper Wild and Scenic Reach and Copeland and Calf creeks.

Years 8 through 20 of New License:

- Monitor the downstream migration of juvenile fish one to three times per week using the fish-screen evaluator (year-round).
- Use mark and recapture testing to determine the relationship between flow and the proportion of migrants that are bypassed by the screen or the spillway (two to three seasons of intermittent tests).
- Monitor condition of all migrants (injury and mortality).
- Determine timing and magnitude of migrations.
- Estimate annual juvenile production.
- Conduct annual spawning-ground surveys for anadromous fish in the North Umpqua River above Soda Springs Dam and in Fish Creek. Document timing of spawning and emergence and locations of spawning. Coordinate with other studies.

Years 21 through 35 of New License (postpassage conditions):

- Determine new baseline conditions (post-reintroduction) by conducting fish inventory in stream reaches upstream of Soda Springs powerhouse (resident/anadromous species abundance and composition, response to increased flow).
- Estimate postpassage juvenile fish production in the main-stem North Umpqua River in the upper Wild and Scenic Reach and Copeland and Calf creeks (to assess potential production benefits to these areas due to fish passage at Soda Springs Dam).
- Conduct postpassage spawning-ground surveys for spring Chinook and steelhead in the upper Wild and Scenic Reach and Copeland and Calf creeks (to assess potential production benefits to these areas due to fish passage at Soda Springs Dam).

Predator Control

These objectives concern the potential predation of anadromous salmonid juveniles by nonnative species.

Prepassage Predator Evaluation at Soda Springs Reservoir

Estimate the predator population and likely effects on juvenile anadromous fish in Soda Springs Reservoir.

Determine if predator control is warranted to minimize effects of predation on anadromous fish in Soda Springs Reservoir.

If the impacts of predation on anadromous fish in Soda Springs Reservoir are likely to be few, evaluate potential costs and benefits of implementing small-scale predator control efforts following initiation of fish passage.

If the impacts of predation on anadromous fish in Soda Springs Reservoir are likely to be many, use data on predator size and number to design predator-control program for implementation following initiation of fish passage at Soda Springs Dam.

Predator-Control Testing

During the period of 2006 through 2008, test prepassage predator-control programs, if a predator-control program is determined to be warranted.

Form a technical committee of the RCC to review data and evaluate whether the predator-control program(s) are successful at achieving goals and are feasible to employ after fish passage, considering potential impacts on anadromous fish.

Assess whether the magnitude of predation in the reservoir and the success and feasibility of the predator-control program(s) warrant implementation of alternative management options at Soda Springs Dam.

Prepare a final report on predation evaluations and predator-control tests, an implementation plan for postpassage predator control, and a monitoring plan to provide data to a technical committee of the RCC. Throughout the license term, the technical committee will review monitoring data and make recommendations for predator-control efforts on a yearly basis and will make recommendations regarding any necessary adjustments to the predator-control program.

APPENDIX 2 – SA 19.2 Technical Working Group and selected events

NAME	AFFILIATION	PHONE #
Stephanie Burchfield	NMFS	503-736-4720
David Harris (Co-leader)	ODFW	541-440-3353
Ken Homolka	ODFW	541-440-3353
Jim Brick	ODFW	541-440-3353
Sam Moyers	ODFW	541-440-3353
Rich Grost (Co-leader)	PacifiCorp	541-498-2617
Craig Street	USFS	541-498-2531
Pam Sichting	USFS	541-957-3342
Rob Burns	USFWS	541-957-3477
Dirk Pedersen (consultant)	Stillwater Sciences	707-822-9607

DATE	EVENT
December 2003	consultation begins on plan
April 2004	first working draft plan released
May, June 2004	plan revisions
September 2004	initial SSR hydroacoustic sampling (report 12/16/04)
October 2004	initial SSR fish sampling (report 11/5/04)
July 2005	revised draft study plan
August 2005	repeat SSR hydroacoustic sampling (report 2/17/06)
August 2005	repeat SSR fish sampling (report 1/25/06)
1/25/06	TWG meeting
February 2006	Stillwater Sciences review of draft study plan
2/14/06	TWG meeting
March 2006	revised plan, TWG meeting, smolt trapping begins
May 2006	revised plan, TWG meeting, spring fish sampling on SSR
June 2006	revised plan, TWG meeting, 2 nights of electrofishing on SSR
July 2006	Final Plan

APPENDIX 3 – Potential Sampling Method Details

The following study methods will be conducted in the first several study years to determine which are most useful and effective for the specific study area. These methods may be revised as necessary by the TWG to meet study objectives as safely and efficiently as possible.

