PacifiCorp Energy and Cowlitz County PUD No. 1

Fish Passage Monitoring and Evaluation Plan for the Lewis River

Revised Draft for ACC Review

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June 19, 2009

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Acronyms and Abbreviations

ACC	Aquatics Coordination Committee
AER	Adult equivalent run
ATE	Adult trap efficiency
C + E	Catch plus escapement
CE	Collection efficiency
CF	Correction factor
cfs	Cubic feet per second
CI	Confidence Interval
CPE	Catch plus escapement
CS	Collection survival
CWT	Coded-wire tag
DART	Data Access in Real Time
FERC	Federal Energy Regulatory Commission
HOR	Hatchery origin recruits
HPP	Habitat preparation plan
H&S Plan	Hatchery and Supplementation Plan
M&E	Monitoring and Evaluation
NMFS	National Marine Fisheries Service
NOR	Natural origin recruits
ODS	Overall downstream survival
PM&E	Protection, mitigation and enhancement
RM	River mile
RMIS	Regional Mark Information System
SA	Settlement agreement
SAR	Smolt-to-adult survival rate
SASR	Smolt-to-adult survival ratio
SDF	Swift downstream facility
Services	US Fish and Wildlife Service and National Marine Fisheries Service
TCC	Terrestrial Coordination Committee
USFWS	U.S. Fish and Wildlife Service
UPS	Upstream passage survival

USACE	U.S. Army Corps of Engineers
UTF	Upstream transport facility
Utilities	PacifiCorp and Cowlitz County PUD
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
YOY	Young-of-the-year
ZOI	Zone of influence

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1.0 INTRODUCTION

This plan is designed to meet the monitoring and evaluation (M&E) requirements outlined in the Lewis River Settlement Agreement (Settlement) entered into by state, federal and local governments, various resource interest groups and the Lewis River Project hydropower licensees (PacifiCorp and Cowlitz PUD 2004). The Federal Energy Regulatory Commission (FERC) issued new operating licenses for all four Lewis River projects (Merwin, Yale, Swift No. 1 and Swift No. 2) on June 26, 2008 and the requirements of these new licenses are also incorporated in this plan.

The primary focus of the M&E plan is the evaluation of upstream fish collection facilities at Merwin Dam and downstream facilities at Swift Dam. As described in Section 9.1 of the Settlement, the M&E Plan shall provide the approach to:

> *"…monitor and evaluate the effectiveness of aquatic PM&E Measures and to assess achievement of the Reintroduction Outcome Goals. The M&E Plan shall address the tasks, and the methods, frequency and duration of those tasks, necessary to accomplish the monitoring and evaluation items…"*

Anadromous fish reintroduction goals were established in the Settlement for coho, spring Chinook and steelhead for the portion of the Lewis River basin located upstream of Merwin Dam. The measures to be monitored and evaluated are described primarily in sections 4 and 9 of the Settlement. The intent of the M&E Plan is to identify monitoring actions to determine the success of constructed fish passage systems and the overall success of the fish reintroduction effort. The reintroduction outcome goal is to:

> *"…achieve genetically viable, self-sustaining, naturally reproducing, harvestable populations above Merwin Dam greater than minimum viable populations ("Reintroduction Outcome Goal")."*

However, it needs to be noted that the metrics for determining whether the Reintroduction Outcome Goal is being met have yet to be developed[1] by the US Fish and Wildlife Service and National Marine Fisheries Service (the Services). Because these metrics are unavailable, the M&E Plan focuses on those studies needed to determine when the performance standards outlined in Section 4 of the Settlement are achieved. A definition of each performance standard and its benchmark value are presented in Table 1.1.1.

The M&E Plan also provides the methods to be used to monitor and evaluate adult fish spawning escapement, fish passage facility hydraulic performance, flow and ramping rates, resident and anadromous fish interactions, and bull trout and kokanee populations. Monitoring related to Clean Water Act Section 401 certification is identified in the Final Water Quality Management Plan which was submitted for comment to the Washington Department of Ecology (WDOE) in September 2008 and will be finalized in 2009. Also, monitoring needed to implement the Lewis River Hatchery and Supplementation Plan (H&S Plan) (PacifiCorp Energy and Cowlitz PUD 2006) is identified in that plan and is

[1] The time frame for the Services to identify this metric is described in Section 3.1.1 of the Settlement.

not addressed in this document. PacifiCorp and Cowlitz PUD will provide an annual report to FERC (ACC/TCC Annual Report), the Aquatics Coordination Committee (ACC) and the Terrestrial Coordination Committee (TCC) and WDOE on or about April of each year. The ACC/TCC Annual Report will contain results of all monitoring activities included in the M&E Plan plus all water quality, hatchery, and terrestrial monitoring results from the previous year.

Table 1.1.1. Reintroduction performance standard definitions and benchmark values.

Performance Standard	Definition[1]	Benchmark Value
Adult Trap Efficiency (ATE)	The percentage of adult Chinook, coho, steelhead, bull trout, and sea-run cutthroat that are actively migrating to a location above the trap and that are collected by the trap.	Determined by the ACC to be 98%
Collection Efficiency (CE)	The percentage of juvenile anadromous fish of each of the species designated in Section 4.1.7[2] that is available for collection and that is actually collected.	95%
Collection Survival (CS)	The percentage of juvenile anadromous fish of each of the species (designated in Section 4.1.7) collected that leave the Release Ponds alive.	Smolts $\geq$ 99.5% Fry $\geq$ 98% Adult Bull Trout $\geq$ 99.5%
Injury	Visible trauma (including, but not limited to hemorrhaging, open wounds without fungus growth, gill damage, bruising greater than 0.5 cm in diameter, etc.), loss of equilibrium, or greater than 20% descaling . "Descaling" is defined as the sum of one area on one side of the fish that shows recent scale loss. This does not include areas where scales have regenerated or fungus has grown.	$\leq$ 2% for smolts
Overall Downstream Survival (ODS)	The percentage of juvenile anadromous fish of each of the species designated in Section 4.1.7 that enter the reservoirs from natal streams and survive to enter the Lewis River below Merwin Dam by collection, transport and release via the juvenile fish passage system, passage via turbines, or some combination thereof (calculated as provided in Schedule 4.1.4. of the Settlement).	Interim $\geq$ 80% $\geq$ 75% after installation of Yale Downstream Collector
Upstream Passage Survival (UPS)	Percentage of adult fish of each species (designated in Section 4.1.7) that are collected that survive the upstream trapping-and-transport process. For sea-run cutthroat and bull trout, "adult" means fish greater than 13 inches in length.	$\geq$ 99.5%

[1] Definitions are taken from Settlement Agreement for the Lewis River Hydropower Projects (PacifiCorp and Cowlitz PUD 2004)
[2] Species designated in Section 4.1.7 of the Settlement Agreement are spring Chinook, winter steelhead, coho, bull trout and sea-run cutthroat trout.

Because the M&E Plan will be updated approximately every five years, this initial plan emphasizes the methods for evaluating the Swift Downstream Facility (SDF) and the Merwin Upstream Transport Facility[2]. The SDF will be used to collect juvenile anadromous salmonids migrating downstream from stream reaches upstream of Swift No. 1 Dam. The Merwin Upstream Transport Facility will collect adults returning to this same portion of the basin or to hatchery facilities.

The performance standards shown in Figure 1.1-1 will be used to determine not only the success of the SDF but also provide the justification for making improvements to this facility over time.

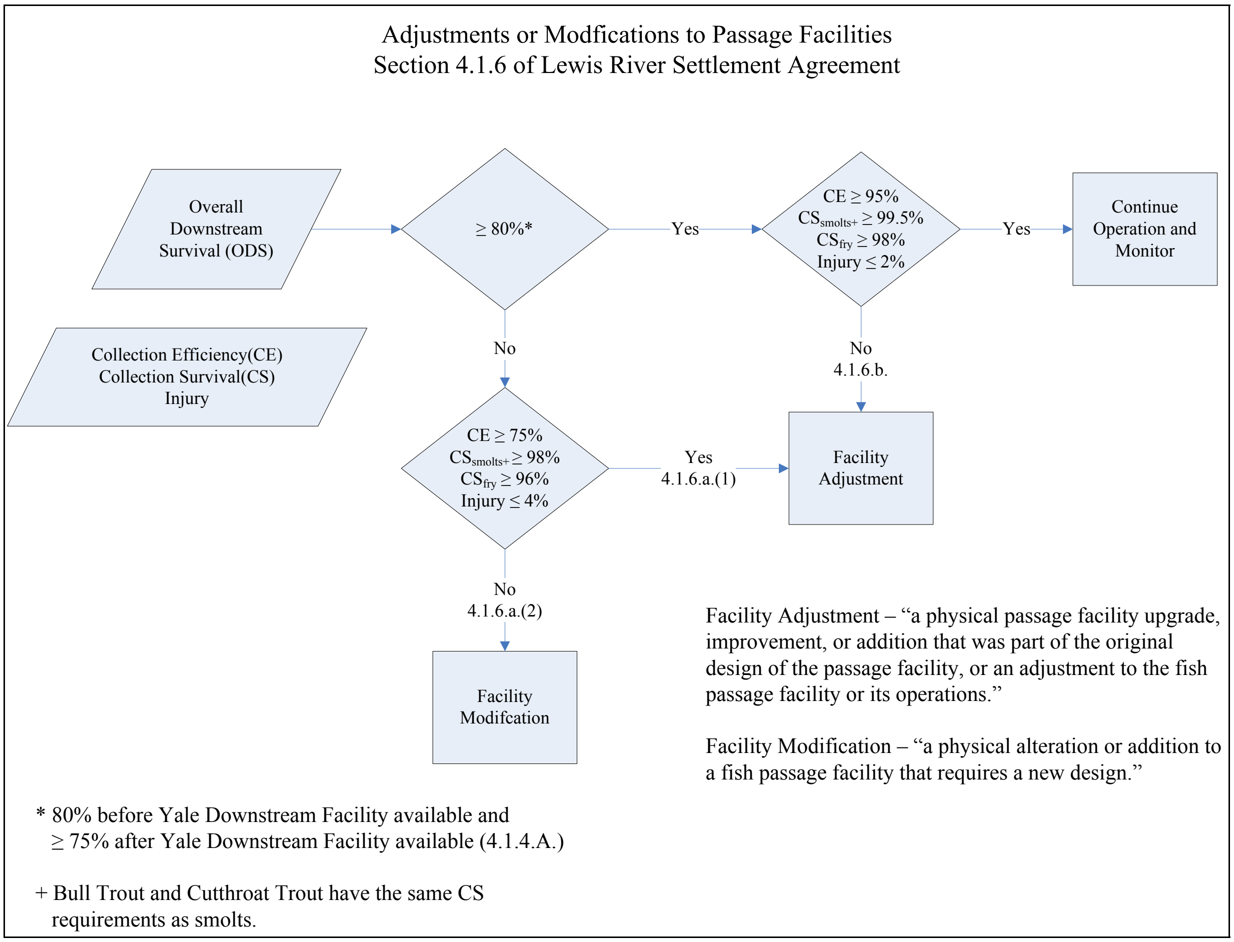

Figure 1.1-1. Swift downstream facility decision flow chart.

The lessons learned from studies undertaken to evaluate these facilities will be applied to new adult and juvenile passage facilities proposed for Yale starting in year 13 (June 2021) and juvenile passage facilities at Merwin starting in year 17 (June 2025) of the new FERC licenses.

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[2] The Settlement states that the licensees shall consult with the ACC as necessary, but not less than every five years (section 9.1).

Finally, the need for updating the M&E Plan will be determined as part of the comprehensive periodic review as outlined in the Settlement (see Sections 8.2.6 and 9.1 of the Settlement). This review will occur within 5-years after the reintroduction of anadromous fish above Swift Reservoir, Yale Lake and also Lake Merwin. The periodic review will be repeated every 10 years from that point forward.

2.0 MONITORING AND EVALUATION OBJECTIVES

The M&E Plan has been designed to achieve twenty objectives. The objectives are as follows:

Objective 1 Quantify overall juvenile fish downstream survival (ODS) which includes reservoir survival, collection survival, transport survival, and survival at the release ponds

Objective 2 Estimate SDF collection efficiency

Objective 3 Determine the percentage of juvenile fish available for collection that are not captured by the SDF and that enter the powerhouse intakes

Objective 4 Estimate juvenile and adult collection survival

Objective 5 Determine juvenile injury and mortality rates during collection at the SDF (includes injury and mortality of adult bull trout, adult sea-run cutthroat, and steelhead kelts)

Objective 6 Quantify the number, by species, of juvenile and adult fish collected at the SDF

Objective 7 Estimate the number of juveniles entering Swift Reservoir

Objective 8 Determine juvenile migration timing

Objective 9 Quantify adult upstream passage survival

Objective 10 Estimate adult trap efficiency at each upstream fish transport facility (emphasizes analysis of the Merwin Adult Trapping Facility)

Objective 11 Quantify the number, by species, of adult fish being collected at the projects (emphasizes Merwin Dam)

Objective 12 Develop estimates of ocean recruits

Objective 13 Determine performance measures for index stocks

Objective 14 Determine upstream and downstream passage facilities compliance with hydraulic design criteria

Objective 15 Determine spawn timing, distribution and abundance of transported anadromous adults

Objective 16 Evaluate lower Lewis River wild fall Chinook and chum populations

Objective 17 Monitor bull trout populations

Objective 18 Determine interactions between reintroduced anadromous salmonids and resident fish

Objective 19 Document Project compliance with flow, ramping rate and flow plateau requirements

Objective 20 Determine when reintroduction outcome goals are achieved

For each objective, the tasks, methods, frequency and duration of sampling, assumptions, results and reporting are discussed in the sections that follow.

Although not explicitly repeated for each objective, the fish handling and facility operations listed in the Incidental Take Statements for the Project will be strictly followed. The Incidental Take Statement can be found in Section 9 of the National Marine Fisheries Service (NMFS) Biological Opinion for the Project (NMFS 2007) and the USFWS Biological Opinion (USFWS 2006). The Post-Season Monitoring and Evaluation Form required by NMFS is attached as Appendix A. This post-season report will be included in the ACC/TCC Annual Report.

2.1 OBJECTIVE 1: QUANTIFY OVERALL JUVENILE DOWNSTREAM SURVIVAL

The Settlement requires that the Utilities achieve an overall downstream survival (ODS) rate of 80%[3]. ODS is defined in Section 4.1.4 of the Settlement Agreement as:

> *The percentage of juvenile anadromous fish of each of the species designated in Section 4.1.7 that enter the reservoirs from natal streams and survive to enter the Lewis River below Merwin Dam by collection, transport and release via the juvenile fish passage system, passage via turbines, or some combination thereof, calculated as provided in Schedule 4.1.4.*

In other words, ODS is the percentage of the fish entering the Project that migrate, or are transported to the lower Lewis River (i.e., downstream of Merwin Dam) and released successfully (i.e., alive). It should be noted that Schedule 4.1.4 of the Settlement contains a caveat that the methodology described in the Schedule needs to be ground-truthed and may or may not be the best method to use.

[3] An ODS of greater than or equal to 80% is required until such time as the Yale Downstream Facility is built or the Yale In Lieu Fund becomes available to the Services, after which ODS shall be greater than or equal to 75%. The parties to the Settlement acknowledge that ODS rates of 80% or 75% are aggressive standards and will take some time to achieve.

2.1.1 Task 1.1- Estimate ODS for Anadromous Fish Species above Swift No. 1 Dam

Initially, ODS will be measured from the head of Swift Reservoir to the exit of the Release Ponds located downstream of Merwin Dam[4] (Figure 2.1-1). Estimates of ODS will be developed for coho, spring Chinook, steelhead and sea-run cutthroat trout. ODS estimates for sea-run cutthroat trout will be delayed until data indicate that this cutthroat life history is present in the upper Lewis River basin and that the number of juveniles produced is sufficient for experimental purposes.

Radio-tags and direct enumeration of fish collected and transported from the SDF will be used to develop estimates of ODS.

Consistent with the Settlement, juveniles passing Swift Dam either through the turbines or spill will not be counted toward meeting the ODS standard because they are unlikely to survive passage through multiple dams and reservoirs not equipped with passage facilities. There is however, an allowance to consider turbine survival if it appears to be higher than expected[5].

2.1.1.1 Methods

The methods proposed for developing estimates of ODS are as follows:

- Test fish will be obtained from the SDF[6] as they represent assumed migrants. This approach is consistent with fish passage survival studies performed by the NMFS throughout the Columbia River Basin (Axel, et al. 2007).
- Fish captured at the SDF will be identified to species, measured for length and tagged with a radio-tag.
- The test fish will be transported and released at the head of Swift Reservoir. Releases will be made weekly throughout the major part of the migration season (April-June). A total of 44 fish of each species will be released each week for six weeks (i.e., 264 tags per species tested). Sample size was based on a juvenile detection probability of 95% and a precision of 0.10 (See Appendix B) The test fish will be held for 24 hours prior to release to insure that fish retain the radio-tags, that the tags are functioning, and to quantify handling mortality.
- A control group will be held in small circular raceways throughout the study to quantify tag failure and decay rate and also to determine post-release mortality. The facilities will be located in a secure area.

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[4] Estimates of ODS will be developed for fish collected at Yale and Merwin dams once downstream passage facilities are constructed.

[5] The Settlement states that fish passing through turbines at Swift Dam can be ignored if they are not expected to contribute substantially to ODS.

[6] According to the Settlement Agreement, the Modular Surface Collector built at Swift No. 1 Dam will be referred to as the Swift Downstream Facility. It is to be operational within 6-months following the 4th anniversary of the issuance of the new license for the Swift No. 1 or 2 Project, whichever is later. That implementation date is December 26, 2012.

- Boat surveys (1 per week) will track the radio-tagged fish as they migrate through Swift Reservoir to determine if fish actively migrate through, or rear in, the reservoir.

- Antennae arrays located at Swift Dam, Swift tailrace (assuming that radio tags survive turbine passage), the SDF, and at the exit of the release ponds will generate the detection histories necessary to estimate ODS and fish behavior.

- The SDF, transport trucks and release ponds will be examined daily by biologists to determine radio-tag loss during the handling and transport processes. Dead tagged fish found in the SDF and release ponds would be assigned to collection loss (S_{COL}) and transport loss (S_{TRAN}), respectively.

- 50 dead fish with live radio-tags will be released into the SDF over the course of the season as a check on the ability of the biologists to detect and recover dead fish. If recoveries are less than 100%, estimates of ODS will be adjusted based on the calculated error rate.

The single release-recapture model will be used to estimate the probability of surviving passage to the lower Lewis River (Appendix B).

ODS will be calculated as:

$ODS = S_1 * (S_{COL} * S_{TRAN})$

Where

S_1 = joint survival probability through reservoir (S_{RES}) and collector (P_{COL}),

P_{COL} = proportion of fish arriving at Swift Dam that enter the surface collector,

S_{COL}= survival probability through the collector,

S_{TRAN} = survival probability through the smolt transport system.

A diagram of each of these four parameters (S_{RES}, P_{COL}, S_{COL} and S_{TRAN}) is shown in Figure 2.1-2.

The ODS estimate will be based on pooling release–recapture data over the season. Success with meeting the ODS 80% standard will be based on an asymptotic Z-test at *a* of 0.10 (Appendix B).