Snorkel Surveys

Snorkel surveys will be conducted to assess species composition and relative abundance in reaches upstream of Soda Springs Powerhouse (Soda Springs bypass reach, Slide Creek full-flow reach, lower Slide Creek bypass reach, upper Slide Creek bypass reach, and Fish Creek bypass reach). Prior to conducting snorkel surveys, habitats units within the reaches will be classified (e.g., pool, riffle, run), habitat unit boundaries will be delineated on base maps, and habitat unit characteristics will be measured and recorded.

In order to compare trends in reaches over time, a subset of habitat units (index units) will randomly selected from within each of the reaches. Snorkel surveys will be conducted at night to improve observation probability. If desired, a reconnaissance survey comparing day and night surveys can be conducted to estimate difference in the observation probability, and determine whether day surveys may be feasible. Snorkel surveys will be conducted in habitat units, surveying in an upstream direction, where stream velocities and depth allow. Surveyors employing this method are less likely to startle fish, because most stream-dwelling fish face upstream (Dolloff et al. 1996). Surveys will be conducted in a downstream direction where units are either too swift and/or too deep to allow upstream surveying (e.g., portions of the lower Slide Creek Reach). Multiple dive passes will be conducted within each of the index units to calculate variance and facilitate comparison. Safety, access, and time required for conducting sampling will be considered when selecting index units. The upstream and downstream ends of index units will be flagged to facilitate locating the reach boundaries at night. The note takers are also responsible for spotting the divers for safety. Species, numbers, and estimated total lengths will be recorded for each fish or group of fish observed.

The number of divers used for each habitat unit will be adjusted according to habitat unit size. When multiple divers are used, sampling units will be divided into lanes of equal width, and divers will work upstream or downstream counting all fish within their assigned lane (Dolloff et al. 1996). The note-takers will walk along the stream bank or in the stream downstream of the diver, recording data as it is communicated to them.

Juvenile fish production estimates

Rotary outmigration traps will be placed in both Copeland and Calf Creeks and the upper North Umpqua River to collect juvenile salmonid data.

Typically a five-foot rotary trap is used in small tributaries such as Copeland and Calf Creeks. Trap operation will commence first in both Copeland and Calf Creeks in order to

calculate salmonid populations. Eight-foot rotary traps are used in larger mainstem rivers such as the North Umpqua River. Trap locations are based on pool depth, upstream habitat features (bedrock shelf, bedrock step, gravel riffle), distance upstream of the confluence of two creeks, or downstream of tributaries. Rotary traps are dependent on water flows to turn the drums and capture fish. Traps are assembled on site if access is limited and secured using a cable/pulley system. Traps can be placed pre-assembled if road access is available to lift or back the trap directly into the creek or river. Traps will be flagged or fitted with flashers to warn swimmers, rafters, and boaters. Signs warning of potential danger will be placed upstream providing ample time to exit the river or creek.

Rotary trap operation occurs seven days a week, typically beginning in March through May. Trap operation on smaller tributaries such as Copeland and Calf Creeks tend to cease by early summer due to reduced water flows. In larger rivers such as the North Umpqua River, trap operation can continue indefinitely if desired. All captured fish are identified, counted, and released downstream below the trap. A sub-sample of salmonids will be anesthetized with carbon dioxide tablets, measured, and weighed. Population estimates are made by fin marking (upper and lower caudal fin) fish and releasing upstream above the trap. Weekly trap efficiencies are obtained and used to estimate the total outmigration population of a species of fish. Additional tagging (PIT Tags) may be implemented during trap operation, assuming antennas are installed at key locations within each stream and bypass facility, to provides life history information such as rates of movement from the natal stream to points downstream. A rotary trap has been operated in the past in Calf Creek by USFS fishery biologists.

Spawning surveys

Spawning ground surveys will be conducted by wading stream reaches and documenting the number and location of live fish, carcasses, redds, and identifying marked and unmarked fish. A two-person crew surveys a stream reach walking upstream to the identified end point. ODFW's Oregon Coastal Salmonid Inventory Project, as part of the Oregon Plan for Salmon and Watersheds, protocol requires a survey every 10 days over the entire spawning period. Data collection includes, but is not limited to the following: Reach ID or segment, UTM coordinates, target species, survey type, weather, flow, visibility, marked or unmarked, etc. ODFW procedure manuals are available for reference. Forest Service protocols will be integrated with survey methods to ensure consistency. To cover coho salmon, spring chinook salmon, summer and winter steelhead, brown trout and rainbow trout, spawning surveys should begin in mid-September and continue with few interruptions through May.

USFS fishery biologists on the Umpqua National Forest have established spawning ground surveys in Boulder, Copeland, and Calf Creeks, as well as the North Umpqua River from Soda Springs generator downstream to Rock Creek. This plan assumes that the USFS will continue to survey these stream reaches, enabling this study to focus on currently unsurveyed reaches. Ultimately, spawning surveys should cover the full distribution of salmonid spawning populations in the study area. Close annual coordination with USFS will ensure that reaches do not go inadvertently unsurveyed.

Gill Netting
For mark-recapture population estimates and analysis of consumption rates (i.e., when live fish with minimal injury are targeted), gill nets will be deployed only when they can be continuously tended. The sampling frequency for the population estimate will be to sample continuously for a three-day period during the three sampling periods. Once deployed, the gill nets will be visually monitored. Fish caught in a net will be removed immediately and processed. Fish will be allowed to recover sufficiently before release.

Gill nets with variable mesh sizes will be used to capture a fish greater than about 5 inches. Nets will be set in various locations throughout the reservoir, although nets will remain close enough to one another to allow multiple nets to be tended by one crew. Set locations will vary and may be concentrated in locations with greater capture efficiency, with a goal of collecting and recapturing as large a sample size as possible.

Trap Netting
Trap nets may be used in selected shallow shore habitat to collect brown trout residing in Soda Springs Reservoir. The trap net (Six Foot Oneida Lake Trap Net) is attached to a fixed object on shore. The trap when set has a 100' lead net, which is 6' in height. Attached is 7' X 6' x 6' box fyke trap, and two wings measuring 12' by 6' set at a 45 degree angle to the box fyke trap. Both the box trap and wings have internal fykes to capture swim in fish. Mesh size is #122, 0.69 inch stretch mesh, which is capable of trapping fish over about 4–6 in. The trap contains a series of zippered compartments in both the box fyke and wings of the trap.

Trap nets will be set throughout the reservoir to collect as large a sample size as possible. The sampling frequency for population estimates will be to sample continuously for a three-day period, for three consecutive weeks. The trap is checked regularly (approximately every 12 hours during the 3-day sampling period. Captured fish are alive within the box fyke trap and wings of the net. The box fyke trap is pulled onto the bow of the boat and each zippered compartment checked for fish. The wings are searched once all fish have been removed from the box fyke trap. Captured trout are netted and placed in holding containers located in the rear of the boat. Fish captured will be taken to shore and worked up in a designated area.

All captured fish will be anesthetized using carbon dioxide tablets, identified to species, measured, weighed, and scanned for a PIT tag. Untagged fish will be tagged.

Hook and Line Sampling
Trout will be collected using hook and line collection techniques which are efficient in deep, complex, and fast-water habitats where nets and electrofishing are not. Anglers will use lures and fish from boats or bank to collect trout samples. Fishing will be conducted opportunistically, when not checking other gear types. All fish landed will be placed in on board holding containers. Both rainbow and brown trout collected will be handled using the same procedures mentioned in the trap netting section. As many fish as possible will be marked.

Boat Electrofishing

Boat electrofishing is typically done from a heavy-gauge aluminum flat bottomed boat measuring at least 12 feet in length by 5 feet in width. Outboard motors of moderate horsepower and trolling speed are required for electrofishing. The boat should have a large forward deck, which will accommodate two standing adult dipnetters. A waist-high bow railing must surround the forward deck. Two retractable booms are located on the front of the boat, which support electrodes. Boat electrofishing requires a 3-person crew, a boat operator and two dipnetters. Electrofishing within the reservoir will concentrate on shallow areas (e.g., <10 feet) and along banks. Reaches are generally 1,300–1,500 feet in length requiring approximately 30–45 minutes of sampling time. All dipnetted fish are placed in on board holding containers. Once each reach is completed, electrofishing ceases and the captured fish are processed. When processing is completed, all captured fish are returned to the reach where they were originally captured.

Both rainbow and brown trout collected will be handled using the same procedures mentioned in the trap netting section. As many fish as possible will be marked. The ODFW owned electrofishing boat is stationed in Corvallis and is available for projects. Coordination several weeks in advance with ODFW's Eastern Oregon warmwater biologist is required.

PIT Tagging

Passive Integrated transponder (PIT) tags (full-duplex style). PIT tags will be inserted surgically by making a small incision on the underside of the trout just below the pectoral fins. The incision will be "glued" shut using Nexaband, a veterinary product used as sutures in moist, wet areas. Once recovered, the tagged trout will be re-released in the area of original capture.