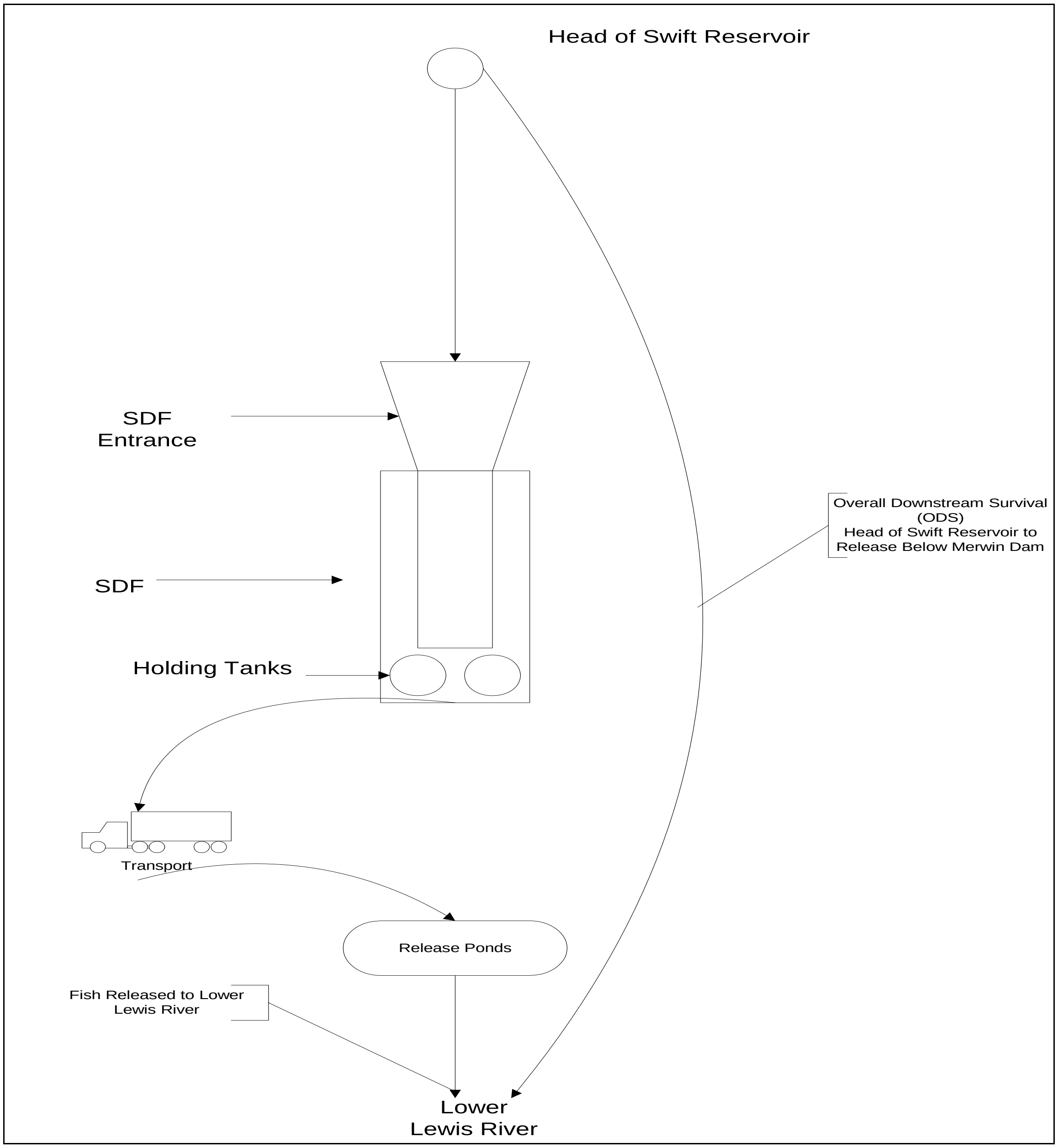

Figure 2.1-1. Schematic showing ODS measurement range and associated facilities.

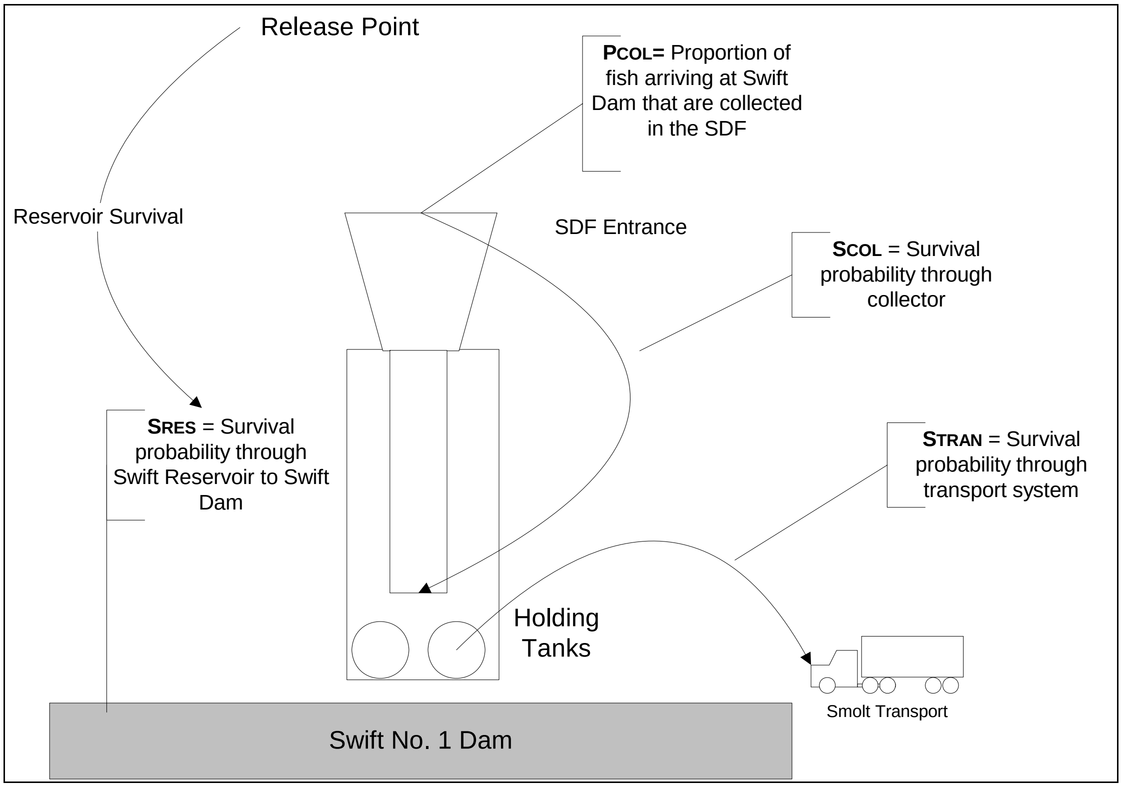

Figure 2.1-2. Schematic showing evaluation parameters for calculating ODS.

2.1.1.2 Frequency and Duration

ODS estimates will be developed weekly throughout the major portion of juvenile migration season, which is expected to vary by species. Releasing fish on a weekly basis will also help to identify whether changing environmental conditions (river flow, temperature, etc.) impact resulting ODS estimates. The study will be performed yearly until such time as study results show that the 80% ODS standard has been consistently achieved for each species.

2.1.1.3 Assumptions

Assumptions associated with conducting the analysis include:

1. All fish act independently.
2. Release size is known without error.
3. There is no post-release handling mortality, tag failure or loss, or these parameters can be estimated and the survival estimates adjusted accordingly.
4. Downstream detection is conditionally independent of detection upstream.

5. Tagged fish are uniquely identifiable at all detection sites.

6. Fish passing through spill and turbine discharge at Swift Dam will not count toward meeting the ODS standard (i.e. these fish will be considered mortalities).

Of the six assumptions listed, number 3 is the most likely to be violated. Tagging and transporting juvenile salmonids can be stressful and result in some mortality both pre- and post-release. To quantify this mortality, a control group will be established as part of the experimental design. These fish will be tagged and handled in an identical fashion as the test fish. However, instead of being released into the reservoir, the fish will be held in small raceways, and then observed over time to determine the mortality rate and radio-tag failure rate and loss. This information will then be used to adjust survival rates for the test fish, if needed.

2.1.1.4 Results and Reporting

The results of the study will be recorded weekly and reported in text and tabular format in the ACC/TCC Annual Report. The type of table that would be presented is shown in Table 2.1.1.

Table 2.1.1. Example table of weekly estimates of the percent ODS for juvenile coho, Chinook and steelhead released at the head of Swift Reservoir.

Date	**Coho**	**Chinook**	**Steelhead**
Week 1			
Week 2			
Week 3			
Week 4			
Week 5			
Week 6			
Season*			

* A weighted average of the weekly ODS estimates may be used for the seasonal estimate dependent on whether the weekly estimates prove to be heterogeneous.

2.2 OBJECTIVE 2- ESTIMATE SDF COLLECTION EFFICIENCY (P_{CE})

The radio-tagged fish released at the head of Swift Reservoir will also be used to measure the juvenile collection efficiency (P_{CE}) of the SDF. Section 4.1.4 of the Settlement defined collection efficiency as:

The percentage of juvenile anadromous fish of each of the species designated in section 4.1.7 that is available for collection and that is actually collected.

In this study, a juvenile that is available for collection is one that is found (detected) within the zone of influence (ZOI) of the SDF entrance[7]. As stated in the Settlement, the performance standard for P_{CE} is 95% or greater for smolts.

Additionally, estimates of the proportion of fish encountering the SDF (P_{ENC}), SDF fish entrance efficiency (P_{ENT}) and SDF retention efficiency (P_{RET}) will also be collected as part of this analysis using radio-tag detections. Collecting this data will give biologists the ability to determine where improvements in the design or configuration of the SDF may be needed to meet the collection efficiency and ODS standards. The importance of each parameter in diagnosing SDF operations are as follows:

- P_{ENC} – A low encounter value indicates that few fish arriving at Swift Dam were detected within the zone of hydraulic influence of the SDF[8]
- P_{ENT} - Fish that have encountered the collector entrance may not actually enter the SDF. This condition would be indicated by a low entrance efficiency value for P_{ENT}. The problem may be caused by poor or confusing hydraulics at the mouth of the collector or a sudden decrease or increase in water velocity just inside the SDF. Such problems may be corrected by altering system hydraulics.
- P_{RET} - Fish that enter the SDF may also swim back out of the system, resulting in low SDF retention efficiency (P_{RET}). Low SDF retention efficiency may be the result of water velocities through the SDF that are too slow to trap the fish. This condition could be alleviated by increasing flow through the collector or changing screen openings to increase water velocities.

2.2.1 Task 2.1- Estimate SDF Collection Efficiency (P_{CE})

2.2.1.1 Methods

The same technology proposed for measuring ODS (Section 1.1.1) will be used for estimating SDF collection efficiency.

Radio-tagged juveniles released at the head of Swift Reservoir and surviving reservoir passage will be detected at a set of antennae arrays located at the SDF (Figure 2.1-3). The first antennae array (A) will be located at the entrance of the SDF; the second, (B), near or within the holding tanks, depending on operational constraints of the facility.

Antennae array (A) will be tuned to detect fish within the ZOI of the surface collector. The ZOI is the area in front of the collector where all flow lines lead to the entrance of the SDF. The actual area of the ZOI will be determined by measuring flow velocities and direction in front of the SDF at the start of each field season.

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[7] The Zone of Influence is the area in front of the SDF entrance where all flow lines within the exclusion nets lead to the collector.

[8] Encounter efficiency is not a performance criteria identified in the Settlement. It is used here to document whether the collector location needs adjustment or that flows into the collector should be increased to better attract juvenile migrants.

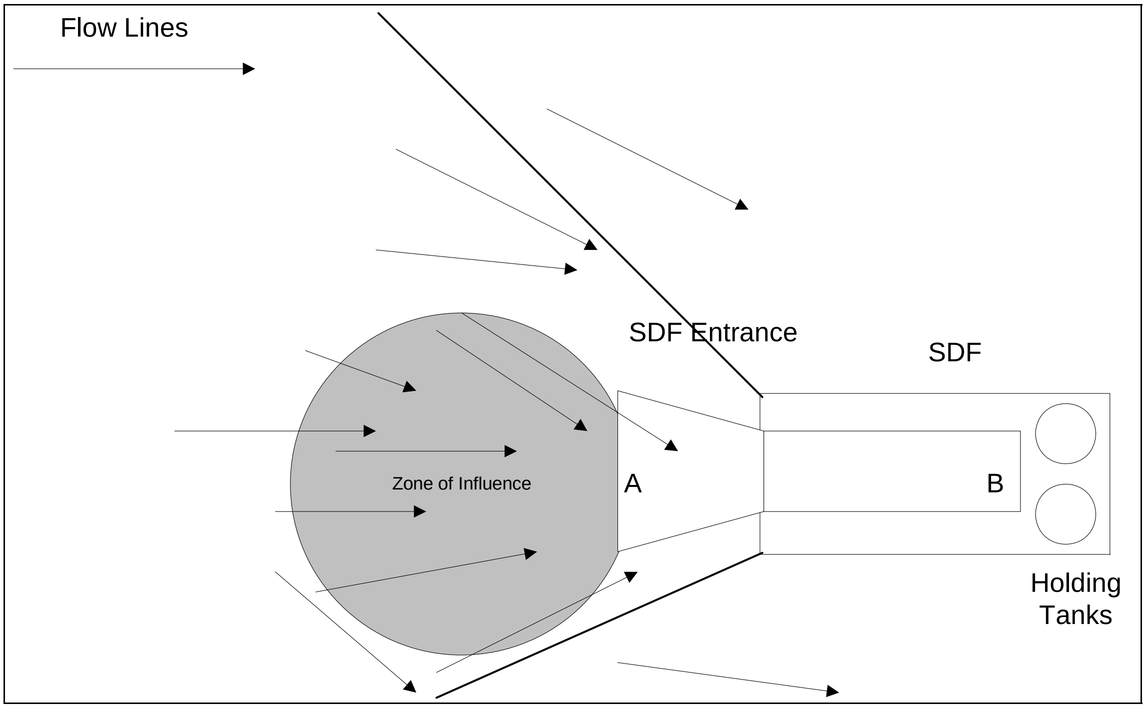


Figure 2.1-3. Schematic of SDF and associated antenna arrays (A and B).

The collection efficiency of the SDF (P_{CE}) will be estimated as:

$$\hat{P}_{CE} = \frac{a_2}{a_1}$$

Where

a_1 = number of unique tagged fish identified in the ZOI of the surface collector

a_2 = number of unique tagged fish identified in the fish holding tanks

2.2.1.2 Frequency and Duration

SDF collection efficiency will be quantified weekly for approximately 6 weeks around the expected peak migration period for each species. The study will continue yearly until either the collection efficiency standard is met, or it is determined by the ACC and the Services that improvement in collection efficiency is not possible. Under either outcome, studies to estimate collection efficiency will be repeated every 5 years to document SDF compliance with the standard.

2.2.1.3 Assumptions

All of the assumptions associated with the single release-recapture model described in Section 2.1.1.3 apply here as well. In addition, it is assumed that the second antennae array will have 100% detection efficiency.

2.2.1.4 Results and Reporting

The results of the study will be reported in tabular format in the ACC/TCC Annual Report. An example is shown below as Table 2.2.1.

Table 2.2.1. Example table for weekly estimates of SDF collection efficiency for coho, Chinook and steelhead.

Date	Coho	Chinook	Steelhead
Week 1			
Week 2			
Week 3			
Week 4			
Week 5			
Week 6			
Season*			

* A weighted average of the weekly collection efficiency estimates may be used for the seasonal estimate depending on whether the weekly estimates prove to be heterogeneous.

2.2.2 <u>Task 2.2- Estimate the Number of Juveniles Encountering the SDF Entrance (P_{ENC})</u>

2.2.2.1 Methods

The number of juveniles (smolts) encountering the SDF will be determined by tracking releases of radio-tagged fish as they arrive at Swift Dam[9]. Antennae arrays will be placed across the face of Swift Dam to detect radio-tagged fish arriving at the dam. Arrays will be located near the spillway and on the earthen embankment both upstream and downstream of the SDF. Actual array locations will be developed once a final design for the SDF has been completed[10].

The proportion of the tagged juveniles encountering the SDF (P_{ENC}) will be calculated as:

$$P_{ENC} = DET_{SDF} / DET_{SWIFT}$$

Where

DET_{SDF} = number of juveniles detected at antenna array A and/or B on the SDF

DET_{SWIFT} = number of juveniles detected at Swift Dam and the SDF

P_{ENC} will provide a simple index to describe the proportion of the tagged fish that were available for collection.

9 Release locations would be developed in consultation with the ACC.

10 Antennae arrays will be tested to determine the detection range of each array. This action will ensure that fish outside of the SDF, for example, are not counted in collection estimates, etc.

2.2.2.2 Frequency and Duration

P_{ENC} estimates will be developed until the collection efficiency standard is achieved.

2.2.2.3 Assumptions

Antenna array A can be tuned to detect fish only within the zone of influence of the SDF.

2.2.2.4 Results and Reporting

Results will be reported in the ACC/TCC Annual Report. Data will be presented in tabular format similar to that shown in Table 2.2.1.

2.2.3 Task 2.3- Estimate Juvenile Entrance Efficiency (P_{ENT}) and Retention Efficiency (P_{RET}) for the SDF

2.2.3.1 Methods

Juvenile entrance (P_{ENT}) and retention efficiency (P_{RET}) will be estimated using radio-tag detections at two locations within the SDF (Figure 2.2-1). Two antennas located at D1 (Entrance) and D2 (Retention Zone) will be used to determine P_{ENT} and P_{RET}, respectively.

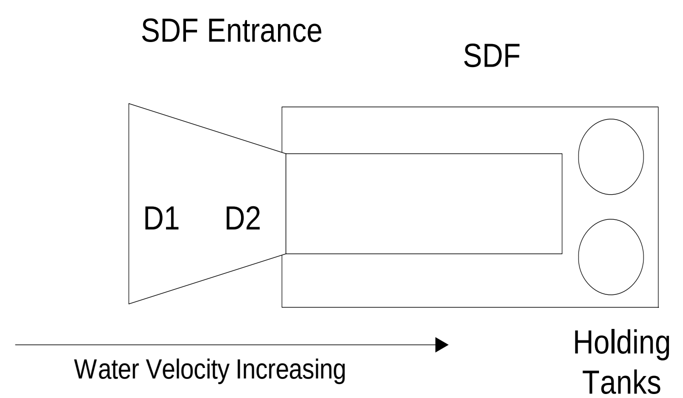


Figure 2.2-1. Location of detection antenna on SDF (D1 and D2).

The antennas will detect radio-tag fish entering the SDF. Detection history of each tagged fish will be used to determine the pertinent variables as described below.

P_{ENT} will be calculated as:

P_{ENT} = number of radio-tag fish detected at D1/ P_{ENC}

P_{RET} will be calculated as:

P_{RET} = number of radio-tag fish detected at D2/number of radio-tag fish detected at D1.

2.2.3.2 Frequency and Duration

Performed at any time SDF collection efficiency estimates are being developed.

2.2.3.3 Assumptions

Key assumptions of the analysis include:

- Antenna power can be adjusted such that detection zones can be estimated.
- Antenna can be placed within the SDF without impacting SDF operations.

2.2.3.4 Results and Reporting

Study results will be provided as a stand-alone report at the conclusion of each evaluation season. A summary of the report will be provided in the ACC/TCC Annual Report.

2.3 OBJECTIVE 3- DETERMINE THE PERCENTAGE OF JUVENILES AVAILABLE FOR COLLECTION THAT ARE NOT CAPTURED BY THE SDF AND THAT ENTER THE TURBINES

The proportion of fish entering the intake of the Swift No. 1 powerhouse will not be quantified until downstream collection systems are installed at Yale and Merwin dams. Once these systems are operational, the M&E Plan will be updated to include study protocols designed to determine turbine entrainment and loss. In the interim, antenna will be located in the Swift No. 2 canal downstream of the Swift No. 1 powerhouse tailrace to detect any radio-tagged fish passing through the Swift No.1 units. This assumes that radio tags remain functional after passing through the Swift No. 1 turbines.

2.4 OBJECTIVE 4- ESTIMATE JUVENILE AND ADULT COLLECTION SURVIVAL (CS)

The objective of this task is to quantify survival from the time the fish (smolt, fry and adult bull trout) enter the SDF to their release downstream of Merwin Dam[11]. This survival rate is defined in the Settlement as collection survival (CS). The CS standard varies by fish size and species as shown below:

- Chinook, coho, steelhead, and sea-run cutthroat smolts = 99.5%
- Chinook, coho, steelhead and sea-run cutthroat fry = 98%
- Bull trout = 99.5%

The radio-tag data collected to estimate ODS can be used to estimate CS for smolts, but not for fry. Fry are too small to tag with a radio transmitter and therefore calculating survival for this size fish requires that mortality be measured directly. The calculations for estimating smolt collection and transport survival using the radio-tag results are presented in Appendix B.

[11] Bull trout survival estimates will also be made for other release sites identified by the USFWS.

Because fish mortality may occur both in the collection and/or transport processes, separate estimates of survival through each process will help determine the cause of any observed mortality and develop appropriate remedial measures. Therefore, CS will be broken into two components, collection survival (S_{COL}) and transport survival (S_{TRAN}).

Estimates of CS, S_{COL} and S_{TRAN} will be developed for coho, Chinook, steelhead, sea-run cutthroat trout (if a run is established) and bull trout captured in the SDF[12].

2.4.1 Task 4.1- Estimate Fish Collection and Transport Survival Rates

2.4.1.1 Methods

The methods to be used for quantifying S_{COL}, S_{TRAN} and CS are presented below.

Determine Fish Survival through the Collection System (S_{COL})
Survival estimates for juvenile fish collected at the SDF (S_{COL}) will be developed daily by collecting a 10% subsample of captured fish prior to their entry into the transport system. Subsampling will be accomplished through the use of gates located on the SDF that can be programmed to automatically divert fish to the subsample tanks. The diverted fish will be physically examined to determine the proportion of fish that die from collection activities. Consequently, estimates of S_{COL} will be based on binomial sampling with the estimator:

S_{COL} = $Fish_{SUB} / Fish_{EX}$

$Fish_{SUB}$ = number of fish found alive in subsample

$Fish_{EX}$ = number of fish examined in subsample

Determining Survival through the Transport System (S_{TRAN})
Juvenile survival, from the time they enter the transport system until they exit the release ponds downstream of Merwin Dam, is defined as S_{TRAN}.

The method used for determining S_{TRAN} is as follows:

- Healthy uninjured smolts and fry will be marked and released directly into the transport tanks located on the SDF on a weekly basis (one test per week). The test fish used for these releases will be collected from the SDF subsample tanks. A control group will be established to determine mortality associated with handling.
- Test fish releases will be made such that these fish spend a similar amount of time in the holding tanks as the fish that were diverted to the tanks through the SDF.
- Fish in the holding tanks will then be loaded onto trucks, transported and released to the ponds located below Merwin Dam. The fish will be held in these ponds for 24 hours.

[12] Survival estimates will be developed for both juvenile and adult bull trout. The adult bull trout CS standard is 99.5%. Unless large numbers of bull trout juveniles are collected at the SDF, testing will not be performed.

- Prior to releasing fish from the ponds, the ponds will be checked for dead fish. Dead or dying fish will be collected, examined for marks and injury, and identified to species. The ponds gates then will be opened and the fish allowed to volitionally exit over a 24-hour period.

- To test the ability of biologists to identify and collect dead fish from the release ponds, a known number of marked dead fish will be periodically released into the transport system. The results of this test will be used to develop a correction factor to account for less than 100% detection of dead fish.

- After 24 hours, the ponds will once again be examined for dead fish. Any dead fish will be collected, examined for marks and injury, and identified to species. Live fish remaining in the ponds at this time will be forced out of the ponds.

S_{TRAN} will be calculated using the formula:

S_{TRAN} = $(Fish_{alive}/Fish_{REL}) * CF$

$Fish_{alive}$ = number of marked fish found alive in release ponds

$Fish_{REL}$ = number of marked fish released in transport system

CF = Correction factor for missed marked fish based on marked dead fish

An estimate of S_{TRAN} will be developed for coho, Chinook, steelhead, sea-run cutthroat trout and bull trout (adults and juveniles) captured in the SDF. It should be noted that S_{TRAN} values for bull trout adults will be based on observed mortalities during transport and release at all release sites identified by the USFWS.

<u>Calculating Juvenile Collection Survival (CS)</u>
CS is the combined juvenile mortality observed for collection (S_{COL}) and transport (S_{TRAN}), calculated as:

$$CS = S_{COL} * S_{TRAN}$$

An estimate of CS will be developed daily for coho, Chinook, steelhead, sea-run cutthroat trout and bull trout (adults and juveniles) captured in the SDF. The daily estimates will be pooled to develop an overall estimate of CS for the monitoring season.

2.4.1.2 Frequency and Duration

Collection survival estimates will be developed daily until it is proven that the collection standards have been met. Once met, survival estimates will be developed monthly to document compliance with the collection survival standard.

2.4.1.3 Assumptions

The major assumptions inherent in the proposed methods include:

1. The subsample fish are representative of the population being collected and transported.
2. Diversion of juvenile fish into the subsample system does not bias mortality estimates.
3. Fish handling protocols for determining S_{TRAN} do not bias juvenile mortality estimates.
4. Biologists will be able to identify and collect dead fish from the release ponds.

2.4.1.4 Results and Reporting

Results of the analysis will be presented in tabular format as shown in Table 2.4.1. The CS standard will be considered met if the calculated confidence interval (CI) spans the target survival rate of smolts, fry and adults.

Table 2.4.1. Daily and seasonal estimates of S_{COL}, S_{TRAN} and CS, with associated 95% CI for coho salmon collected and transported from the SDF.

	Collection Survival	**Transport Survival**	**Collection + Transport (CS)**	
Week	S_{COL}	S_{TRAN}	CS	95% CI
Day 1				
Day 2				
Day 3				
Season				

2.5 OBJECTIVE 5- DETERMINE JUVENILE INJURY RATES DURING COLLECTION AT THE SDF

The objective of this analysis is to determine the injury rate for fish collected at the SDF. The Settlement establishes a SDF design performance objective for injury of less than or equal to two percent for all fish examined.

Injury is defined in Settlement Table 4.1.4 as:

> *Visible trauma (including, but not limited to hemorrhaging, open wounds without fungus growth, gill damage, bruising greater than 0.5 cm in diameter, etc.), loss of equilibrium, or greater than 20% descaling. "Descaling" is defined as the sum of one area on one side of the fish that shows recent scale loss. This does not include areas where scales have regenerated or fungus has grown.*

2.5.1 Task 5.1- Determine Collection Injury Rate (P_{CINJ})

The method proposed for estimating the proportion of fish injured (P_{CINJ}) each day from collection activities at the SDF is presented below.

2.5.1.1 Method

Estimates of P_{CINJ} will be determined by closely examining a subsample of the total juvenile population collected each day. Sample fish will be diverted (through the use of automatic gates on the SDF) into small holding tanks where they will be anesthetized and examined for injury[13]. Injured smolt and fry will be classified into the categories shown in Table 2.5.1.

Table 2.5.1. Categories used for documenting visible injury at the SDF collection and transport system.

Hemorrhaging	Open Wound (No Fungus)	Open Wound (Fungus)[1]
Gill Damage	Bruising > 0.5 cm diameter	Bruising ≤ 0.5 cm diameter
Loss Of Equilibrium	Descaling > 20%	Descaling < or = 20%

[1]Open wound fish with fungus will not be counted as an injured fish. The presence of fungus indicates the wound likely occurred prior to entry into the SDF.

The proportion of juvenile fish injured (P_{CINJ}) will be calculated using the formula:

$$P_{CINJ} = \text{\# of fish injured / \# of fish sampled}$$

2.5.1.2 Frequency and Duration

Injury rates will be determined daily for as long as the SDF is operational.

2.5.1.3 Assumptions

The major assumptions for measuring P_{CINJ} include:

1. The subsample fish are representative of the population being collected.
2. Diversion of juvenile fish into the subsample system does not bias estimates of injury.
3. Fish handling protocols do not result in an increase in fish injury.

2.5.1.4 Results and Reporting

Results of the injury analysis will be summarized in tabular format similar to that shown in Table 2.5.2.

[13] These fish will not be used for any additional tests of collector mortality.

Table 2.5.2. The injury type and number of juvenile coho injured during collection and transport operations of the SDF.

	Date		
Data/Injury	5/22/13	5/23/13	5/24/13
Number Examined			
Number Injured (Visible)			
Hemorrhaging			
Open Wound (No Fungus)			
Open Wound (Fungus)			
Gill Damage			
Bruising 0.5 cm diameter			
Bruising ≤ 0.5 cm diameter			
Loss Of Equilibrium			
Descaling > 20%			
Descaling ≤ 20%			

2.6 OBJECTIVE 6- QUANTIFY THE NUMBER, BY SPECIES, OF JUVENILE AND ADULT FISH COLLECTED AT THE SDF

The objective of this analysis is to quantify the number of juvenile and adult fish collected at the SDF by species.

The number of juvenile fish entering the SDF will be calculated through subsampling and the use of an AquaScan CSE-1600 (Scanner) that will automatically count all fish passing through the SDF. A combination of these two methods was chosen for estimating this parameter as it is currently unknown how accurate the Scanner will be at enumerating small juvenile salmonids under field conditions[14]. System reliability is especially uncertain during periods of high debris load which may trigger a reading, thereby biasing estimates upwards.

2.6.1 <u>Task 6.1- Calculate Juvenile and Adult Collection Numbers Using SDF Subsampling</u>

The methods proposed for quantifying the number of juveniles and adult collected at the SDF are detailed below.

2.6.1.1 Methods

A diversion gate on the SDF will be used to subsample fish entering the system. Diverted fish will be anesthetized, enumerated, checked for marks and identified to species. The number of fish collected each day in the SDF (SDF_{COL}) will be calculated as follows:

---

[14] Lab tests conducted on October 15th and 16th (2009) at the Merwin Hatchery indicated that Scanner accuracy for enumerating smolts and fry was 99% and 97%, respectively. However, these tests were done under ideal conditions (See R2 Resources Technical Memorandum dated November 12, 2008).

$$SDF_{COL} = N_{SUB} * (SDF_{OP} / S_{SUB})$$

Where

N_{SUB} = # of fish sub-sampled each day

SDF_{OP} = # of hours the SDF was operated each day

S_{SUB} = # of hours the diversion gate was operated each day

The total number of fish (by species) entering the SDF each year will be calculated by summing the daily totals for each sample year.

2.6.1.2 Frequency and Duration

Daily counts of the number of fish entering the SDF will continue for as long as the facility is operational. Subsampling rates will be developed over time as more is learned about facility effectiveness and total basin fish production.

2.6.1.3 Assumptions

The major assumption inherent in the methodology is that the subsampled fish are representative of the general population.

2.6.1.4 Results and Reporting

The results of the analysis will be presented in tabular format and included in the ACC/TCC Annual Report.

2.6.2 Task 6.2- Calculate Juvenile and Adult Collection Numbers Using Scanner

2.6.2.1 Methodology

Scanners will be located at both the subsample and adult holding tanks on the SDF.

To test the accuracy of the Scanner, physical counts of fish collected in the fry and smolt subsample tanks and adult holding tanks will be compared to the fish counts produced from the Scanners. Testing will be conducted weekly throughout the migration season to determine if system accuracy varies by species, size and environmental condition present at the SDF.

For each system test, fish will be subsampled hourly over a single 24-hour period. All fish diverted will be counted by hand, identified to species, and measured for length. The number of fish enumerated through the hand count will be compared to the count produced from the Scanner for each sample taken.

2.6.2.2 Frequency and Duration

Daily counts of the number of fish entering the SDF will continue for as long as the facility is operational.

2.6.2.3 Assumptions

A key assumption is that the Scanner juvenile counts are not biased due to species composition, fish size or environmental condition present at the SDF; or that the bias can be accounted for statistically.

2.6.2.4 Results and Reporting

The results of the analysis will be presented in tabular format by day and included in the ACC/TCC Annual Report.

2.7 OBJECTIVE 7- ESTIMATE THE NUMBER OF JUVENILES ENTERING SWIFT RESERVOIR

Estimating the number of juveniles entering each reservoir is stipulated in Section 9.2.1 of the Settlement[15]; however, the Settlement does not ascribe a rationale for why these data are needed or provide any information on the level of precision required for the estimate. Because this type of data are not needed to quantify any of the performance standards agreed to in the Settlement and will be difficult to measure, it is suggested that the ACC revisit the need for this information as part of their review of this draft report.

2.7.1 <u>Task 7.1– Estimate the Number of Juveniles Entering Swift Reservoir using the SDF</u>

Should the ACC agree that this metric is necessary information, the proposed method for estimating the number of juveniles entering Swift Reservoir from data collected at the SDF is presented below. Otherwise this estimate will not be pursued.

2.7.1.1 Methods

Total juvenile production would be calculated using the following formula:

$$N_{JUV} = SDF_{COLW} / P_{DET}$$

Where

N_{JUV} = number of fish entering Swift Reservoir

SDF_{COLW} = number of juveniles collected weekly in the SDF

P_{DET} = Proportion of radio-tagged fish released weekly at the head of Swift Reservoir detected at Swift Dam, SDF and/or the tailrace[16]

These weekly estimates of juvenile production will be combined to calculate the total number of smolts entering the reservoir each migration season.

---

[15] Section 9.2.1 defines juveniles as Chinook, steelhead, coho, bull trout and sea-run cutthroat trout.

[16] Radio-tagged fish could also be released in streams within Swift Reservoir. However, this would require accurate estimates of the proportion of the run emigrating from all areas in order to determine the correct proportion of radio-tagged fish to be released in each.

2.7.1.2 Frequency and Duration

Estimates of the number of juveniles entering the reservoir will be conducted weekly for at least one year. At that time, the ACC will be consulted to determine the usefulness of this type of data. If still needed, it is likely that the juvenile abundance estimates would be conducted on the same schedule as the SDF collection efficiency tests.

2.7.1.3 Assumptions

Key assumptions inherent in the analysis are:

1. Estimates of fry abundance are not needed for management decisions.
2. Juvenile survival rate from small tributaries in the reservoir to the SDF are similar to those for tributaries upstream of Swift Reservoir.
3. Survival rate for radio-tagged fish is the same as for un-tagged fish.
4. Tagged fish do not show trapping tendency or trap avoidance that differs from untagged fish.

2.7.1.4 Results and Reporting

Trapping results will be summarized in the ACC/TCC Annual Report. An example of a table that may be used to present juvenile production estimates (by species) developed from fish captured at the SDF is shown in Table 2.7.1.

Table 2.7.1. SDF estimates of the number of juvenile coho entering Swift Reservoir

	Swift Downstream Facility	
Sample Period	**Number of Coho**	**95% CI (+/-)**
Week 1		
Week 2		
Week 3		
Week 4		
Season Summary		

2.8 OBJECTIVE 8- DETERMINE JUVENILE MIGRATION TIMING

Juvenile migration timing will be determined by tracking juvenile abundance at the SDF each migration season.

2.8.1 Task 8.1- Operate SDF to Develop Juvenile Migration Timing Index

The methods, analysis and assumptions required for using the SDF to develop a juvenile migration timing index are presented in the following section.

2.8.1.1 Methods

An index of juvenile migration timing will be developed by tracking the number of fish captured each day at the SDF and then plotting this information over time.

The number of fish collected each day at the SDF (SDF_{COL}) will be calculated as follows:

$$SDF_{COL} = N_{SUB} * (SDF_{OP} / S_{SUB})$$

Where

N_{SUB} = Number of fish sub-sampled each day

SDF_{OP} = Number of hours the SDF was operated each day

S_{SUB} = Number of hours the diversion gate was operated each day

Fish counts from the scanner also will be used to generate a run-timing index for juvenile fish.

2.8.1.2 Frequency and Duration

Juvenile migration timing will be collected each year that the SDF is operational.

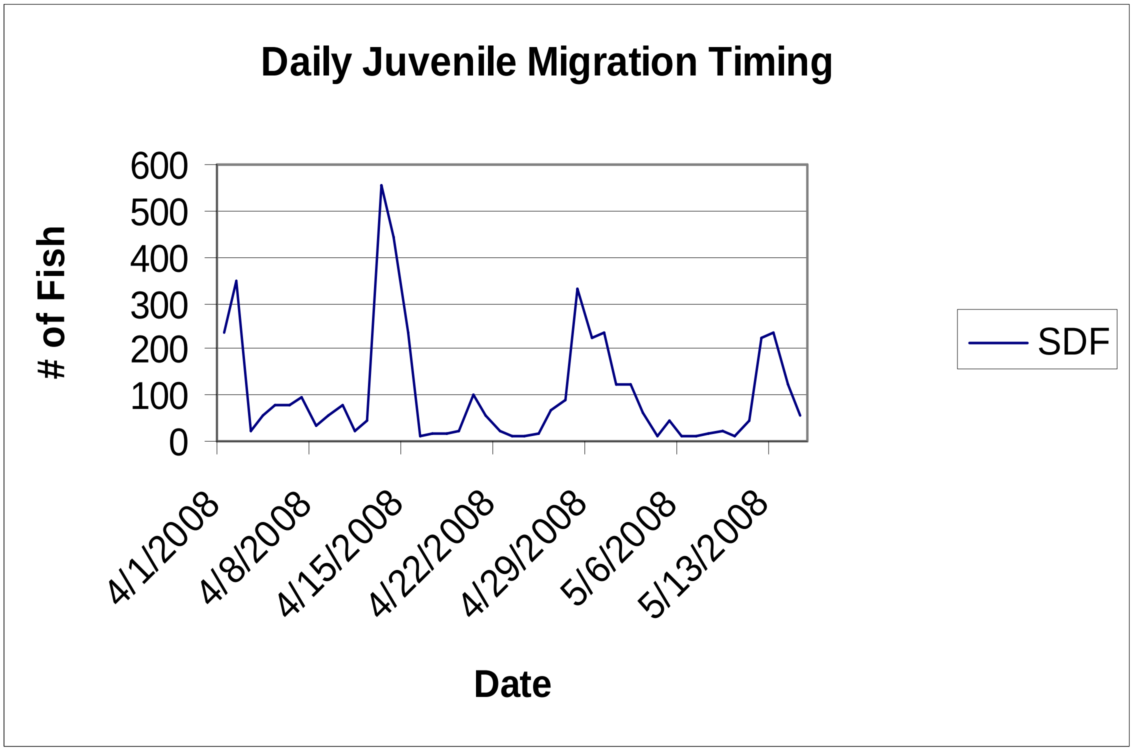
2.8.1.3 Assumptions

The major assumption inherent in this analysis is:

1. The run-timing estimate is an index that applies to fish arriving at the SDF.

2.8.1.4 Results and Reporting

Migration timing results will be presented as shown in example Figure 2.8-1. Trapping results will be summarized in the annual fish monitoring and evaluation report.