Hydroacoustic Sampling

MaxDepth Aquatics, Inc. will estimate fish population size and distribution using hydroacoustic techniques. A BioSonics DT-X digital echosounder equipped with a 6.6^{o} 200 KHz split-beam transducer will be deployed from a 12 ft Zodiac boat. A calibration using a standard 33mm steel ball will be preformed on-site to ensure accurate target strength measurements. The transducer will be oriented at a forward-looking angle for the fish target acquisition tasks. This will help minimize boat avoidance in the shallow water. The boat speed will be maintained at or below 8 kph for the deployment. The echosounder will be integrated with a Trimble DGPS capable of sub-meter level accuracy. Echograms and positioning information will be interlaced on the ehcosounder's dedicated Linux box, and stored on a Panasonic Toughbook CF-28. Field data will be backed up on CD from the laptop. Data acquisition will be set to 5 pings per second with a pulse length of 0.4 ms. The echograms will be analyzed using Biosonics Visual Analyzer software to yield fish target strength and location information. Target strength information will be converted to estimate fish length using Love's equation. Results will be tabulated and estimates of abundance and size class distribution included in contractor's report.

Consumption Rates

Trout will be tagged (PIT tags) and placed in recovering containers prior to release as part of a mark recapture population estimate. Stomach contents will be sample for all trout captured during the evaluation of consumption rates. Stomach analysis will be preformed using gastric lavage (stomach pumping). Water is forced into the trout's stomach via a pump system. Stomach content is forced out of the mouth into individual collection containers, and placed on ice for later analysis. Stomach contents will be examined, and number and proportion (wet mass) of fish in the diet will be measured. The number and size of fish consumed will be used to estimate predation, and proportion of diet will be used in bioenergetics modeling.

Water temperature in Soda Springs reservoir will be monitored since trout energetics (e.g., consumption and evacuation rates) is strongly influenced by temperature.

Bioenergetics Modeling

Size-specific estimates of population size and consumption rates will be used to estimate the number of juvenile salmonids likely to be consumed given the present population size, and various potential levels of production. A bioenergetics model such as Fish Bioenergetics 3.0 (Hanson et al., 1997) will be used to estimate the effect of predation on juvenile fish production. Data to populate the model will be based on methods described in Sections 4.1.1 and 4.1.2, including size class-specific population estimates, size at first piscivory, growth rate, consumption rate, and water temperature.

APPENDIX 4 – Cost Estimate Details

The estimated cost of a three-person ODFW EBA (experimental Biological Aide) or PUR (Partnership for Umpqua Rivers) crew is $7,500/month. An additional $750/month for service and supplies should be added. Consideration should be given to having PUR employees do a portion of the work as a way of strengthening the relationship with our local watershed council and providing work/opportunities for young people and interested local people.

Estimate Baseline and Benchmmark Fish Population Conditions

Snorkel Surveys
Snorkel surveys will be conducted annually, and require approximately one week to complete for two 2- or 3-person crews. Snorkel equipment including dry suits, hood, mask, snorkel, etc. cost approximately $1,000.

Spawning Surveys
Spawning surveys will be conducted annually and will require approximately 2–3 days/week for a two person crew for the period of mid-September to January, and 1–2 days/week for a two person crew for the period of February to May. The estimated cost of a two-person ODFW EBA (experimental Biological Aide) crew is $5,000/month. Assuming half-time for a 9-month period, the crew would cost approximately $26,375. The remaining costs would include miscellaneous materials (waders, polarized glass, wading boots, measuring equipment, etc.), which is an additional $500.

Juvenile Production Estimates
A five-foot rotary outmigrant trap is approximately $13,000. A trailer to transport the trap is an additional $4,000. Eight-foot rotary outmigrant traps are approximately $16,000. Depending on the number of traps operating (1–3), a three-person crew would be required to run the traps. For a 3-month period, the crew would cost approximately $24,750.

Estimate predator population, consumption rates, and growth rates

Predator population and consumption rates would be conducted concurrently over approximately a one month period. Assuming two 3-person crews and intensive sampling (24 hr/day), labor would cost approximately $33,000–$49,500. Estimating predator growth rates will require an abbreviated field effort of approximately 2–3 days, using similar methods, at a cost of approximately $6,250.

Gill Netting
Gill nets cost approximately $200 each. Each crew of two people could probably attend three gill nets while sampling.

Trap Netting
The trap net portion of the study plan will require a three-person crew, boat, trap net, along with miscellaneous materials (waders, holding containers, measuring equipment, etc.). The cost of a boat and motor to deploy and retrieve the trap net is approximately $20,000. To purchase a standard trap net, the cost is approximately $2,300 (1995 quote). Miscellaneous supplies would add an additional $1,500. Tag costs are described in the PIT tagging section

Currently ODFW's Umpqua Fish District does have a boat and two trap nets which meet these requirements. Availability is unknown at this time, and it is recommended that the District Biologist be contacted to request use of this equipment as soon as a need is identified. Tagging materials may also be available from the Umpqua Fish District.