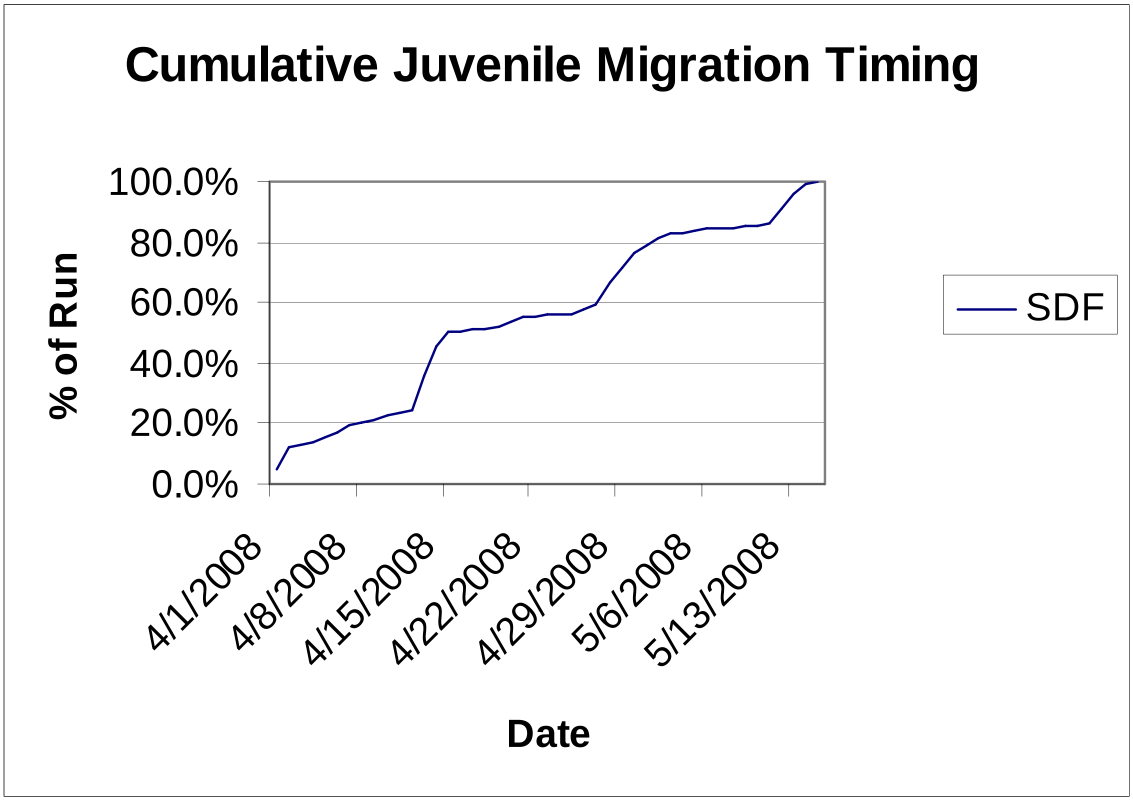


Figure 2.8-1. Example of juvenile migration timing graphs.

2.9 OBJECTIVE 9 - QUANTIFY ADULT UPSTREAM PASSAGE SURVIVAL

The adult upstream passage survival (UPS) performance standard is defined in the Settlement as:

> *Percentage of adult fish of each species designated in Section 4.1.7 that are collected that survive the upstream trapping-and-transport process. For sea-run cutthroat and bull trout, "adult" means fish greater than 13 inches in length.*

The Settlement requires the Utilities to achieve a UPS rate for all species of 99.5%. Given the UPS definition, it is assumed survival is measured from the point of collection to the point of release. The UPS standard will be considered achieved when the point estimate (mean) is $\geq$ 99.5 %.

2.9.1 Task 9.1- Quantify Upstream Passage Survival

Methods proposed for measuring UPS for adult fish captured at Merwin Dam are presented below.

2.9.1.1 Methods

The UPS will be measured through the direct enumeration of adult fish at the Merwin Upstream Transport Facility (UTF) and at transport release sites. Any dead fish recovered at trapping or release sites will be identified to species and examined for signs of physical injury, to the extent possible.

UPS will be calculated as follows:

$$UPS = 1-((AD_{TRAP}+AD_{REL}) / N)$$

Where

N =	Number of total adults collected
AD_{TRAP} =	Number of dead adults in trap
AD_{REL} =	Number of dead adults at release site

An estimate of UPS will be calculated for each day fish are collected and/or transported from the Merwin UTF. The daily estimates will be summarized to produce a single estimate of UPS for the year.

In order to determine possible causes of any adult mortality observed in the collection and transport process, the following environmental data will also be collected:

Temperature- Water temperatures at the Merwin UTF, in the transport truck and release site will be collected each day. Transport truck water temperature will be collected during fish loading and at the time of release. Stream temperature will be recorded for each release group. Stream temperature will not exceed 10°C. If the difference is greater than 10°C then truck water will be tempered with stream water before releasing adults.

Dissolved Oxygen- Measurements of dissolved oxygen will be collected and monitored in the transport truck from initial loading to release.

Transport Time and Distance- Transport time and distance will be recorded for each load of fish.

Species Mix- The number of fish by species will be recorded for each load of fish.

These data will be reviewed throughout the transport season to determine possible cause and effect relationships between transport conditions and fish loss.

2.9.1.2 Frequency and Duration

An estimate of UPS will be calculated for each day fish are collected and/or transported from the Merwin UTF.

2.9.1.3 Assumptions

A major assumption in the proposed method is that staff operating the adult trapping facility, and transporting and releasing adult fish to the river, will be able to accurately count the number of dead and live adults.

2.9.1.4 Results and Reporting

Results will be presented in tabular format by species as shown in Table 2.9.1.

Table 2.9.1. Estimated adult UPS for coho captured and transported from Merwin Dam.

Date	Number Loaded Alive	No. Dead Release Site	% Survival
4/01/12			
4/02/12			
4/03/12			
4/04/12			
4/05/12			
4/06/12			
4/07/12			
Season Total			

2.10 OBJECTIVE 10- ESTIMATE ADULT TRAP EFFICIENCY AT EACH UPSTREAM FISH TRANSPORT FACILITY

Adult trap efficiency (ATE) is defined in Table 4.1.4 of the Settlement as:

> *The percentage of adult Chinook, coho, steelhead, bull trout and sea-run cutthroat that are actively migrating to a location above the trap and that are collected by the trap.*

The Settlement calls for the licensees to consult with the resource agencies and the ACC to develop such a standard as soon as practicable. This effort was completed in 2008 and the ACC selected 98% as the target ATE value for each species.

2.10.1 Task 10.1- Develop Estimate of ATE for Adult Fish Originating Above Swift No. 1 Dam.

The methods, metrics, and definitions developed by the ACC for this study are included as Appendix C.

2.10.1.1 Methods

Methods are described in Appendix C.

2.10.1.2 Frequency and Duration

Until ATE performance standards are achieved or the Services and the ACC are satisfied with the UTF performance, the Merwin Trap will be adjusted or modified per Settlement Agreement Section 4.1.6. After ATE performance standards are achieved, no further adjustments or modifications to the Merwin upstream passage facility will be required.

2.10.1.3 Assumptions

Key assumptions inherent in the analysis include:

1. Test fish are captured either at the new Merwin trap or some point downstream of the tailrace;
2. All radio-tagged test fish are released at the Merwin boat ramp regardless of their original capture location; and,
3. The tailrace is that entire area of river upstream of the powerhouse access bridge.

2.10.1.4 Results and Reporting

Study results will be provided in the ACC/TCC Annual Report.

2.11 OBJECTIVE 11- QUANTIFY THE NUMBER, BY SPECIES, OF ADULT FISH COLLECTED AT THE PROJECTS

The accurate enumeration of adults arriving at Merwin Dam is important not only to determine the success of the anadromous reintroduction program, but is also needed to make changes to the program as defined in the Settlement. For example, when natural-origin adult production exceeds the abundance targets shown in Table 2.11.1, hatchery production levels may be decreased on a fish-for-fish basis (1:1)[17].

Table 2.11.1. Natural-origin adult abundance numbers governing modifications to hatchery production targets.

	Spring Chinook	Steelhead	Coho	Total
Natural Production Threshold for Hatchery Reduction	2,977	3,070	13,953	20,000

2.11.1 Task 11.1- Quantify the Number, by Species, of Adult Fish Collected at Merwin Dam

The methods proposed for determining the number of adult fish being collected at Merwin Dam each year is presented below.

2.11.1.1 Methods

All fish arriving at Merwin Adult Trapping Facility will be anesthetized, enumerated and identified to species. Adult fish will be counted by species and recorded on a data entry form. The Settlement definition of adult for each species of interest is as follows[18] :

Bull trout: ≥ 13 inches

Chinook: ≥ 22 inches

Coho: ≥ 18 inches

Sea-run cutthroat trout: ≥ 13 inches

Steelhead: ≥ 20 inches

The number of live and dead adults captured at Merwin Dam will be summarized on a daily basis. The daily counts will be combined to quantify total adults captured by species for the year.

2.11.1.2 Frequency and Duration

The number of adult fish entering the facility will be calculated for each day the facility is operated.

[17] The surplus abundance of one species cannot be used to reduce the number of hatchery fish of another species.
[18] Note that in some years, jack lengths may actually exceed the values identified for adults.

2.11.1.3 Assumptions

The primary assumption of this analysis is that biologists working the adult trap will be able to accurately count and identify to species all captured fish.

2.11.1.4 Results and Reporting

Results of this analysis will be reported in tabular format similar to that shown in Table 2.11.2 in the ACC/TCC Annual Report.

Table 2.11.2. Example table for reporting the number of adult coho, Chinook, steelhead, bull trout and sea-run cutthroat trout captured at the Merwin Adult Trapping Facility.

Date	Coho	Chinook	Steelhead	Bull Trout	Sea-run Cutthroat	Daily Total
4/01/12						
4/02/12						
4/03/12						
4/04/12						
Season Total						

2.12 OBJECTIVE 12- DEVELOP ESTIMATES OF OCEAN RECRUITS

According to the Settlement, a juvenile tagging program is needed to determine when the hatchery and natural adult production targets identified in Table 2.12.1 are achieved.

Table 2.12.1. Hatchery and naturally produced adult threshold levels (ocean recruits) for spring Chinook, steelhead and coho.

	Spring Chinook	Steelhead	Coho (Type S and Type N)	Total
Hatchery	12,800	13,200	60,000	86,000
Natural Production Threshold	2,977	3,070	13,953	20,000
Grand Total	**15,777**	**16,270**	**73,953**	**106,000**

These targets are referred to in the Settlement as Ocean Recruits[19]. This parameter is defined in Section 8.1 of the Settlement as:

> *"… total escapement (fish that naturally spawned above Merwin and hatchery fish) plus harvest (including ocean, Columbia River, and Lewis River Harvest)."*

[19] The ACC agreed to change the ocean recruits definition so that jacks are not included or counted as part of the ocean recruits analysis (March 9, 2005 ACC meeting).

The Settlement does not however, define (1) if the species specific values are averages, or (2) the time frame over which they must be observed to invoke a possible change in hatchery production.

For this analysis the average ocean recruits for five consecutive brood years will be used to determine if and when hatchery production levels should be altered.

2.12.1 Task 12.1- Calculate Ocean Recruits

2.12.1.1 Methods

The Lewis River Hatchery and Supplementation Plan (H&S Plan) identified three indices that could be used to measure ocean recruits (PacifiCorp Energy and Cowlitz PUD 2006):

1. **Age 2 Recruits (Age 2)**: Number of fish alive at the time of first recruitment into a fishery (typically at age 2). Represents the maximum number of fish available to be managed.
2. **Adult Equivalent Run (AER)**: The total number of fish that would have returned to the spawning grounds at all ages in the absence of fisheries. In other words, AER is the best estimate of adult run-size absent human harvest.
3. **Catch Plus Escapement (C+E)**: Total catch of all ages plus total escapement of all ages. This method is in reality the outcome of harvest management activities affecting the species.

The formulas used to calculate each of the three ocean recruits estimates are presented in Appendix D. The indices that will be used to calculate this parameter by species is shown in Table 2.12.2.

Table 2.12.2. Methods used for estimating ocean recruits by species.

Stock	Age 2	AER	C+E[1]
Spring Chinook Hatchery	✓	✓	✓
Spring Chinook Natural	✓	✓	✓
Coho Hatchery	✓	✓	✓
Coho Natural	✓	✓	✓
Steelhead Hatchery			✓
Steelhead Natural			✓

[1] Because steelhead are not harvested in large numbers in ocean fisheries, the H&S Plan recommended that only C+E be used for estimating ocean recruits for this species.

Calculating ocean recruits requires that Lewis River-origin fish be marked such that they are distinguishable in fisheries, traps and on the spawning grounds. Test fish will be marked using a combination of coded-wire tags (CWTs) and fin-clips (AD-clip). The mark used for each index group will be consistent with the marking designations presented in Table 2.12.3. However, the marking program would be reviewed prior to initiation to confirm that protocols conform to other research activities undertaken in the basin or nearby basins.

Table 2.12.3. Juvenile marking program for supplementation, hatchery, and natural-origin spring Chinook, coho and steelhead.

Location	Fish Origin	Spring Chinook	Steelhead*	Coho
Swift	Natural	None	None	AD intact, 21,000 CWT (right cheek)
	Supplementation	AD intact, (100% CWT located in adipose fin)	None	None
Yale	Natural	None	None	AD intact, 21,000 CWT (left cheek)
	Supplementation	AD intact, 100% CWT	None	None
Merwin	Natural	None	None	None
	Supplementation	AD intact, 100% CWT	AD intact, 50,000 blank wire (nose)	None

* CWTs may be coded or blank dependent on the harvest sampling program in net fisheries. In addition, the decision to use CWTs or another tag type for upper basin wild production will be coordinated with the resource agencies.
Note: AD =adipose fin clip

The number of fish to be tagged by species and stock is also shown in Table 2.12.3. Sample sizes for fish released from Lewis River hatcheries are based on historical practices. Sample sizes for natural-origin fish are based on the smolt-to-adult survival ratio (SAR) presented in the H&S Plan. The release size for each group was designed to produce 1,000 marked adults, on average, for each brood year (Table 2.12.4). Sample sizes would be adjusted in the future as data become available on SARs for each species.

Table 2.12.4. Release size, Smolt-to-Adult Survival Ratio (SASR) and expected adult production for marked natural-origin spring Chinook, coho and steelhead.

Species	Release Size	SASR	Number of Adults
Spring Chinook	34,000	3%	1,000
Coho	21,000	4.8%	1,000
Steelhead	16,700	6%	1,000

SASR- Includes fish caught in all fisheries, at the hatchery and spawning grounds. This value is reported in the CWT database for the west coast (http://www.rmpc.org/).

Calculating Sample Sizes

A portion of the natural-origin fish entering the SDF will be diverted to the subsample tanks for marking. Here the fish will be anesthetized, tagged, allowed to recover and then transported to the release ponds downstream of Merwin Dam. The formula for calculating the number of tagged natural-origin fish released downstream of the dam is:

$$N = \text{number of fish tagged at SDF} - \text{number lost due to tagging and transport}$$

Hatchery-origin fish will be tagged at basin hatcheries and then released according to protocols in place at each hatchery. Sample size (N) for these groups equals:

N= number of total fish tagged - number of fish found dead before release

Supplementation fish destined for release upstream of Swift No. 1 Dam will be tagged at the Lewis River hatcheries, transported and released into the upper watershed (either in streams or acclimation ponds).

The number of tagged supplementation fish caught in the SDF will be determined using the protocols described in Section 2.6. The formula for calculating the number of supplementation fish released downstream of Merwin Dam is:

N= number of tagged fish collected in SDF - number lost due to collection and transport

Tagged Lewis River-origin fish captured in ocean and freshwater fisheries, as well as on the spawning grounds and at hatcheries will be collected by those agencies responsible for monitoring these areas. PacifiCorp will also recover tagged fish during any spawning surveys they conduct in the Lewis River basin both downstream and upstream of Merwin Dam. CWT recoveries will be reported to the Regional Mark Information System (RMIS) where the data will be stored (http://www.rmpc.org/).

Adjusting Hatchery Production

The Settlement allows the Utilities to reduce hatchery production on a 1:1 basis after the natural production target for each species shown in Table 2.12.1 is achieved. The calculations used for adjusting spring Chinook, coho and steelhead hatchery production is as follows:

$H_{JUV} = N_{OR} – (N_{PTH} / H_{SUR})$

Where:

H_{JUV} =	Number of hatchery juveniles eliminated
N_{OR} =	Natural ocean recruits (five brood year running average)
N_{PTH} =	Natural production threshold
H_{SUR} =	Hatchery survival rate (five brood year running average)

The hatchery survival rate (H_{SUR}) is calculated:

$H_{SUR} = (H_{OR} / H_{REL})$

Where:

H_{OR} =	Hatchery ocean recruits (five year running average)
H_{REL} =	Number of hatchery fish released (five year running average)

The need for hatchery production adjustment will be determined every five brood years. An example hatchery production adjustment for spring Chinook is shown in Table 2.12.5. In this example, hatchery spring Chinook production would be reduced by 55,471 fish.

Table 2.12.5. Spring Chinook hatchery adjustment example.

Brood Year	N_{OR}	N_{PTH}	Difference	H_{SUR}
1	3,500	2,977	523	1.0%
2	4,500	2,977	1,523	2.0%
3	6,900	2,977	3,923	4.0%
4	1,500	2,977	-1,477	0.5%
5	3,200	2,977	223	1.0%
Average	3,920	2,977	943	1.7%
Adjustment (H_{JUV}) (Calculated: 943 / 1.7%)	55,471			

2.12.1.2 Frequency and Duration

Estimates of ocean recruits will be developed for each brood year and species throughout the term of the licenses.

2.12.1.3 Assumptions

Key assumptions inherent in completing the analysis include:

1. Sample sizes provide sufficient precision for making management decisions.
2. Tagged fish can be readily and reliably identified in ocean and freshwater fisheries, on the spawning grounds and at trapping facilities.
3. Recovered CWT data will be reported to RMIS in a timely manner.

2.12.1.4 Results and Reporting

The results of the ocean recruits analysis will be documented in the ACC/TCC Annual Report. The data will be presented in tabular format similar to that shown in Table 2.12.6.

Table 2.12.6. Estimates of ocean recruits for coho, Chinook and steelhead using three different indices.

		Age 2	AER	C+E
Species	**Stock**	**Ocean Recruits**	**Ocean Recruits**	**Ocean Recruits**
Spring Chinook	Natural			
	Hatchery			
	Supplementation			
Coho	Natural			
	Hatchery			
	Supplementation			
Winter Steelhead	Natural			
	Hatchery			
	Supplementation			

2.13 OBJECTIVE 13- DETERMINE PERFORMANCE MEASURES FOR INDEX STOCKS

The H&S Plan recommends that other Lower Columbia River stocks be used as index groups to determine whether the success or failure of the Lewis River reintroduction program is the result of in-basin or out-of-basin factors. This would be determined by comparing the survival rates of hatchery and natural-origin fish produced in other basins (such as the Cowlitz River) with releases made in the Lewis River. The methods that will be used to calculate juvenile-to-adult survival rates are presented below.

2.13.1 Task 13.1- Develop Estimates of Survival for Lower Columbia River Fish Stocks

2.13.1.1 Methods

Two different juvenile to adult survival estimates will be developed for marked test groups. These are:

- Smolt-to-adult Survival Ratio (SASR): Represents the total number of fish caught in fisheries, on the spawning grounds and at hatcheries. The SASR is equivalent to C+E described in Section 2.12.1.1.

- Smolt-to-adult Survival Rate (SAR): Measures the number of adults that return to the basin at a pre-defined point. For this analysis, SAR will be measured at the Merwin Dam upstream trap and/or Lewis River Hatchery ladder.

For almost all hatchery stocks, SASR is tracked on the Data Access in Real Time (DART) web site (http://www.cbr.washington.edu/cwtSAR/)[20]. DART uses data from

[20] Note: this web site uses the abbreviation SAR in presenting data for what they refer to as the smolt-to-adult ratio. The abbreviation was changed to SASR in this report to eliminate confusion with the more well known smolt-to-adult survival rate (SAR) used in the fisheries literature.

RMIS to calculate both SASR and a standard error for CWT fish released in the Columbia River Basin.

The DART system will be used to develop and contrast survival rates for index stocks and fish released in the Lewis River. All hatchery and natural stocks located below Bonneville Dam will be used as index stocks as recommended in the H&S Plan as long as data are available for comparison. This M&E plan does not propose to initiate a tagging program for those lower river fish stocks that are not currently marked.

The SAR for each tagged group of fish originating from upper basin-origin juveniles will be determined by sampling fish at Merwin Dam[21]. Hatchery SARs will be based on tag recoveries at both Merwin and Lewis River hatcheries. SAR will be calculated as:

SAR = number of tagged fish recovered / number tagged fish released

Scale samples will be collected on upper basin-origin tagged fish to determine age and assign tags to the correct brood year[22]. Results from this analysis will be checked against tags and scales recovered on the spawning grounds. The additional step of reading scales is needed because it is currently unknown what proportion of the upper basin spawners will be sampled as part of the spawning surveys described in Section 2.14. The inability of biologists to access some spawning areas may result in few CWT fish being recovered during survey work, making it difficult to accurately assign adult returns to the correct release year based on CWTs alone[23].

Finally, SAR estimates will also be developed for unmarked natural-origin adults returning to Merwin Dam. The SAR for this group of fish will be calculated as follows:

SAR= number of unmarked adults/ number of unmarked juveniles released below Merwin Dam

The estimated number of unmarked juveniles released below Merwin comes from the analysis described in Section 2.6 of this report.

2.13.1.2 Frequency and Duration

Survival estimates will be developed for each brood year throughout the term of the licenses.

2.13.1.3 Assumptions

Key assumptions inherent in completing the analysis include:

1. Sample sizes provide sufficient precision for making management decisions.

---

[21] Upper basin-origin fish collected at the Lewis River hatcheries would also be included in SAR calculations.

[22] Although the vast majority of coho are three-year old fish, scale samples will be collected on this species until such time as data indicate that no or few 4+ fish return to the basin.

[23] Scale sampling will be eliminated if sufficient numbers of CWT are recovered during spawning surveys.

2. Tagged fish can be readily identified in ocean and freshwater fisheries, on the spawning grounds, hatcheries and at trapping facilities.
3. All unmarked fish arriving at Merwin Dam originated from upstream reaches.
4. Scale samples accurately identify fish age.
5. Recovered CWT data will be reported to RMIS in a timely manner.

2.13.1.4 Results and Reporting

The results of the SAR analysis will be documented in the ACC/TCC Annual Report. The data will be presented in tabular format similar to that shown in Table 2.13.1. Results of SAR analysis for index stocks developed by others will be provided in a similar table (if available).

Table 2.13.1. Estimated SAR for hatchery and natural origin Lewis River coho, Chinook and steelhead.

Species	Stock	Brood Year	SAR	Standard Error

Results of the SASR analysis will be downloaded from the DART site and presented in a similar manner.

2.14 OBJECTIVE 14: DETERMINE COMPLIANCE OF UPSTREAM AND DOWNSTREAM PASSAGE FACILITIES WITH HYDRAULIC DESIGN CRITERIA

As new fish passage facilities are implemented, they will be tested to determine if they are operating as designed. For the SDF, the key design variables are total attraction flow and water velocities passing through and past the screens. At the Merwin UTF, adult attraction flows, water drop in elevation over weirs, and uniformity of flow across attraction flow diffusers are the indicators of facility performance that will be tested.

2.14.1 Task 14.1- Confirm SDF System Compliance with Hydraulic Design Criteria

The method used for determining the hydraulic performance of the SDF is discussed below.

2.14.1.1 Methods

Both acoustic Doppler and hand-held water velocity meters will be used to determine the hydraulic performance of the SDF. The two systems will collect data on flow velocity and direction at the following locations (see Figure 2.14-1 for SDF schematic):

- Collection entrance
- Collection enhancement structure
- Primary and secondary dewatering screens (including floor screens)

Water velocity and directional measurements will be collected over the full range of SDF operational conditions. The results will be compared to the SDF design criteria to document system compliance.

2.14.1.2 Frequency and Duration

Flow measurements required to document compliance with design criteria will be conducted until it is proven that these criteria have been achieved. After that time, flow measurements within the SDF will be made once yearly to ensure that the system continues to perform as designed.

2.14.1.3 Assumptions

Key assumptions inherent in completing the analysis include:

- Measurement points are readily accessible to staff.

2.14.1.4 Results and Reporting

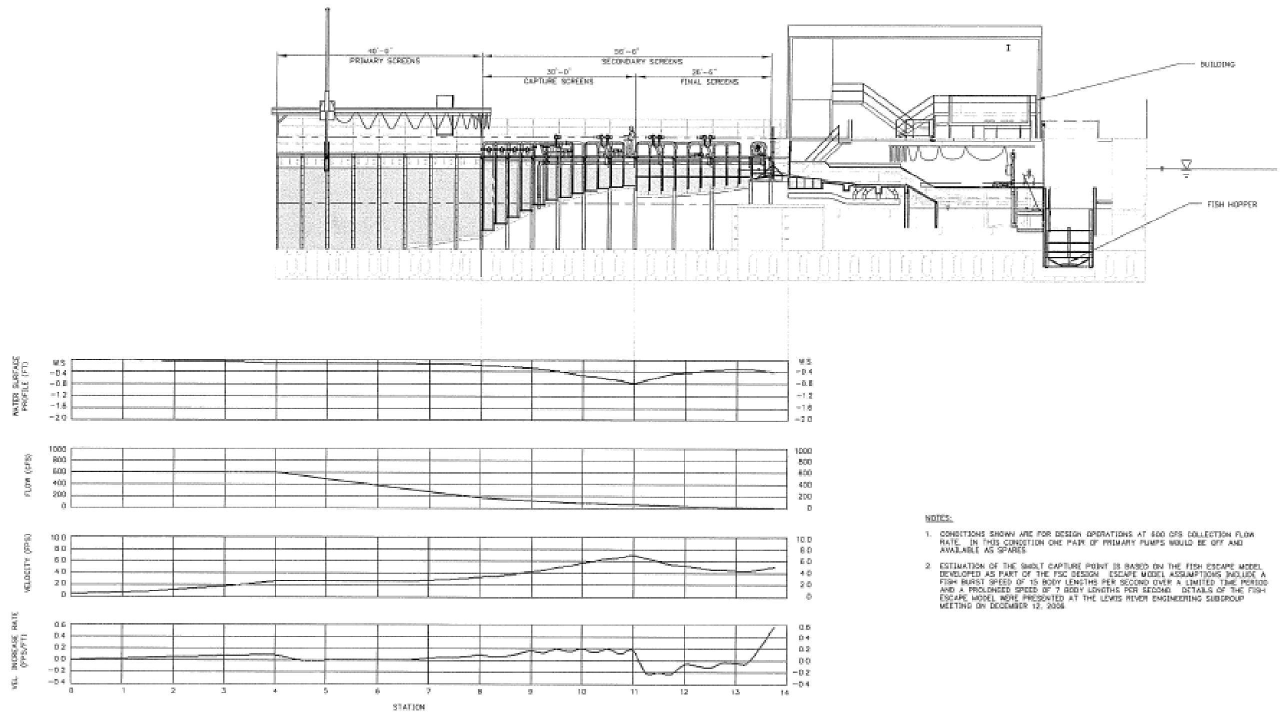
Yearly monitoring results will be reported in the ACC/TCC Annual Report.

2.14.2 Task 14.2- Confirm Compliance of Merwin Upstream Transport System with Design Criteria

The method used for determining that the Merwin upstream transport system is operating as designed is presented below.

2.14.2.1 Methods

To be determined after facility design is complete.



NOTES:

1. CONDITIONS SHOWN ARE FOR DESIGN OPERATIONS AT 600 CFS COLLECTION FLOW RATE. IN THIS CONDITION ONE PAIR OF PRIMARY PUMPS WOULD BE OFF AND AVAILABLE AS SPARES.

2. ESTIMATION OF THE SMOLT CAPTURE POINT IS BASED ON THE FISH ESCAPE MODEL DEVELOPED AS PART OF THE FSC DESIGN. ESCAPE MODEL ASSUMPTIONS INCLUDE A FISH BURST SPEED OF 15 BODY LENGTHS PER SECOND OVER A LIMITED TIME PERIOD AND A PROLONGED SPEED OF 7 BODY LENGTHS PER SECOND. DETAILS OF THE FISH ESCAPE MODEL WERE PRESENTED AT THE LEWIS RIVER ENGINEERING SUBGROUP MEETING ON DECEMBER 12, 2006.

	NET TRANSITION STRUCTURE					PRIMARY SCREENS				CAPTURE SECTION					FINAL SCREEN SECTION			
STATION:	0	1	2	3	4	5	6	6.5	8	9	9.5	10	10.5	11	11.75	12.50	13.25	13.75
DISTANCE ALONG FSC (FT)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	65.0	80.0	90.0	95.0	100.0	105.0	110.0	117.5	125.0	132.5	137.5
FLOOR ELEV. (RES. W.S.=16.0 FT)	-21.50	-14.12	-6.73	-1.94	0.00	0.00	0.00	0.00	2.25	7.25	9.25	10.50	11.50	12.13	12.26	12.94	13.94	14.80
CHANNEL WIDTH (FT)	30.00	26.13	22.25	18.38	14.50	11.88	9.25	7.94	4.00	3.50	3.25	3.00	3.00	3.00	2.33	1.67	1.00	1.00
FLOW (CFS)	600.0	600.0	600.0	600.0	600.0	491.6	383.2	329.0	183.0	126.0	102.2	85.3	74.1	65.3	41.5	21.1	7.7	4.0
DEPTH (FT)	37.49	30.11	22.71	17.89	15.89	15.89	15.89	15.89	13.57	8.47	6.37	4.99	3.86	3.11	3.29	2.72	1.76	0.79
VELOCITY (FPS)	0.53	0.76	1.19	1.83	2.60	2.60	2.61	2.61	3.57	4.25	4.94	5.70	6.40	7.01	5.40	4.65	4.37	5.05
FROUDE NUMBER	0.02	0.02	0.04	0.08	0.12	0.12	0.12	0.12	0.18	0.26	0.34	0.45	0.57	0.70	0.52	0.50	0.58	1.00
WATER SURFACE (FT BELOW RES.)	-0.01	-0.01	-0.02	-0.05	-0.11	-0.11	-0.11	-0.11	-0.18	-0.28	-0.38	-0.51	-0.64	-0.77	-0.46	-0.34	-0.30	-0.40
MAX. ACC. IN SECTION UPSTREAM (FPS/FT)*		0.03	0.06	0.08	0.09	0.00	0.00	0.00	0.10	0.16	0.20	0.20	0.20	0.17	-0.22	-0.12	-0.04	0.55
SCREEN VEL. IN SECTION UPSTREAM (FPS)**		N/A	N/A	N/A	N/A	0.39	0.39	0.39	0.38	0.31	0.37	0.36	0.31	0.30	0.39	0.38	0.35	0.32

NOTES: *ACCELERATIONS CALCULATED OVER 6-INCH LENGTHS. **AVE. SCREEN VELOCITIES BASED ON 87.5% EFFECTIVE AREA UPSTREAM OF CAPTURE, AND 90% EFFECTIVE AREA DOWNSTREAM.

NOT TO BE USED FOR CONSTRUCTION

Resource Consultants, Inc.
REDMOND, WA

BLACK & VEATCH
Black & Veatch Corporation
Kansas City, Missouri

ENG PJC | DES PJC | DR JES | CH
APPROVAL

SWIFT RESERVOIR FISH FACILITY LAYOUT
HYDRAULIC PROFILE VIEW
DESIGN OPERATION CONDITION

PACIFICORP ENERGY — HYDRO

SCALE: AS SHOWN | SHEET | FIGURE FSC-1

Figure 2.14-1. 60% draft Swift Dam downstream facility schematic.

2.14.2.2 Frequency and Duration

Compliance activities will be conducted yearly.

2.14.2.3 Assumptions

Assumptions will be determined after facility design is complete.

2.14.2.4 Results and Reporting

Yearly evaluations to document that the facility continues to operate as designed will be reported in the ACC/TCC Annual Report.

2.15 OBJECTIVE 15- DETERMINE SPAWN TIMING, DISTRIBUTION AND ABUNDANCE OF TRANSPORTED ANADROMOUS ADULTS

Article 9.2.2 of the Settlement Agreement requires the licensees to identify the spawning timing, distribution, and abundance for transported anadromous species that are passed upstream. This is to be done by monitoring a statistically valid sample of each stock. The primary objective of this task is to identify preferred spawning areas in order to (1) inform revisions to the H&S Plan and the Upstream Transport Plan and (2) guide the ACC in determining how to direct restoration efforts with the Aquatics Fund.

To fulfill this requirement, the licensees will conduct annual spawning ground surveys for Chinook, coho, and winter steelhead in the mainstem Lewis River and selected tributaries located upstream of Swift Dam.

2.15.1 Task 15.1- Conduct Mainstem and Large Tributary Spawning Surveys

2.15.1.1 Methods

The mainstem and large tributary spawning reaches listed in Table 2.15.1 will be intensively surveyed for redds, carcasses, and live fish once every two weeks throughout each species' spawning period using traditional survey techniques. The spawning surveys will begin in 2011 following the initial adult reintroduction and will continue for a minimum of 5 years. At this time, the need for on-the-ground surveys will be re-evaluated by the ACC.

Table 2.15.1. Mainstem and large tributary reaches targeted for spawning ground surveys.

Reach Name	Survey Reach Length[1]	Migration Barrier Location
North Fork Lewis River	RM 59.1 to RM 72.2	RM 72.2
Pine Creek	RM 0 to RM 3.2	RM 8.0
Muddy River	RM 0 to RM 6.0	RM 13.8
Clear Creek	RM 0 to RM 5.1	RM 12.3
Clearwater Creek	RM 0 to RM 5.2	RM 5.2
Smith Creek	RM 0 to RM 3.7	RM 5.7
Drift Creek	RM 0 to RM 1.6	RM 1.6

[1]It should be noted that these reach lengths are preliminary and may be adjusted (shortened or lengthened) based on initial survey results or access concerns; however, any modification would be made in consultation with the ACC.

During the spawning surveys, biologists will work in pairs, walk in an upstream direction on opposite sides of the stream bank, at a pace adapted to weather and viewing conditions. It is anticipated that crews will be able to walk two to three miles during each survey day; however, some of the more remote sites may require more time to survey (due to difficult access conditions). Surveyors may also elect to float selected mainstem reaches in rafts or kayaks during periods of higher flows. To minimize stress on pre-spawning salmonids, surveyors will move carefully and quietly through holding and spawning areas. In order to avoid adult disturbance or redd trampling, surveys will not be conducted in a given reach if the streambed is obstructed from view due to high flows turbidity or inaccessibility (e.g., snow).

While moving upstream or floating downstream, surveyors will count redds and collect basic biological and physical data including live fish and carcass counts. Carcasses will also be sampled for coded-wire tags, scales and examined to determine egg retention and spawning success. After examination, all sampled carcasses will have the tails removed to prevent re-sampling during subsequent surveys. Individual redds or groups of redds will be flagged, documented and the GPS location recorded. Each flag will be marked with the date, location of redd, redd number for the survey, fish species observed near the redd, and the surveyors initials. The number of days between the survey when a redd was first marked and when it was no longer visible will define the period of "redd life" for that redd. Because all redds will be marked, they represent a total count in a given reach[24].

Using the above redd count information, the total number of redds excavated in the mainstem Lewis River or large tributary reach, in each spawning season, will be estimated. The total salmon and steelhead escapement to the upper watershed will be determined from adult counts at Merwin Dam.

In addition to these traditional “on-the-ground” spawning surveys, PacifiCorp will conduct a series of annual aerial spawning ground surveys. Low elevation helicopter flights will be made over the identified reaches of each stream listed in Table 2.15.1 during the peak spawning period of each species. The aerial surveys will begin in 2011 following adult reintroduction and will continue for a period of three years. The need for additional aerial surveys will be evaluated by the ACC. The objective of these surveys is to document the full extent of spawning distribution of each species in the upper basin as needed to refine (lengthen or shorten) the preliminary index reach lengths listed in Table 2.15.1. The aerial surveys will also help to determine the best access into those streams located in remote areas of the basin (i.e., the upper Muddy River, Smith Creek, and Clearwater Creek).

During these aerial counts, fisheries biologists will count and record the number of fish and redds observed in each survey reach (Table 2.15.1). To facilitate counts, the pilot will maintain the slowest airspeed possible at an altitude that will provide the best possible view of the streambed. All flights will be scheduled to minimize sampling error by avoiding periods of turbid flow and inclement weather. The direction of the surveys (upstream or downstream) will be dictated by local wind and visibility conditions. When

24 All flagging used to mark redds will be removed at the conclusion of each field season.

necessary, the pilot will hover or circle over areas with a large number of redds or large schools of fish to assist with the counting. Hand-held GPS units and digital cameras will be used to record areas of peak spawning activity and to refine index reach demarcations.

In general, the accessible reaches of large tributaries will be surveyed until they begin branching into numerous small tributaries, or until the vegetation canopy or canyon walls limit the ability of observers to count fish.

2.15.1.2 Frequency and Duration

Ground surveys of mainstem and large tributaries will be conducted every two weeks throughout the defined spawning season (Table 2.15.2).

Table 2.15.2. Proposed schedule for the mainstem and large tributary spawning surveys upstream of Swift Creek Reservoir.

Species	Dates*	Frequency	Activity
Winter Steelhead	March 15 through June 30	Every two weeks	Spawning surveys
Chinook	September 1 through October 31	Every two weeks	Spawning surveys
Coho	October 15 through December 1	Every two weeks	Spawning surveys

* Preliminary schedule is based on spawning periodicity observed in the Lewis River downstream of Merwin Dam. These dates may be modified in consultation with the ACC as more information becomes available.

2.15.1.3 Assumptions

The major assumptions associated with this study include:

1. Biologists are able to accurately determine the presence of redds, and identify redds to species.

2. Spawning occurs during the time frames identified in Table 2.15.2.

3. Identified stream reaches are and remain accessible to surveyors during the sampling period.

2.15.1.4 Results and Reporting

Study results will be provided in the Utilities' ACC/TCC Annual Report.

2.15.2 <u>Task 15.2- Conduct Supplemental Small Tributary Spawning Surveys</u>

2.15.2.1 Methods

In addition to the mainstem and large tributary reach surveys described above, PacifiCorp biologists will conduct supplemental spawning ground surveys during peak spawning periods, in up to nine randomly selected small tributaries not previously surveyed during the mainstem and large tributary reach surveys (Table 2.15.3). The supplemental surveys will be conducted during the peak spawning period of each species and will be conducted to further define the extent of spawning activity in the upper basin. Methods used for this work will be the same as described for the mainstem and large tributaries and may intensify if the designated areas are not being utilized by salmon and steelhead.

Table 2.15.3. Small tributary reaches targeted for supplemental spawning ground surveys.

Reach Name	Survey Reach Length	Migration Barrier Location
Swift Creek	RM 0 to RM 0.3	RM 0.3
Range Creek	RM 0 to RM 0.7	RM 0.7
S10	RM 0 to RM 0.4	RM 0.4
S15	RM 0 to RM 1.3	RM 1.3
P3	RM 0 to RM 1.0	RM 1.0
P7	RM 0 to RM 1.1	RM 1.1
P8	RM 0 to RM 4.2	RM 4.2
P10	RM 0 to RM 0.3	RM 0.3
U8	RM 0 to RM 0.3	RM 0.3
Pepper Creek	RM 0 to RM 0.4	RM 0.4
Rush Creek	RM 0 to RM 1.7	RM 1.7
Little Creek	RM 0 to RM 0.3	RM 0.3
Big Creek	RM 0 to RM 0.3	RM 0.3
Spencer Creek	RM 0 to RM 0.6	RM 0.6
Cussed Hollow Creek	RM 0 to RM 0.3	RM 0.1
Chickoon Creek	RM 0 to RM 0.3	RM 0.3
Diamond Creek	RM 0 to RM 0.1	RM 0.1

2.15.2.2 Frequency and Duration

The supplemental small tributary surveys will occur once a year for each species during the peak spawning period of each species.

2.15.2.3 Assumptions

Major assumptions associated with this study include:

1. Biologists are able to accurately determine the presence of redds, and identify redds by species.
2. Spawning occurs during the time frames identified in Table 2.15.2.
3. A single survey in small tributaries adequately captures data needed for decision-making.
4. Identified stream reaches are and remain accessible to surveyors during the sampling period.