Hook and Line Sampling
Collection of fish using hook and line from both boat and bank is the least effective method for trout collection, but can easily be incorporated into the existing sampling protocols at low cost. Sampling gear would include fishing rods and reels, line, lures, bait, etc. Cost to outfit a three-person crew is approximately $500. Tagging equipment costs are included under PIT tagging, and general field equipment (waders, holding containers, measuring equipment, etc.) are included under general equipment costs would be equal to those previously mentioned.

Boat Electrofishing
Based on Smith-Root estimates, electrofishing boats range in price from $40,000-$60,000 (boat trailer $4,500). Miscellaneous costs would be similar to the trap netting estimates ($2,350). Electrofishing should be done at night over the same time period as trap netting occurs. Trap netting and boat electrofishing can be used in combination with mark and recapture efforts. ODFW owns two boat electrofishing units. One of the electrofishing boats is stored at ODFW's Salem District Office. Availability for long-term projects is unknown at this time.

PIT Tagging
The placement of PIT tags will be concurrent with the sampling efforts described above. In addition to costs associated with the three-person crew, trap netting or boat electrofishing, the cost for 100 PIT tags is approximately $325. Miscellaneous equipment (nexaband, scalpels, disinfectant, etc.) is an additional $200. The cost of a hand held PIT tag reader is $300.

Hydroacoustic Sampling for Fish Abundance and Size Distribution
An estimate from MaxDepth Aquatics, Inc. regarding the cost to complete both the hydroqustics and bathymetry has been acquired. Max Depth Aquatics, Inc. will provide all equipment needed to collect and analyze data. Each survey will be compared with previous ones to identify trends. This estimate does NOT include direct fish sampling, which is required to determine the species and size of fish detected by hydroacoustics. Completed reports will be provided via email to all Parties. Estimated cost is $7,000 per survey.

APPENDIX 5 – Work plan to evaluate potential for predation by nonnative piscivorous trout in Soda Springs Reservoir on juvenile salmonids produced upstream of the reservoir

May 2006

Introduction

The Settlement Agreement (SA) for the Relicensing of the North Umpqua Hydroelectric Project requires PacifiCorp to fund a Long Term Monitoring and Predator Control study and program (SA Section 19.2). The purposes of this measure are: 1) to formulate and implement a study plan, implementation plan, and monitoring and adaptive management plan concerning the potential predation of anadromous salmonid juveniles by nonnative predator species in Soda Springs Reservoir; and 2) to monitor and evaluate the success of the anadromous fish reintroduction in the North Umpqua River upstream of Soda Springs Dam.

Schedule 19.2.1 further defines the following four objectives of the prepassage predator evaluation:

- Estimate the predator population and likely effects on juvenile anadromous fish in Soda Springs Reservoir.
- Determine if predator control is warranted to minimize effects of predation on anadromous fish in Soda Springs Reservoir.
- If the impacts of predation on anadromous fish in Soda Springs Reservoir are likely to be few, evaluate potential costs and benefits of implementing small-scale predator-control efforts following initiation of fish passage.
- If the impacts of predation on anadromous fish in Soda Springs Reservoir are likely to be many, use data on predator size and number to design predator-control program for implementation following initiation of fish passage at Soda Springs Dam.

This work plan is intended to provide details on the tasks that will be performed to evaluate potential predation of anadromous salmonid juveniles by nonnative predator species in Soda Springs Reservoir (Purpose 1 above). Work contained in this work plan has been broken down into 5 tasks: (1) parameter review, (2) fish growth evaluation, (3) predator consumption rate evaluation and population estimate, (4) analysis, and (5) reporting. Details of these tasks are described below. The four field efforts that will be scheduled during 2006 and 2007 to achieve the objectives of the study plan are summarized in Table 1.

Table 1. Schedule of anticipated field efforts

Effort	Date	Objectives	Sampling Duration (hours)
I	May 2006	1. Tag fish for growth rate estimates, and 2. Tag fish for Program MARK survival and population estimates	24–32 (12–16 hours per day)
II	Mid-April 2007*	1. Directly measure consumption before releases of hatchery fish 2. Directly measure consumption after releases of hatchery fish 3. Tag and recapture fish for Program MARK survival and population	64 (8 hrs on day one, 16 hrs/day thereafter)

		estimates, and 4. Recapture fish for growth rate estimates, and	
III	Late-April 2007*	1. Directly measure consumption after releases of hatchery fish 2. Tag and recapture fish for Program MARK survival and population estimates, and 3. Recapture fish for growth rate estimates, and	48 (16 hrs/day)
IV	Early-May 2007*	1. Directly measure consumption after releases of hatchery fish 2. Tag and recapture fish for Program MARK survival and population estimates, and 3. Recapture fish for growth rate estimates, and	48 (16 hrs/day)

* Release dates will be determined from outmigrant trapping data collected in 2006.

Task 1 Parameter review

The software and/or models to be used for this project will be reviewed prior to data collection efforts to ensure that all of the necessary data are collected and will be entered in a format conducive to the model structure, in order to decrease the need to manipulate data sets for analysis.

Staffing:
Stillwater Sciences' staff

Cost:
Anticipated cost (Stillwater only): ***$1,500***

Task 2. Fish growth evaluation (Effort I)

Annual growth rate will be estimates using two consecutive mark-recapture efforts (spring 2006 and spring 2007), with the first effort being only two days (Effort I), and the other one being the predator population and consumption rate estimate (Efforts II–IV in 2007). Tag/recapture data collected in Efforts II–IV) will also be analyzed using Program MARK to estimate the species- and size-specific predator population size, and survival.

In Effort I the predator population will be sampled with gill nets, trap nets (Oneida), box traps, minnow traps, angling, and electrofishing. Sampling will be conducted during day and night throughout the reservoir and at different depth intervals to sample different segments of the population if they exist (e.g., deep vs. shallow, near dam vs. near inflow). Effort 1 will familiarize the field crew with the gear and provide valuable information regarding which gear types work best, and which sampling periods are most effective. This information will be used to design the sampling strategy for the predator population and consumption rate estimates in spring 2007.

Gill nets with variable mesh sizes will be used to capture fish greater than about 13 cm (5 in). Gill nets will be deployed and tended frequently to reduce injury and mortality of captured fish. Nets will be set throughout the reservoir, although nets will remain close enough that multiple nets can be tended by one crew (soaking times may be adjusted to reduce fish mortalities). Set locations may vary depending on concentrations of fish in the reservoir identified using sonar, with a goal of collecting and recapturing as many fish as possible. Methods (e.g., soak time) for using gill nets to capture live fish will be refined based on experience. Immediately removing fish as they are captured may become a logistical challenge, and could reduce your catch rates by disturbing the nets, however, leaving nets unchecked may increase mortality.

Trap nets (Oneida traps) will be used in selected shallow shore habitat, although reservoir fluctuations will have to be considered. Baited box traps will be used mainly to capture adult fish in deeper sections of the reservoir where other gear types are not effective. Trap nets, box traps, and minnow traps will be checked regularly during the sampling period (Table 2). Hook and line sampling will be conducted throughout the sampling period (day, corpuscular, night) and may be the most effective method for catching predators during daylight (e.g., Cartwright et al. 1998).

Table 2. Anticipated trap locations and soak times

Trap type	**Location**	**Soak time**
Oneida traps	The only place it fits	6–12 hours
Baited box traps	Throughout deep portions of reservoir	6–12 hours
Minnow traps	Throughout reservoir	6–12 hours
Gill nets	Throughout reservoir	0–3 hours (adjusted based on fish mortalities)

A fish sampling station will be set-up in a location considered safe and appropriate. One to two boats will be used to tend nets, and bring fish to the processing station. All three crew persons will tend nets, and process fish, although if need be two people will tend nets, and the third person will process fish.

Every fish captured will be measured, weighed, and scanned for a PIT tag. Scale samples will be removed from the preferred area (along the diagonal line of scales between posterior insertion of dorsal fin and lateral line, skipping at least 2 rows of scales above lateral line). Otoliths and scales will be removed from any mortalities. Non-tagged fish greater than about 100 mm (4 in) will be marked with a full-duplex passive integrated transponder (PIT) tag (12mm/134.2kHz), or half-duplex tags for larger fish.

Scales will be used to back-calculate length-at-age for each annulus and generate annual growth histories for each consumer. These estimates will provide at least annual growth increments for input into the bioenergetics model and serve as a reference for growth estimates from the mark-recapture growth study. Otoliths may be used opportunistically to corroborate scale-based age interpretations.

Staffing:
Two crews of three or more, working in alternating shifts of 8–12 hours each for Effort I. Total sampling of about 24 hours is expected for Effort I. Staff will be composed of TWG members to the extent possible. Stillwater Sciences will have two scientists participating in the field effort.