2.15.2.4 Results and Reporting

Study results will be provided in the ACC/TCC Annual Report.

2.16 OBJECTIVE 16: EVALUATE LOWER LEWIS RIVER WILD FALL CHINOOK AND CHUM POPULATIONS

Section 9.3 of Lewis River Settlement Agreement calls for the continued monitoring of wild fall Chinook and to begin monitoring chum populations in the Lewis River below Merwin Dam (including juvenile tagging). To meet this obligation, PacifiCorp will conduct juvenile Chinook monitoring activities and spawning surveys for adult fall Chinook and chum.

2.16.1 Task 16.1- Tag Lower Lewis River Wild Fall Chinook Juveniles

2.16.1.1 Methods

In May or early June of each year, PacifiCorp will collect fall Chinook young-of-the-year (YOY) from rearing areas in the Lewis River using stick seines. YOY fish will be collected from just above Colvin Creek (RM 16.5) to a point upstream of the county road bridge in Woodland (RM 6.6). The goal will be to collect and CWT tag approximately 100,000 YOY fall Chinook each year. Fish less than 47 mm in length will not be tagged. All tagged fish will also have their adipose fin removed.

2.16.1.2 Frequency and Duration

Wild YOY fall Chinook will be tagged each year throughout the term of the new license.

2.16.1.3 Assumptions

Key assumptions of the analysis include:

1. Chinook captured in the lower river are fall Chinook and not juvenile spring Chinook.

2. Fish handling and tagging does not bias study results.

3. Failing to tag fish less than 47 mm does not bias study results or interpretation.

2.16.1.4 Results and Reporting

The results of this work will be summarized in the ACC/TCC Annual Report.

2.16.2 Task 16.2- Conduct Fall Chinook and Chum Spawning Surveys in Lower Lewis River

2.16.2.1 Methods

Starting in September and continuing through December, PacifiCorp will perform weekly spawning and carcass recovery surveys for fall Chinook and chum on the lower Lewis River. Surveys will include all reaches extending from just downstream of Merwin Dam to just downstream of Eagle Island.

To better accommodate redd counts and fish carcass data collection, PacifiCorp will reduce river flows when feasible at Merwin Dam during scheduled survey days. The magnitude of each drawdown will be prescheduled and subject to change based on inflow conditions. PacifiCorp will coordinate with crews conducting this survey work to the best of their ability depending on runoff conditions.

Field crews will count carcasses and collect length and sex data on a subset of the carcasses found. The snout of any carcass missing an adipose fin will be sampled with a wire detector wand to determine if it has a CWT. Snouts with CWTs will be sent to a lab for tag removal and submittal to RMIS. The tails of sampled carcasses will be removed so they will not be counted in future surveys.

Counts of live fish and redds will be made for all reaches where spawning is observed. A mark-recapture study using tagged carcasses will be conducted every five years to verify sample rates and escapement estimates.

2.16.2.2 Frequency and Duration

Fall Chinook and chum spawning and carcass surveys will be conducted yearly throughout the term of the new license.

An annual report that estimates run size and population demographics for the Lewis River will be developed. The tagging information is provided to the Pacific States Marine Fisheries Commission.

2.16.2.3 Assumptions

The key assumptions of the analysis include:

1. Surveyors can identify fall Chinook and chum carcasses and redds.
2. Historic areas sampled are representative of the spawning area downstream of Merwin Dam for each species.
3. Fall Chinook carcasses and redds can be distinguished from spring Chinook.
4. Recovery of tagged adult returns is adequate and representative of the fall Chinook population

2.16.2.4 Results and Reporting

Study results will be provided in the ACC/TCC Annual Report.

2.17 OBJECTIVE 17- MONITOR BULL TROUT POPULATIONS

As described in Section 9.6 of the Settlement Agreement, the Utilities have agreed to include, in this M&E Plan, a series of measures designed to monitor bull trout populations in the Lewis River basin for the duration of the new Licenses[25]. Specifically, Sections 9.6.1 and 9.6.2 of Settlement Agreement direct the Utilities to continue their annual bull trout net-and-haul program in the Yale and Swift No. 2 tailraces or as designated by the USFWS in the Bull Trout Annual Monitoring Plan (in the absence of anadromous fish passage). Note that since 2007, the USFWS has endorsed bull trout collection in the Swift Bypass Reach rather than the Swift No. 2 tailrace. In addition, PacifiCorp is to monitor and evaluate protection, mitigation and enhancement (PM&E) measures relating to bull trout using tagging, snorkel surveys, or other methods. The information gathered during these monitoring activities may then be used by the ACC to prioritize expenditures for restoration from the Aquatics Fund.

2.17.1 Task 17.1- Monitor Swift Reservoir and Cougar Creek Bull Trout Populations

This task will be included in the Utilities Annual Bull Trout Monitoring Plan. Revisions to the Annual Plan will occur in consultation with USFWS.

2.17.1.1 Methods

Methodologies, frequency, and duration of the monitoring of bull trout populations in Swift Reservoir and Cougar Creek will be submitted annually to the Services in the Utilities' Annual Bull Trout Monitoring Plan.

2.17.1.2 Results and Reporting

Study results will be provided in the in the ACC/TCC Annual Report.

2.17.2 Task 17.2- Conduct Bull Trout Trapping in Yale Tailrace and the Swift Bypass Reach (or as directed by the USFWS)

This task will be included in the Annual Bull Trout Monitoring Plan. Revisions to the Annual Plan will occur in consultation with USFWS.

2.17.2.1 Methods

Methodologies, frequency, and duration of the trap and haul program of bull trout in the Yale Tailrace and Swift Bypass Reach (or as directed by USFWS) will be

[25] In the event that bull trout are found by USFWS to no longer warrant protection under the ESA, the licensees and USFWS will reevaluate the need to continue the bull trout monitoring program.

submitted annually to the Services in the Utilities Annual Bull Trout Monitoring Plan.

2.17.2.2 Results and Reporting

The results of this study will be presented in the ACC/TCC Annual Report.

2.17.3 Task 17.3- Describe Fish Utilization of Constructed Channels and Mainstem Lewis River Bypass Reach

Water discharged from the Swift No. 1 Project has been flowing into the bypass reach since May 2002. The presence of water attracts bull trout as well as other fish species into this reach which extends from Swift Dam to Yale Reservoir. Fish can also enter the bypass reach from either the Swift No. 2 canal wasteway, the Canal Drain, or the Swift No. 1 Project spillway. When completed, the upper and lower constructed channels will also create additional resident and anadromous salmonid spawning and rearing habitat. To document fish presence in the bypass reach and constructed channels, the Utilities will conduct quarterly snorkel surveys to describe fish utilization of these areas.

2.17.3.1 Methods

Snorkel surveys will be used to document juvenile and adult fish use of stream habitat in the Constructed Channel, the Upper Release Channel, and Swift bypass reach.

Snorkel survey methods will be consistent with the protocols outlined in “Underwater Methods for Study of Salmonids in the Intermountain West” (Thurow 1994). Day snorkel surveys will be conducted when water temperatures in the survey area are generally greater than 9°C. At water temperatures below 9°C, most juvenile salmonids hide during the day, and therefore night surveys are likely to be more effective (O’Neal 2007). However, due to safety concerns and the greater potential for the Swift No. 1 Project to spill during the winter months when temperatures are below 9°C, night snorkeling will be discretionary and limited to defined reaches within the bypass area.

Surveys crews will collect data on fish species present, their size and location. The crews will also identify any redds observed and spawning activity by species, if possible.

In addition to these snorkel surveys, the Utilities will conduct spawning surveys (redd surveys) in the bypass reach and constructed channels once every two weeks from September 15th to November 15th and from February 1st to May 31st. These surveys will be conducted during the years listed in Table 2.17.1 and follow the same general protocols described in Section 2.15.

2.17.3.2 Frequency and Duration

Consistent with Ecology’s Section 401 Certification for the Swift No. 1 Project (WDOE 2006), PacifiCorp and Cowlitz PUD’s proposed snorkel surveys will follow the schedule and survey frequency presented in Table 2.17.1.

Table 2.17.1. Schedule for conducting snorkel surveys in Swift Bypass Reach, Upper Release constructed channel, and the Constructed Channel.

Start Date	Frequency	Rationale
Beginning after the first full year of operation of both constructed channels.	Quarterly for one full year	Waiting one full year after both release points and channels become operational will allow the aquatic ecosystems to become established.
Beginning after the fourth full year of operation of both constructed channels.	Quarterly for one full year	Surveying in the fourth year will determine fish response to the combined flow schedule described in the Settlement Agreement.
Beginning one year after any change in the Settlement's combined flow schedule (made in consultation with the ACC).	Quarterly for one full year	Survey after any changes in the flow regime will determine any fish response to the modified habitat conditions.
Beginning one year after the reintroduction of anadromous fish into Yale Lake (likely in Year 13).	Quarterly for one full year	Surveying one year after the reintroduction of anadromous fish into Yale Lake (likely in Year 13) will determine anadromous fish use in the bypass reach and constructed channels.
Beginning one year after the construction of upstream fish passage facilities at the Swift projects.	Quarterly for one full year	Will determine anadromous fish use in the bypass reach and constructed channels after the construction of upstream fish passage facilities at the Swift projects.

Additionally, foot surveys to document redds will be performed once every two weeks from September 15th to November 15th and from February 1st to May 31st, for each area and time frame shown in Table 2.17.1.

2.17.3.3 Assumptions

Major assumptions associated with this task include:

- Biologists are able to correctly identify fish use by species in the stream areas being surveyed.
- Redds can be identified to species.

2.17.3.4 Results and Reporting

Study results will be presented in tabular format in the ACC/TCC Annual Report.

2.17.4 <u>Task 17.4- Conduct Bull Trout and Kokanee Surveys in Cougar Creek</u>

Since 1979, PacifiCorp biologists, along with various state and federal agencies, have conducted annual surveys to estimate kokanee and bull trout spawning escapement and identify migration barriers in Cougar Creek. This work is continuing under the new licenses. These activities will be included in the Utilities Annual Bull Trout Monitoring Plan. Revisions to this Annual Plan will occur in consultation with USFWS.

2.17.4.2 Methods

Methodologies, frequency, and duration of Cougar Creek surveys will be submitted annually to the Services in the Utilities Annual Bull Trout Monitoring Plan.

2.17.4.3 Results and Reporting

Study results will be presented in the Utilities ACC/TCC Annual Report.

2.18 OBJECTIVE 18: DETERMINE INTERACTIONS BETWEEN REINTRODUCED ANDROMOUS SALMONIDS AND RESIDENT FISH

As called for in Section 9.7 of the Settlement, PacifiCorp will monitor the interaction between reintroduced anadromous salmonids and resident fish species. Of specific interest to the Settlement parties was the possible effect resident trout released in Swift Reservoir may have on reintroduced salmonids and the effect of anadromous fish introductions on the kokanee populations in Yale Lake. Additionally, concern was expressed that anadromous fish may impact the health of ESA listed bull trout populations. The methods proposed for addressing these concerns are presented separately below.

2.18.1 Task 18.1- Develop and Implement a North Fork Lewis River Baseline Assessment Plan

During preparation of this draft M&E Plan, the ACC expressed their desire to conduct an aquatic baseline assessment prior to implementing the full anadromous fish reintroduction program. In response to this request, PacifiCorp Energy, along with a Baseline Monitoring subgroup of the ACC, prepared the North Fork Lewis River Baseline Assessment Plan (PacifiCorp Energy 2009). The objective of this assessment plan is to monitor specific tributary and reservoir aquatic index sites within the Lewis River watershed upstream of Merwin Dam to gather baseline information on the aquatic biological community, in order to compare and document conditions and changes over time within the watershed. Specifically, data collected during monitoring would be used to document changes in species assemblage, species relative abundance, tropic interactions, and nutrient availability resulting from anadromous fish reintroduction efforts.

2.18.1.1 Methods

According to North Fork Lewis River Baseline Assessment Plan, baseline monitoring is scheduled to be conducted in June, August, and October of 2009 at a total of 28 index sites located upstream of Merwin Dam (Table 2.18.1). The 100 meter stream index sites were chosen in coordination with USFWS bull trout Patch Model sampling activities which are an ongoing effort in the Lewis River basin.

Table 2.18.1. Reservoir and tributary index site locations associated with the North Fork Lewis River Baseline Assessment Plan.

Reservoir Index Site Locations:	100 Meter-long Tributary Index Site Locations:
Lake Merwin (a site across from Speelyai Bay Park and a site near Merwin Dam)	Jim Creek (two sites) Brooks Creek (two sites)
Yale Lake (a site across from the mouth of Cougar Creek and a site near Yale Dam)	Siouxon Creek (two sites) Cougar Creek (two sites) Lewis River Bypass Reach (two sites)
Swift Reservoir (a site across from the mouth of Drift Creek and a site near Swift No. 1 Dam)	Swift Creek (two sites) Drift Creek (two sites) P8, an unnamed tributary to Pine Creek (two sites) Rush Creek (two sites) Cussed Hollow Creek (two sites) Mainstem North Fork Lewis River above Lower Falls (two control sites)

The six reservoir index sites will be sampled for fish species composition and relative abundance using 150 -to 250 foot variable mesh experimental tangle nets (0.25- to 2.5-inch stretch mesh) deployed perpendicular to the shoreline. At the tributary index sites, field personnel will use single-pass electrofishing techniques to determine fish species composition, fish species relative abundance, and forage fish nutrient availability. For fish, tissue samples will be taken from individuals in each of three size categories for each species encountered. For resident salmonids, the size-class distinctions will be <200mm, 200-300mm, >300mm. For other resident fish species, the size-class distinctions will be <50mm, 50-100mm, >100mm. The collection goal is 5 individual samples per size-class strata per species.

Two locations within each reservoir and tributary index site will also be sampled for macroinvertebrates (using a Serber Sampler or benthic dredge). To address concerns about the effects of reintroduced anadromous fish on kokanee in Yale Lake, pelagic plankton tows will also be performed near the Yale Park index area. These 28 reservoir and tributary sites will then be re-sampled following the same method after full anadromous fish reintroduction to record changes from the 2009 baseline data.

Trophic relationships in the reservoirs and identified tributaries will be evaluated using stable isotope analysis. Tissue samples will be taken from captured organisms (fish, macroinvertebrate, and for Yale Lake, plankton) at each index site, and when funding allows, samples will be sent to a lab and analyzed for distinct nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) isotopic signatures as needed to identify trophic interactions within and between individual organisms of each identified species.

2.18.1.2 Frequency and Duration

The initial baseline assessment will be conducted in June, August, and October of 2009. The timeline and duration of subsequent sampling will be described in PacifiCorp and Cowlitz PUD's Monitoring and Evaluation Plan, scheduled to be completed in June 2010.

2.18.1.3 Assumptions

Major assumptions associated with this task include:

1. Fish sampling efforts in the tributary and reservoir index sites result in the collection of at least 5 fish per size-class strata per species.

2. Adequate funding will be available to process tissue samples.

2.18.1.4 Results and Reporting

All sampling activities will be a conducted in collaboration with representatives of the Parties to the Settlement Agreement. Data will be compiled at the end of each scheduled sampling period and the cumulative findings presented to the Aquatic Coordination Committee in a single report.

2.18.2 Task 18.2- Determine Spawning Competition in Rush, Pine and Cougar Creeks

Reintroduced coho salmon have the potential to compete with bull trout for limited spawning habitats in the upper Lewis River basin as a result of their similar spawning period and generally comparable spawning habitat preferences. Steelhead and Chinook salmon spawn prior to bull trout in the Lewis River and therefore do not pose a risk of competition for spawning sites (USFWS 2006). Potential negative effects on bull trout can include redd superimposition and associated increases in egg and alevin mortality. The objective of this task therefore is to determine if coho spawners compete with bull trout for spawning areas in the identified streams.

2.18.2.1 Methods

Following implementation of the formal reintroduction effort upstream of Swift Dam (i.e., the completion of the upstream and downstream fish passage facilities), PacifiCorp will work in coordination with the USFWS and WDFW to evaluate potential bull trout redd superimposition by coho salmon in Pine Creek. An evaluation in Cougar Creek will begin as soon as the Habitat Preparation Plan is implemented in the Yale Lake reach (fall of 2016).

During the bull trout spawning surveys described in the Utilities' Bull Trout Monitoring Plan, survey crews will mark each clearly defined bull trout redd with a piece of rebar or a wooden dowel driven into the streambed so that bull trout redds can continue to be identified after potential superimposition by coho (ODFW 2005)[26].

For each bull trout redd, the combined length of the pocket and mound, maximum depth of the pocket, and maximum width of the mound will be measured and recorded. Spawning substrate size will also be determined by counting gravel along a 0.5 meter length of each pocket and mound of selected redds.

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[26] Because of access, turbulence, and water clarity issues it may be difficult to find many bull trout redds. Thus impacts of coho spawning on top of bull trout redds may be difficult to ascertain.

After each bull redd is located and marked, they will be revisited twice per month during the coho spawning period to determine whether spawning coho superimpose on bull trout redds. Superimposition of redds will be defined as overlapping redd pits or tailspills resulting from construction of multiple redds in the same area. Estimates of the percent of each bull trout redd affected by coho spawning and the total number of redds superimposed will be determined for each tributary for each sample period.

2.18.2.2 Frequency and Duration

Surveys will be performed every two weeks starting in September and continuing until January, weather and access permitting. The study may be repeated for up to 5-years. Study termination would be determined in consultation with the ACC.

2.18.2.3 Assumptions

- Biologists are able to correctly assign redds to species.

2.18.2.4 Results and Reporting

Study results will be summarized in the ACC/TCC Annual Report.

2.18.3 Task 18.3 – Determine if Anadromous Fish Introductions are Having a Detrimental Effect on Kokanee Populations in Yale Lake.

As described in Section 2.17.4, kokanee and bull trout spawning surveys will be conducted yearly in Cougar Creek throughout the spawning period of each species. The entire 1.5 miles of Cougar Creek will be surveyed for adult fish. Information such as redd superimposition and displacement of kokanee redds will be identified following reintroduction of anadromous fish into Yale Lake. Annual abundance information for both kokanee and adult anadromous fish will be reviewed by and in consultation with the ACC to inform adaptive management of the reintroduction program and to help guide the operation of the passage facilities.

2.18.3.1 Assumptions

The key assumption of the study is:

- Biologists can accurately identify and enumerate kokanee spawners.

2.18.3.2 Results and Reporting

Study results will be presented in the ACC/TCC Annual Report.

2.19 OBJECTIVE 19 - DOCUMENT PROJECT COMPLIANCE WITH WATER MANAGEMENT REQUIREMENTS

PacifiCorp is required to document project flow, ramping rate, flow plateau, and flood storage requirements of the new Licenses for the Project. The monitoring locations for flow requirements will be at the Ariel Gage located in the lower Lewis River and at two sites in the Lewis River bypass reach downstream of Swift No. 1 Dam. Flood storage requirements will be monitored at each of the Project dams.

2.19.1 Task 19.1 – Monitor River Flow, Ramping Rate and Flow Plateau for the Lewis River Projects

2.19.1.1 Monitoring Locations

Minimum stream flow values for the Lewis River are measured in real-time at the USGS Gage No. 14220500 (Ariel Gage) located downstream of the Merwin Dam. This gage is the official compliance point for minimum stream flow releases, ramping rates and plateau operations downstream of Merwin Dam.

Flow into the Swift bypass reach will be measured in two locations in accordance with Section 6.1 of the Settlement Agreement. These locations are the "Upper Release Point" in the upper end of the bypass reach, and at the "Canal Drain", located approximately one-third the length of the canal downstream of the Swift No. 1 tailrace. [27]

The methods used for determining Project compliance with all flow and ramping rate license requirements at these monitoring locations are presented below.