Equipment:

Table 3. Equipment required, and anticipated source

Item	Quantity	Anticipated provider	Notes
Oneida trap nets	1	ODFW/PacifiCorp	
Boat	1	PacifiCorp	
Gill nets	2	ODFW	
Box traps	2–4	Stillwater	
Minnow traps	5–10	Stillwater	
Angling		BYO	
Electrofishing boat	1	ODFW	
Fish sampling equipment (PIT tag reader, gastric lavage, scale, etc)	1	Stillwater	
Data sheets	lots	Stillwater	

Cost (total for Effort I):
Assumes that:

- Lodging and meals will be provided by PacifiCorp
- All boats and gill nets will be provided by ODFW or PacifiCorp

Anticipated cost (Stillwater only): ***$12,500***

Task 3. Predator consumption rates evaluation and population estimate (Efforts II–IV)

Three population estimates/consumption rate measurements will be conducted, each about one week apart, beginning in mid-April 2007. Each effort will be three days long, and will begin with the release of hatchery spring Chinook salmon (fry and smolts). This task assumes that hatchery-reared chinook salmon released in the reservoir will behave and be preyed upon similar to that of naturally-produced and migrating salmon. Although we will not be able to test this assumption until after fish passage is achieved at Soda Springs Dam, we believe this test will give us an early estimate of the extent of predation that might occur under present conditions in the reservoir.

Hatchery spring Chinook salmon releases
Spring Chinook salmon to be used in release groups will be raised at the Rock Creek Hatchery in separate ponds from other hatchery Chinook salmon. The temperature and feeding rations of the fish will be controlled so that in April 2007 the fish will be age 1+ and around 100 mm fork length (this will be adjusted based on 2006 smolt trapping data in the project area). Predator sized trout (rainbow and brown trout) will be released into the ponds at least one-week prior to release to acclimate Chinook smolts to predation. During the releases Chinook salmon age 0+ fry from the 2007 cohort will also be released (Table 4). Release groups should reflect the proportion of smolt and fry leaving based on trapping data from 2006 (e.g., a higher proportion of smolt to fry in mid-April, a more even proportion of smolt to fry in late-April, and a reduced proportion of smolt to fry in early-May). Each group of fish will be coded wire tagged prior to release to indicate which release group and age class they represent.

Table 4. Anticipated spring 2007 release schedule

Effort	Date*	Number of 0+ fry	Number of 1+ smolts
II	Mid-April	500	500
III	Late-April	2,000	2,000
IV	Early-May	8,000	8,000

* Release dates and age composition will be determined from outmigrant trapping data collected in 2006.

Field Sampling
We will attempt to determine the relationship between prey density and predator consumption rates with three separate releases of batch-marked hatchery fish. Prior to hatchery fish releases, we will sample predatory fish in the reservoir for 24 hours to determine consumption rates prior to hatchery fish releases.

Each release, starting with the smallest group first, would be followed by at least three days of intense sampling (e.g., 16 hrs/day) to capture potentially piscivorous trout and evaluate stomach contents. Stomach contents of live fish will be removed using gastric lavage (stomach pumping), transferred into individual storage containers, and placed on dry ice (to quick-freeze samples in the field) for later analysis. Stomach contents will be examined, and the number, weight, and proportion (wet mass) of fish in the diet will be measured. Diet date will be recorded individually for each consumer and linked to the consumer's catch and size data. The proportion of diet composed of fish will be used in bioenergetics modeling, and the number and size of fish consumed will be used to directly estimate the magnitude of potential predation. Fish will be placed in a net pen to recover before release.

Sampling will continue until a decrease or stabilization in the percentage of hatchery salmon in the diet is observed. Releases (i.e. "efforts") would be conducted at least one week apart to allow fish to redistribute. After the first effort sampling gear types, duration and/or timing may be adjusted to maximize capture probability.

Staffing:
Assumes that Stillwater Sciences will have two scientists participate in the field efforts. Other staff TBD.

Schedule:
Mid-April, Late April, and early May 2007 (actual dates will be determined based from outmigrant trapping data from 2006). Two crews of at least three. One day of sampling prior to first release (16 hours), and then three days of sampling after each release (16 hrs/day). Total of 64 hours of sampling for Effort II, and 48 hours total in Efforts III and IV.

Equipment:
Same as task 1, modified based on effectiveness of the different gear types.

Cost (Efforts II-IV):
Assumes that:

- Lodging and meals will be provided by PacifiCorp
- All boats and gill nets will be provided by ODFW or PacifiCorp

Anticipated cost (Stillwater only): ***$45,000***

Task 4. Analysis

Analysis of the data collected in Efforts II–IV will include:

- Growth rates
- Program Mark (population abundance and survival estimates)
- Daily consumption rates
- Bioenergetic modeling

Growth rates
Species- and size-specific annual growth rates will be calculated and average daily growth rates will be used in the bioenergetics model.