2.19.1.2 Rating Tables and Gage Station Maintenance

Where used, rating tables will be maintained by PacifiCorp or a qualified contractor. Maintenance of relevant monitoring instrumentation will meet PacifiCorp's need for real time access to flow data. Instruments will be maintained by PacifiCorp or other qualified contractors.

2.19.1.3 Data Management and Publication

Data will be managed by PacifiCorp. Any data deficiencies discovered during the review and publication process (e.g., rating table shifts, stage offsets) will be edited to produce an accurate record.

<u>Ariel Gage</u>

Real-time 15-minute provisional data from the Ariel gage will be logged by PacifiCorp to monitor hourly average flow and hourly ramping rates downstream of Merwin Dam. Minimum streamflow excursions will be reported as provided in Section 2.19.1.4.

<u>Swift Bypass Reach: Upper Release Point</u>

Flow from the Upper Release Point will be recorded every 15 minutes. This data will be used to calculate hourly average flow. Mean hourly stream flow values measured at the Upper Release Point will be published in the ACC/TCC Annual Report. All reviewed and published records will be archived by PacifiCorp.

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[27] PacifiCorp will pay for the maintenance, operation and replacement, if necessary, of both gages.

In the event of an extended unplanned interruption to flow from the upper release point, PacifiCorp will provide flow via the spill gates (or other means) to allow at least the required minimum flow into the upper bypass reach. During this particular scenario, flow will be calibrated by PacifiCorp at the most suitable point downstream of the spillway to verify that the temporary flow release is equal to the flow required by the 401 Certification. The spill gates will be adjusted until such time as the appropriate minimum flow is achieved and the spill gates fixed to this opening. In addition, PacifiCorp will send a notice by electronic mail (email) to the ACC members within 48 hours after each adjustment or change to the flows in the Bypass Reach (unless the Parties agree upon an alternate method of notification). In the case of planned interruptions (e.g., for canal maintenance) flow will be provided to the Upper Release channel using a pump or siphon until the flows can be restored.

Swift Bypass Reach: Canal Drain

Flow into the lower Swift bypass reach from the canal drain will be monitored by logging 15-minute stage data in the Swift canal. This data will be used to calculate hourly average flow into the lower Swift bypass reach. Since the required flow release from the canal drain remains constant throughout the year (14 cfs), the canal drain opening will be fixed to release required flows at the lowest possible canal stage in the canal. Most of the time, flow from this release point will likely exceed the required minimum since the stage in the canal generally is operated higher than this minimum elevation, thereby increasing the head at the release point. Mean hourly stream flow values measured at the canal drain will be published in the ACC/TCC Annual Report. All reviewed and published records will be stored by PacifiCorp in a permanent repository.

In the event of a planned or unplanned interruption of flow release from the canal drain, PacifiCorp will place a pump siphon or use other means to allow at least the minimum flow into the bypass reach from this location. During this particular scenario, flow will be calibrated by PacifiCorp or a qualified contractor at the most suitable point downstream of the canal drain to verify that the temporary flow release is equal to the flow required by the 401 Certification. Flow will be adjusted until such time as the appropriate minimum flow is achieved and set at this level. As is the case for the Upper Release Point, PacifiCorp will send a notice by email to the ACC members and WDOE within 48 hours after each adjustment or change to the flows in the Bypass Reach via the canal drain (unless the Parties agree upon an alternate method of notification).

2.19.1.4 Flow and Ramp Rate Monitoring and Excursion Reporting

Flow Monitoring and Excursion Reporting

If flows at gage sites are discovered to be less than the required minimum flows, or ramping occurs that exceeds the compliance limits, PacifiCorp will correct these conditions as rapidly and prudently as possible. Any excursions from the flow requirements will be clearly documented by date, time and duration and reported as discussed below.

Ariel Gage

PacifiCorp will review hourly average stage data for compliance with the minimum stream flow requirements in the new license (Table 2.19.1). Excursions from hourly minimum stream flow requirements will be reported to FERC, WDOE, and the ACC within 24 hours of verifying the excursion. Notification will include a detailed explanation of why the event occurred and corrective actions implemented.

These initial notifications will be distributed via email, and will describe the location, time, duration, magnitude, and cause of the event; what immediate corrective actions were taken; and any long-term plans to prevent repetition. Comprehensive reports may be requested by the agencies for individual circumstances.

Minimum flow excursions measured at the Ariel Gage site will be described in the ACC/TCC Annual Report.

Swift Bypass Reach Upper Release

PacifiCorp will review hourly average flow data for compliance with the minimum stream flow requirements in the new license (Table 2.19.1). Excursions from minimum stream flow requirements will be reported to FERC, WDOE, and the ACC within 24 hours of verifying the excursion. Notification will include a detailed explanation of why the event occurred and corrective actions implemented.

These initial notifications will be distributed via email, and will describe the location, time, duration, magnitude, and cause of the event; what immediate corrective actions were taken; and any long-term plans to prevent repetition. Comprehensive reports may be requested by the agencies for individual circumstances. Minimum flow excursions measured at the Upper Release site will be described in the ACC/TCC Annual Report.

Swift Bypass Reach Canal Drain

Flow in the lower Swift bypass reach from the canal drain will be monitored by logging 15-minute stage data in the Swift canal. PacifiCorp will review mean hourly average stage data for compliance with the minimum stream flow requirements in the new license (Table 2.19.1). Excursions from minimum (stage) stream flow requirements will be reported to FERC, WDOE and the ACC within 24 hours of verifying the excursion. Notification will include a detailed explanation of why the event occurred and corrective actions implemented.

These initial notifications will be distributed via email, and will describe the location, time, duration, magnitude, and cause of the event; what immediate corrective actions were taken; and any long-term plans to prevent repetition. Comprehensive reports may be requested by the agencies for individual circumstances.

Minimum flow excursions measured at the canal drain will be described in the ACC/TCC Annual Report.

Table 2.19.1. Minimum flow releases in the Lewis River from Merwin Dam and the Swift bypass reach from the Swift canal as required by the FERC licenses and Section 401 Certifications.

Lewis River Downstream of Merwin Dam	
Date	**Minimum Flow (cfs)**
October 16 through October 31	2,500
November 1 through December 15	4,200
December 16 through March 1	2,000
March 2 through March 15	2,200
March 16 through March 30	2,500
March 31 through June 30	2,700
July 1 through July 10	2,300
July 11, through July 20	1,900
July 21 through July 30	1,500
July 31 through October 15	1,200
Swift Bypass Reach*	
Date	**Minimum Flow (cfs)**
January	65
February	89**
March	90
April	90
May	90
June	68
July	68
August	68
September 1-23	68
September 24-30	69
October	75
November 1-15	90
November 16-30	70
December	65

* Flow levels were taken from the WDOE 401 Certification for the Swift No. 1 Hydroelectric Project (WDOE 2006) and are the “Combined Flow Schedule” for the required stream flow releases from the “Upper Release Point” and the “Canal Drain.”
** During leap years, 88 cfs shall be released for the first 7 days in February and 89 cfs for the rest of the month.

Ariel Gage Ramp Rate and Plateau Operations Monitoring and Excursion Reporting

When ramping occurs that exceeds compliance limits, PacifiCorp will correct these conditions as rapidly and prudently as possible. If plateau operations are violated, PacifiCorp will not attempt to correct the action by returning to the flow level preceding the event since plateau operations seek to limit flow changes.

PacifiCorp will review hourly Ariel gage stage data to ensure compliance with project ramping rate restrictions and plateau changes downstream of Merwin Dam[28]. Stage will be measured in tenths of feet per hour, and will be calculated using available 15-minute Ariel gage flow data to calculate an hourly average. The ramping rates will then be compared with the Settlement required ramping rate and flow plateau requirements on an hourly basis.

The requirements are as follows:

1. PacifiCorp will limit the up-ramping rate as observed at the Ariel gage (downstream of Merwin Dam) to 1.5 feet per hour for all periods when flows below Merwin Dam are at or less than the hydraulic capacity of the Merwin Project turbines (currently 11,400 cfs).

2. PacifiCorp will limit the down-ramping rate to 0.17 ft per hour for all periods when flows are at or less than 8,000 cfs. From February 16 through June 15, no down-ramping shall occur (1) commencing one hour before sunrise until one hour after sunrise and (2) commencing one hour before sunset until one hour after sunset.

3. PacifiCorp will further restrict daily flow fluctuation from February 16 through August 15 of each year by maintaining flow plateaus (periods of near-steady discharge) as described in Section 6.2.2 of the Settlement Agreement.

Excursions from hourly ramp rate requirements or plateau changes will be reported to FERC, WDOE, and the ACC within 24 hours of verifying the excursion. Notification will include a detailed explanation for why the event occurred and corrective actions implemented.

These initial reports will be distributed via email, and will describe the location, time, duration, magnitude, and cause of the event; what immediate corrective actions were taken; and any long-term plans to prevent repetition. Comprehensive reports may be requested by the agencies for individual circumstances.

PacifiCorp will describe ramping rate and plateau operation excursions as measured at the Ariel gage in the ACC/TCC Annual Report.

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[28] "Ramping" means those Project-induced increases ("up-ramping") and decreases ("down-ramping") in river discharge and associated changes in river surface elevation over time below Merwin Dam caused by Project operations or maintenance (Section 6.2.1 of the Settlement).

High Run-Off Procedure Monitoring and Reporting

The reporting requirements described here are pending approval of PacifiCorp's Lewis River High Run-Off Procedures by FERC and the U.S. Army Corps of Engineers (USACE)).

The High Run-Off Procedures define vacant (available) storage requirements for flood control purposes throughout the flood control season extending from September 20 through April 30 or April 15 in years of low snowpack (Table 2.19.2). Generally, vacant storage is a function of reservoir elevation relative to the normal full operating level in the reservoir[29]. PacifiCorp will report daily average vacant storage to the nearest tenth of a foot for the flood control season to the FERC by July 31, annually. In the event that the average daily storage requirement is encroached upon for flood control purposes or other reasons, this will be reported to the FERC within 24 hours of verifying the reservoir storage encroachment. Notification will be provided via email and will include an explanation for the need/use of the vacant storage. Notification will occur when the vacant storage requirement (as measured to the nearest tenth of a foot) is encroached upon by more than 0.2 feet for 6 hours or more.

Table 2.19.2. Vacant storage requirements for the Lewis River Project reservoirs (Merwin, Yale and Swift reservoirs)

Date	**Vacant Storage (feet)**
Normal Vacant Storage	
Sept. 20	0
Oct. 10	8.5
Nov. 1 thru Apr. 1	17.0
Apr. 15	8.5
Apr. 30	0
Vacant Storage in Low Snowpack Years	
Sept. 20	0
Oct. 10	8.5
Nov. 1 thru Mar. 15	17.0
Apr. 1	8.5
Apr. 15	0

The high runoff procedure also defines elevations at which the reservoirs are considered "full" under normal operating conditions. However, during some high flow events, it may be necessary to surcharge the reservoirs beyond these normal operating limits. At such time that this occurs in any of the three project reservoirs, PacifiCorp will notify the FERC of this occurrence within 24 hours of verifying the reservoir surcharge. Notification will be provided via email and will include an explanation for the need to surcharge. Notification will occur when the normal maximum elevation in each reservoir is exceeded by more than 0.2 feet (measured to the nearest tenth of a foot) for 6 hours or more.

[29] Vacant storage is measured in feet of depth between the current reservoir water levels and elevation 1,000 feet-msl at Swift, elevation 490 feet-msl at Yale, and elevation 239.6 feet-msl at Merwin. Because the average storage space in the top foot of the three Lewis River reservoirs is approximately the same, depth can be summed over multiple reservoirs.

Reservoir elevation monitoring devices are located at the project dams and are operated and maintained by PacifiCorp. Data from these devices will be archived in PacifiCorp's operations databases.

2.20 OBJECTIVE 20 - DETERMINE WHEN REINTRODUCTION GOALS ARE ACHIEVED

The Settlement Agreement notes:

> *…the Services, after discussion with the ACC, shall determine how they will assess whether Reintroduction Outcome Goals have been met, e.g., metric, model, qualitative factors ("Evaluation Methodology"). The determination shall take into account the variability of the factors influencing the success of the comprehensive aquatics program over time such as cycles of ocean conditions and will include an appropriate temporal component in developing and applying the Evaluation Methodology.*

Although the responsibility of the Services, the Utilities are interested in playing a significant role in putting forth viable approaches for the Services to consider in establishing the reintroduction Evaluation Methodology. The H&S Plan (PacifiCorp Energy and Cowlitz PUD 2006) provides some ideas as to what type of information should be considered in determining program success. In general the H&S Plan suggests:

1. Using other lower Columbia River spring Chinook, coho and steelhead as index stocks to track out-of-basin effects on the success of the Lewis River program.

2. Tracking similar reintroduction efforts on the Cowlitz River and other lower Columbia River tributaries.

3. Calculating yearly harvest rates, smolt-to-adult survival rates, juvenile production etc., to estimate when runs are self-sustaining.

<u>Methods</u>

Methods for conducting each of the three analyses are presented in different sections of this M&E Plan. Yet to be defined is a numeric adult goal that dictates when run-size is sufficient for achieving both recovery and harvest goals. Until the Services develop numeric goals, the natural adult abundance targets presented under Objective 11 (Ocean Recruits) will be used as the benchmarks for determining the success of the reintroduction effort.

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Appendix A

Incidental Take Statement

APPENDIX A- INCIDENTAL TAKE STATEMENT

Post-Season Monitoring and Evaluation Form
Scientific Research Plan
Annual Report

Date: ___________

Plan Name: _____________ **Evaluator's Name:** _______________________________________

Contact Name: ___________________ **Contact Email:** __________________________ **Contact Phone #:** __________________
(Contact = person submitting report)

Study Number and Title (if applicable): ____
Provide separate tables for each study.

Part I: This is an example of how to fill out the table. **Replace all red text with the information in the plan. Replace all blue text with the actual results of your activities.**

ESU/Species and population group if specified in your permit	Life Stage	Origin	Take Activity	Number of Fish Authorized for Take	Actual Number of Listed Fish Taken	Authorized Unintentional Mortality	Actual Unintentional Mortality	Evaluation Location	Evaluation Period
Lower Columbia River (LCR) Chinook	Juvenile	Naturally Produced	Capture, mark, release	100	90	5/100	4/90	Columbia River, Oregon	January – February
LCR Chinook	Adult	Artificially Propagated	Capture, handle, release	10	9	1/10	0/9	Bonneville Dam	June
LCR Chinook	Adult	Naturally Produced	Intentional mortality	20	15	N/A	N/A	Bonneville Dam	June
Oregon Coast Coho	Juvenile	Naturally Produced	Observe / Harass	500	400	N/A	N/ A	Nehalem River	October

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Appendix B

Radio-Tag Recapture Design

APPENDIX B - RADIO-TAG RELEASE-RECAPTURE DESIGN AT SWIFT DAM

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11 JULY 2007

APPENDIX B

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1.0 INTRODUCTION

This report describes the design and analysis of the 2008 radio-tag release-recapture study at Swift Dam No. 1. Mark-recapture models will be used to estimate survival through the Swift Reservoir and Project. This report describes the release and detection locations used in the proposed study along with the recommended data analyses. Specific objectives of the tagging study include the following:

1. Estimate the joint probability of smolt surviving through the reservoir and entering the surface collector.
2. Estimate entrance efficiency and retention efficiency of the surface collector.
3. Estimate smolt survival through the transport system.

These goals will be accomplished using one or more groups of tagged fish.

2.0 RELEASE-RECAPTURE DESIGN

Releases of the radio-tagged fish at the top of the Swift Reservoir will be used to estimate passage survival through the project. Survival through the Swift No. 1 Project can currently be conceptualized by the equation

$$S_{PROJ} = S_{RES}\left[P_{COL}\cdot S_{COL}\cdot S_{TRAN} + P_{TIT}\cdot S_{TIT} + \left(1 - P_{COL} - P_{TIT}\right)S_{SP}\right] \quad (1)$$

where

S_{RES} = survival probability through reservoir,
S_{PROJ} = total Project passage survival,
P_{COL} = proportion of fish arriving at Swift Dam that enter the surface collector,
P_{TIT} = proportion of fish arriving at Swift Dam that enter the turbine intake tower,
S_{COL} = survival probability through the collector,
S_{TIT} = survival probability through the turbine intake tower,
S_{SP} = survival probability through the spillway,
S_{TRAN} = survival probability through the smolt transport system.

Currently it is assumed that $S_{TIT} = S_{SP} = 0$, in which case

$$S_{PROJ} = S_{RES}\cdot P_{COL}\cdot S_{COL}\cdot S_{TRAN}. \quad (2)$$

A single release-recapture model will be used to estimate joint probability

$$S_{RES}\cdot P_{COL} = S_1 \quad (3)$$

Independent sampling of fish known to have entered the collector in will be used to estimate the probability of surviving through the collector and the transport system, i.e., $S_{COL} \cdot S_{TRAN} = S_2$. The product $\hat{S}_1 \cdot \hat{S}_2$ will therefore provide an estimate of overall Project passage survival with associated variance

$$\text{Var}\left(\hat{S}_1 \cdot \hat{S}_2\right) = S_1^2 \cdot \text{Var}\left(\hat{S}_2\right) + S_2^2 \cdot \text{Var}\left(\hat{S}_1\right) + \text{Var}\left(\hat{S}_1\right) \cdot \widehat{\text{Var}}\left(\hat{S}_2\right)$$

and estimated variance

$$\widehat{\text{Var}}\left(\hat{S}_1 \cdot \hat{S}_2\right) = \hat{S}_1^2 \cdot \widehat{\text{Var}}\left(\hat{S}_2\right) + \hat{S}_2^2 \cdot \widehat{\text{Var}}\left(\hat{S}_1\right) - \widehat{\text{Var}}\left(\hat{S}_1\right) \cdot \widehat{\text{Var}}\left(\hat{S}_2\right).$$

2.1 Estimating Survival through the Reservoir to the Surface Collector

Fish known to be active migrants will be collected in the surface collector and subsequently used in estimating project passage survival. Fish gathered from the surface collector, tagged, and transported back to the top of the Swift Reservoir will be released to estimate reservoir survival and entry into the surface collector (S_1, Fig. B-1).

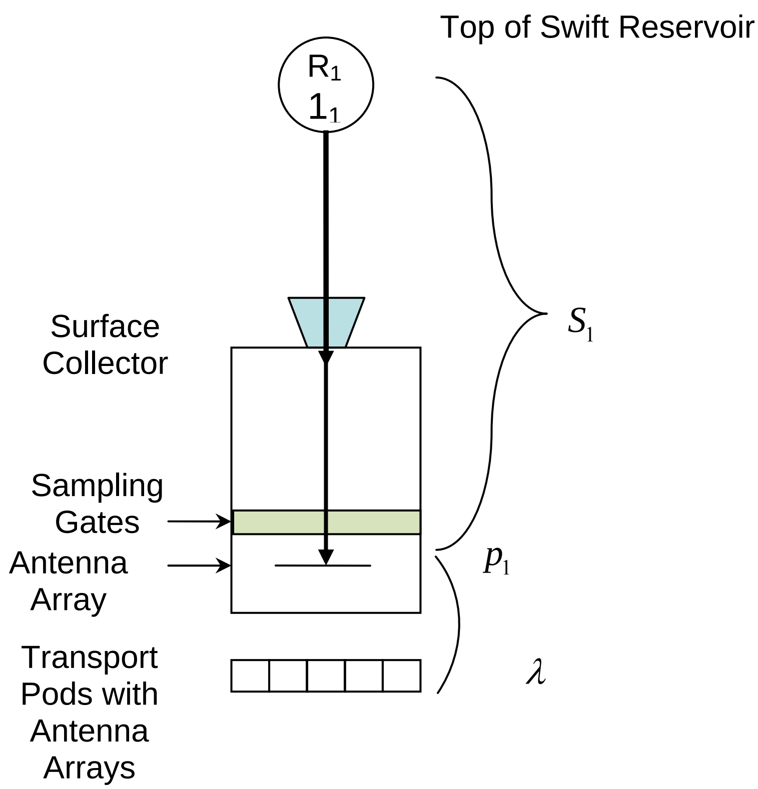

Figure B-1. Schematic of release-recapture design used in estimating survival through the reservoir and into the surface collector (S_1).