Program Mark
Size-specific population estimates using mark-recapture data will be conducted using Program MARK, which provides a number of models depending on the available data. Pre-passage population will be estimated assuming a closed system.

Scale Analysis
Scales will be used to back-calculate length-at-age for each annulus and generate annual growth histories for each consumer. These estimates will provide at least annual growth increments for input into the bioenergetics model and serve as a reference for growth estimates from the mark-recapture growth study.

Daily Consumption Rates
Daily consumption rates (C_d) will be calculated for the average predator based on (Ney 1993):

$$C_d = 24 \bullet S \bullet R$$

where S is the mean mass of fish consumed during a 24-hour period, and R is a temperature-dependant stomach evacuation rate (He and Wurtsbaugh 1993). Comparison of pre- and post-release consumption rates may provide an indication of the response of the predator population to production resulting from fish passage, and direct evidence of predation on juvenile salmonids in Soda Springs Reservoir. This assumes that hatchery salmonids released into the reservoir will behave and be preyed upon similar to naturally migrating salmonids from upstream. The difference in predation between test releases of hatchery fish and naturally produced fish is uncertain.

Bioenergetics Modeling
The potential effects of predation will be estimated using bioenergetics modeling, and a spread sheet exercise similar to that used by Stillwater Sciences to evaluate potential impacts of predation (Stillwater Sciences 2000).

A bioenergetics model such as Fish Bioenergetics 3.0 (Hanson et al., 1997) will be used to estimate the number of juvenile salmonids likely to be consumed given the present population size, and various potential levels of production. Bioenergetics modeling uses the energy balance equation that consumption equals the sum of metabolism, waste, and growth:

$$C=M+W+G$$

where growth is used to calculate consumption. Bioenergetics modeling has been used successfully to determine the potential total consumption of a piscivorous population (e.g., Beauchamp 1995; Baldwin et al. 2000; Ruzycki et al. 2003). The strength of bioenergetics modeling is that it integrates environmental and physiological factors that regulate production and growth of a predator population, and allows different scenarios to be evaluated to assess potential future conditions, or to account for uncertainty in the values used (e.g., if predator population size is larger, or smaller, than estimated). Bioenergetics modeling, when coupled with results from the functional response to different numerical releases of salmon, will provide a predictive tool to assess potential predation under various scenarios of anadromous smolt production, and of changes in the predator population (i.e., potential success of a control program). The bioenergetics model will also be a useful gaming tool for adaptive management of the predator control strategy subsequent to fish passage.

Data to populate the model will be based on results from the field sampling described above, and from literature values. Data requirements include: species and size-specific estimates of predator population size, temporal diet composition (i.e., proportion of diet composed of fish), growth rates, size at first piscivory; and water temperature. Results from the bioenergetics model will be in the form of the biomass (grams) of fish that could be consumed by the predator population for a given set of model parameters. Different scenarios can be simulated for different size structures and abundances of the predator population.

The spread-sheet exercise will provide a measure of the potential magnitude of predation on juvenile fish production upstream of Soda Springs Reservoir, using refined estimates of the predator population, species composition, minimum size of predation, and consumption rates by species and size.

Results from these assessments should provide the Technical Work Group of the Resource Coordination Committee, with the tools and information necessary to evaluate the potential effects of predation on production from reaches upstream of Soda Springs Dam, and determine whether, and to what extent, a predator control program may be warranted. The response of the predator population to control measures, however, will be difficult to predict (e.g., may result in a larger number of smaller predators or shift from brown to rainbow trout) and will likely require periodic monitoring throughout the 35-year license term.

Staffing:
Stillwater Sciences' staff

Schedule:
Analysis will begin directly following Effort I, and will be concluded Summer 2007 (unless determined otherwise by the TWG).

Cost: $ 6,000 (2006)
$ 25,000 (2007)
$ 31,000 (total)

Task 5. Reporting

Reporting will include a draft to the TWG for review in Summer 2007, followed by a final report in Fall 2007. Report will include complete description of methods used, and final results of all analysis.

Cost: $ 7,500 (2006)
$ 15,000 (2007)
$ 22,500 (total)

Cost Summary

Table 5. shows the schedule and costs (Stillwater only) of all tasks.

Table 5. Anticipated schedule and costs

Task	2006	2007
1	$ 1,500	$ --
2	$ 12,500	$ --
3	$ --	$ 45,000
4	$ 6,000	$ 25,000
5	$ 7,500	$ 15,000
Totals	***$ 27,500***	***$ 85,000***