The single release-recapture model will be used to estimate the joint probability of surviving the reservoir and entering the surface collector to the point of the sampling gates. Two detection arrays, one in the collector just below the "point of no return" and another set in the collection pods will be used to generate the capture histories necessary to estimate the survival parameter S_1.

With 2 detection arrays, there are $2^2 = 4$ possible capture histories, and the following likelihood model:

$$L = \binom{R_1}{\underset{\sim}{n}} \left(S_1 p_1 \lambda_1\right)^{n_{11}} \left(S_1 p_1 \left(1-\lambda_1\right)\right)^{n_{10}} \left(S_1 \left(1-p_1\right) \lambda_1\right)^{n_{01}} \cdot \left(\left(1-S_1\right) + S_1 \left(1-p_1\right)\left(1-\lambda_1\right)\right)^{R-n_{11}-n_{10}-n_{01}}, \quad (4)$$

where

R_1 = number of tagged fish released above Swift Reservoir;
n_{ij} = number of fish with capture history *i* (0,1 detected or not at first array) and *j* (0,1 detected or not at second array);
S_1 = joint probability $S_{RES} \cdot P_{COL}$;
p_1 = probability of being detected at first collection array;
λ = joint probability of surviving between arrays 1 and 2 and being detected at second array.

Survival is then estimated by the quantity

$$\hat{S}_1 = \frac{\left(n_{10} + n_{11}\right)\left(n_{01} + n_{11}\right)}{R_1 n_{11}} \quad (5)$$

with associated variance

$$\text{Var}\left(\hat{S}_1\right) = S_1^2 \left[\frac{(1-\lambda)(1-p_1)^2}{R_1 \lambda S_1 p_1} + \frac{(1-\lambda)^2 p_1 (1-p_1)}{R_1 \lambda (1-\chi_1)} + \frac{\chi_1}{R_1 (1-\chi_1)}\right] \quad (6)$$

where

$$\chi_1 = \left(1-S_1\right) + S_1\left(1-p_1\right)\left(1-\lambda\right).$$

The other model parameters are estimated by

$$\hat{p}_1 = \frac{n_{11}}{n_{01} + n_{11}}, \quad (7)$$

$$\hat{\lambda} = \frac{n_{11}}{n_{10} + n_{11}}. \qquad (8)$$

Assumptions associated with the single release-recapture model include the following:

1. All fish act independently.
2. Release size is known without error.
3. There is no post-release handling mortality or tag loss.
4. Downstream detection is conditionally independent of detection upstream.
5. Tagged fish are uniquely identifiable at all detection sites.
6. Fish that residualize are considered mortalities.

2.2 Estimating Collector and Transport Survival

Survival through the surface collector and subsequent transport process to re-release will be estimated using a conceptual release group of fish that were known to have entered and were retained in the collector. Antenna at the sampling gate (Figure B-1) will identify fish known to have entered the collector (i.e., both alive and dead). These collected fish will then enter the transport system and eventually be transported to the recovery ponds prior to re-release. Two antenna arrays in the release channel will monitor fish as they exit the holding facilities. All visual mortalities in the recovery pond will be collected to compare against known fish entering the transport system. A single release-recapture model analogous to Equation (1) will be used to estimate smolt survival from the vicinity of the sampling gate to the release channel (Figure B-2).

To assure all dead tagged fish are properly identified and adjusted for in the statistical model, a known release of 50 dead tagged fish will be monitored through the system from the sampling gate to the antenna array in the release channel. If all known tagged fish are identified and recovered before the release channel, no adjustments to the release-recapture model would be necessary. If, on the other hand, some of the known dead tagged fish are detected at the recovery channel antenna, the likelihood model will need to be adjusted for the observed rate of false positives. In which case, the likelihood can be rewritten as follows:

$$L = \binom{R_2}{\underset{\sim}{m}} \left[\left(S_2 + \left(1 - S_2\right)\left(1 - p_d\right) \right) p_2 \lambda_2 \right]^{m_{11}}$$

$$\cdot \left[\left(S_2 + \left(1 - S_2\right)\left(1 - p_d\right) \right) p_2 \left(1 - \lambda_2\right) \right]^{m_{10}}$$

$$\cdot \left[\left(S_2 + \left(1 - S_2\right)\left(1 - p_d\right) \right) \left(1 - p_2\right) \lambda_2 \right]^{m_{01}}$$

$$\cdot \left[\left(S_2 + \left(1 - S_2\right)\left(1 - p_d\right) \right) \left(\lambda_2 + p_2 \left(1 - \lambda_2\right) \right) \right]^{R_2 - m_{11} - m_{10} - m_{01}}$$

$$\cdot \binom{D}{d} \left(p_d \right)^d \left(1 - p_d\right)^{D-d}, \qquad (9)$$

where

D = number of dead tagged fish released into collector system,
d_2 = number of dead tagged fish retrieved before exiting recovery ponds,
p_d = probability a dead fish is recovered in the transport/handling facilities.

In a similar vein, a tag-life study will be performed to construct a tag-failure curve to adjust perceived survival rates (S_1 and S_2) for rates of tag failure during outmigration. This adjustment will be based on the methods in Townsend et al. (2006) to account for any negative bias due to tag failure during the course of the release-recapture study.

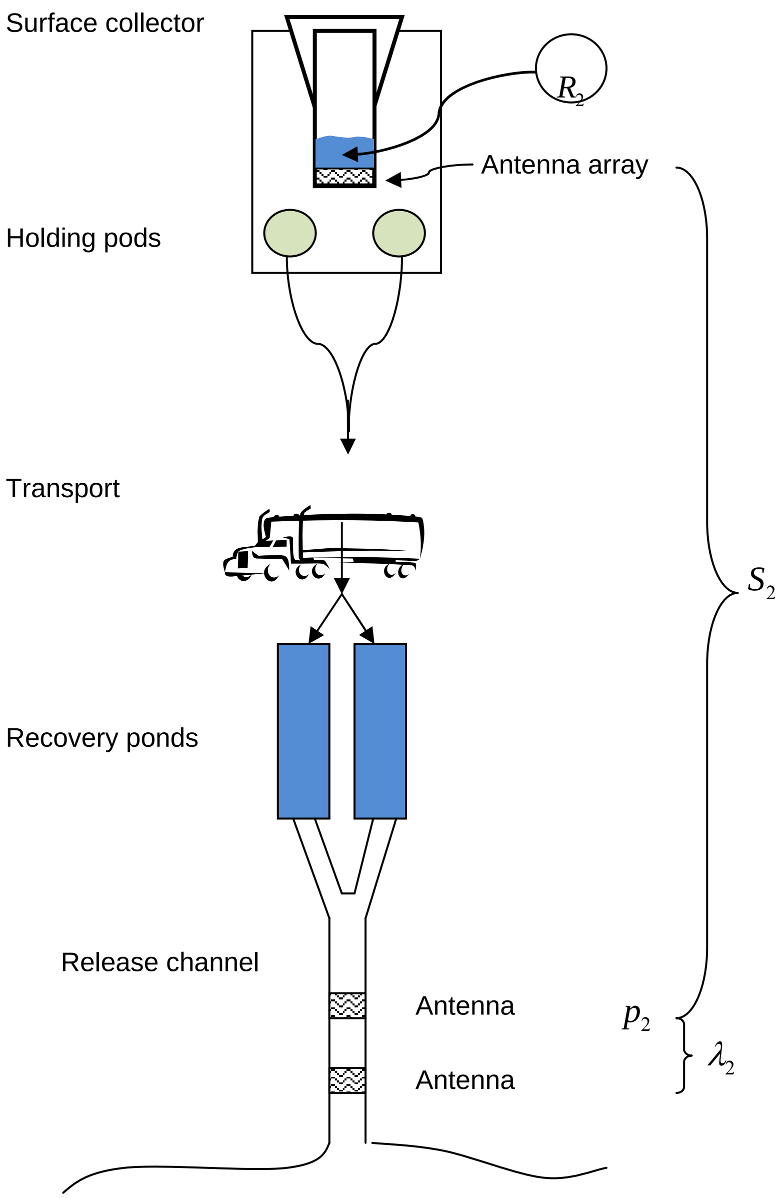

Figure B-2. Schematic of release-recapture design used in estimating survival through collector, transport system, and recovery ponds (S_2). Release group (R_2) composed to tagged fish known to have arrived at the sampling gates in the surface collector.

2.3 Test of Seasonal Performance

Overall dam survival $\left(S_1 \cdot S_2\right)$ will be compared to a desired project goal of 0.80 or greater using an asymptotic Z-test of the form

$$Z = \frac{\hat{S}_1 \cdot \hat{S}_2 - 0.80}{\sqrt{\hat{\text{Var}}\left(\hat{S}_1 \cdot \hat{S}_2\right)}},$$

testing the null hypotheses

$$\text{H}_\text{o}: S_1 S_2 \geq 0.80$$

vs.

$$\text{H}_\text{a}: S_1 S_2 < 0.80$$

(at an $\alpha = 0.10$)

Should the estimate of $S_1 S_2$ be significantly less than 0.80, H_o will be rejected, and it will be concluded survival goals have not been achieved. The estimate of $\hat{S}_1 \hat{S}_2$ will be based on pooling the release-recapture data over the season. Should weekly estimates of $\hat{S}_1 \hat{S}_2$ prove to be heterogeneous, then a weighted average, weighted by an index of smolt migration, will be used to construct an annual estimate.

2.4 Estimating Collector Efficiency

Two sets of antennas will be used to estimate collector efficiency $\left(P_{CE}\right)$ at the surface collector (Figure B-3).

The first antenna array will be in front of the collector, identifying tagged fish within the vicinity of the entrance. The second antenna array will be in the holding pods, assumed to have a 100 % detection efficiency. Then the overall collector will be estimated by the fraction

$$\hat{P}_{CE} = \frac{a_2}{a_1} \qquad (10)$$

with associated variance estimator

$$\hat{\text{Var}}\left(\hat{P}_{CE}\right) = \frac{\hat{P}_{CE}\left(1 - \hat{P}_{CE}\right)}{a_1}, \quad (11)$$

where

a_1 = number of unique tagged fish identified in the vicinity of the surface collector,

a_2 = number of unique tagged fish identified in the fish collection pods.

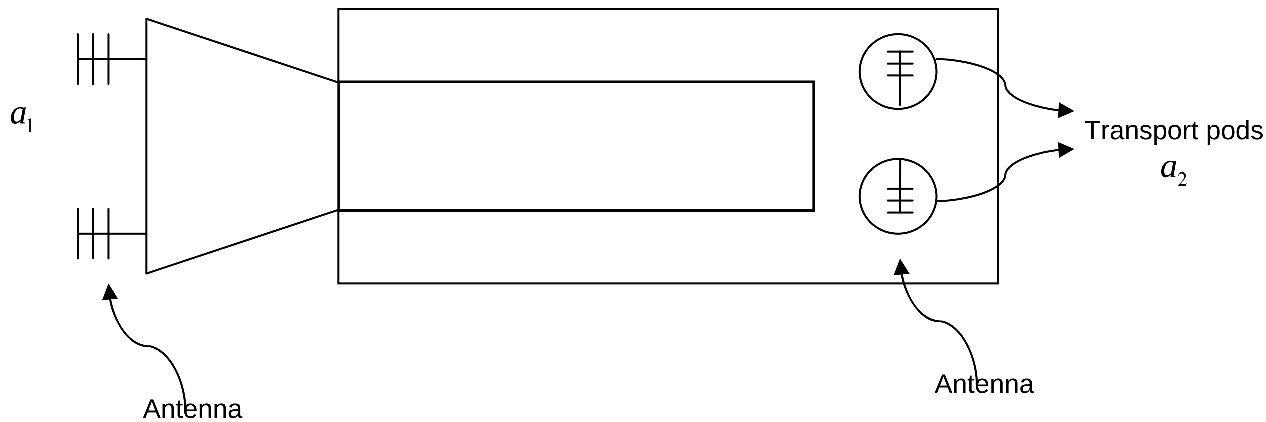

Figure B-2. Schematic of detection data used in estimating collector efficiency.

2.5 Release Schedule

Values of overall Project survival and transport mortality might be expected to vary over the outmigration season due to changes in smoltification and ambient conditions. For these reasons, tag releases need to be distributed across the season in order to more accurately reflect intra-annual trends. Releases will be conducted weekly in order to represent average migrational conditions. Efforts will be coordinated to assure estimates of S_1 and S_2 will be paired over the same time frames in order to estimate overall project survival (i.e., $S_1 \cdot S_2$).

2.6 Sample Size Calculations

Using the single release-recapture model, sample size calculations were performed for precision defined as

$$P\left(\left|\hat{S}_1 - S_1\right| < \varepsilon\right) = 1 - \alpha ;$$

In other words, the absolute error in estimation $\left(\text{i.e.} \left|\hat{S}_1 - S_1\right|\right)$ is less than $\varepsilon, (1-\alpha)100\%$ of the time. For example,

$$P\left(\left|\hat{S}_1 - S_1\right| < 0.05\right) = 0.90 .$$

specifies that the absolute error in estimating *S* should be less than .05, 95% of the time. Here ε is equivalent to the half-width of a 90% confidence interval.

Required release sizes were calculated under alternative combinations of:

a. S_1 = 0.50, 0.60, 0.70, 0.80, 0.90

b. p_1 = 0.85, 0.90, 0.95, 0.98

c. λ = 1

d. ε = 0.05, 0.10

e. $1-\alpha$ = 0.90

Required release sizes are summarized in Table B-1. For example, to be within ± 0.05 of the true survival value (S_1), 90% of the time when S_1 = 0.90, p_1 = 0.90, a total of 109 radio-tagged fish need to be released.

TableB-1. Release sizes to estimate $S_1 = S_{RES} \cdot P_{COL}$ at the Swift Reservoir for alternative values of survival and collection S_1, and detection probability (p_1) at the slide gates for a precision of ε = 0.05 or 0.10, $1-\alpha$ = 0.90 when λ = 1 at the holding pods.

		ε				ε	
S_1	p_1	0.05	0.10	S_1	p_1	0.05	0.10
0.50	0.85	285	72	0.80	0.85	197	51
	0.90	277	70		0.90	183	46
	0.95	272	69		0.95	176	44
	0.98	271	69		0.98	174	44
0.60	0.85	277	70	0.90	0.85	124	31
	0.90	267	67		0.90	109	28
	0.95	262	66		0.95	100	25
	0.98	261	65		0.98	98	25
0.70	0.85	248	62	0.95	0.85	79	20
	0.90	236	59		0.90	63	16
	0.95	230	58		0.95	55	14
	0.98	228	57		0.98	52	13

3.0 REFERENCES

Townsend, R.L., Skalski, J.R., Dillingham, P., and Steig, T.W. 2006. Correcting bias in survival estimation resulting from tag failure in acoustic and radiotelemetry studies. Journal of Agricultural Biology and Environmental Statistics **11**(2): 183-196.

Appendix C

Adult Trap Efficiency

APPENDIX C - MERWIN ADULT TRAP EFFICIENCY DIAGRAM AND CALCULATIONS

Table 4.1.4 of the Lewis River Settlement Agreement (SA) defines Adult Trap Efficiency (ATE) as "The percentage of adult Chinook, coho, steelhead, bull trout, and sea-run cutthroat that are actively migrating to a location above the trap and that are collected by the trap." Section 4.1.4c of the SA requires the ACC to "… develop an ATE performance standard for the term of each New License to ensure the safe, timely and efficient passage of adult salmonids."

The ACC agrees that for ATE performance standard evaluation purposes at Merwin Dam, the following conditions apply:

a) ATE is calculated by taking the number of actively migrating test fish that are passed upstream in a safe, timely and efficient manner, divided by the number of actively migrating test fish entering the Merwin tailrace.

b) Actively migrating is defined as fish that enter the Merwin tailrace and are migrating to a location above the trap.

c) The Merwin tailrace is defined as the river between Merwin Dam and the Project access bridge.

d) Test fish are fish that are tagged for the ATE tracking study, after capture from the Merwin Trap or locations downstream, and are considered to be active migrants subject to the conditions below.

e) Dropbacks are test fish that do not enter the Merwin tailrace. Dropbacks are considered to be either fish that have strayed into the Lewis River system, or fish that spawn in the Lewis River below the Merwin tailrace. Dropbacks are <u>not</u> considered to be active migrants for purposes of calculating ATE.

f) Fallbacks are test fish that require multiple attempts to pass Merwin Dam, and may re-enter the Merwin tailrace multiple times. Fallbacks are considered to be active migrants for purposes of calculating ATE.

g) Tag loss and tagging mortality will be identified by methods to be described in the tracking study plan. Test fish that lose their tags or are tagging mortalities are not considered to be active migrants for purposes of calculating ATE.

h) Test fish that enter the Lewis River Hatchery are not considered to be active migrants for purposes of calculating ATE.

i) Test fish that are captured by the sport or commercial fisheries are not considered to be active migrants for purposes of calculating ATE.

j) Delay time is defined to be the total time it takes for a test fish to locate and enter the Merwin Trap, calculated as the time period between initial tailrace entry and final trap capture.

To achieve the ATE performance standard, the ACC agrees that:

a) Safe passage means that active migrants must be re-captured and passed upstream of Merwin Dam with facility-induced injury less than 2% and mortality rates less than 0.5% as defined in Section 4.1.4 of the SA. Adult injury rate (AIR) will be calculated as follows:

AIR = IAC/TAC

Where:

IAC = Number of injured actively migrating adults collected in the Merwin Trap

TAC = Total number of actively migrating adults collected in Merwin Trap

Adult mortality rate (AMR) will be calculated as follows:

AMR= AM/TAC

Where:

AM = Number of actively migrating adults killed through Merwin adult trapping operations, as measured at point of release

TAC = Total number of actively migrating adults collected in the Merwin Adult Trap

b) Timely passage means that the median delay time for active migrants must be measured at less than or equal to 24 hours, with no more than 5% of the active migrants taking longer than one week to pass, and migrants must be transported upstream of Merwin Dam within 24 hours of trap capture. If study results show the median delay is less than 30 hours and all other upstream fish passage SA performance standards at Merwin Dam are met, the 30-hour median delay may be acceptable based on consensus of the ACC. Median delay times of less than 24 hours have been demonstrated to be achievable for multiple adult salmonid species at other hydro projects (see April 10, 2008 ACC meeting minutes: simple median and percent exceedence calculations).

c) Efficient passage means that at least 98% of the active adult migrants must be passed upstream of Merwin Dam. Passage success has been measured at greater than 98% for multiple adult salmonid species at other hydro projects (see July 10, 2008 ACC meeting minutes). Adult passage efficiency (APE) will be calculated as follows:

APE= TAC/AMA

Where:
TAC = Total number of actively migrating adults collected in the Merwin Adult Trap
AMA = Number of actively migrating adults

The ATE criteria would be when the four adult passage sub-criteria are achieved:

1. Adult Injury Rate (AIR) is less than 2%.
2. Adult Mortality Rate (AMR) is less than 0.5%.
3. Adult Timely Passage (ATP) is less than or equal to 24 hours (median value) and no more than 5% of the active migrants take longer than 1 week to pass.
4. Adult Passage Efficiency (APE) is equal or greater than 98%.

If median delay time is less than 30 hours, and all other criteria are achieved, then the ATE criteria may be met with a consensus vote of the ACC.

Until ATE performance standards are achieved, the Merwin Trap will be adjusted or modified per Settlement Agreement Section 4.1.6 and in consultation with the ACC. After ATE performance standards are achieved, no further adjustments or modifications to the Merwin upstream passage facility will be required.

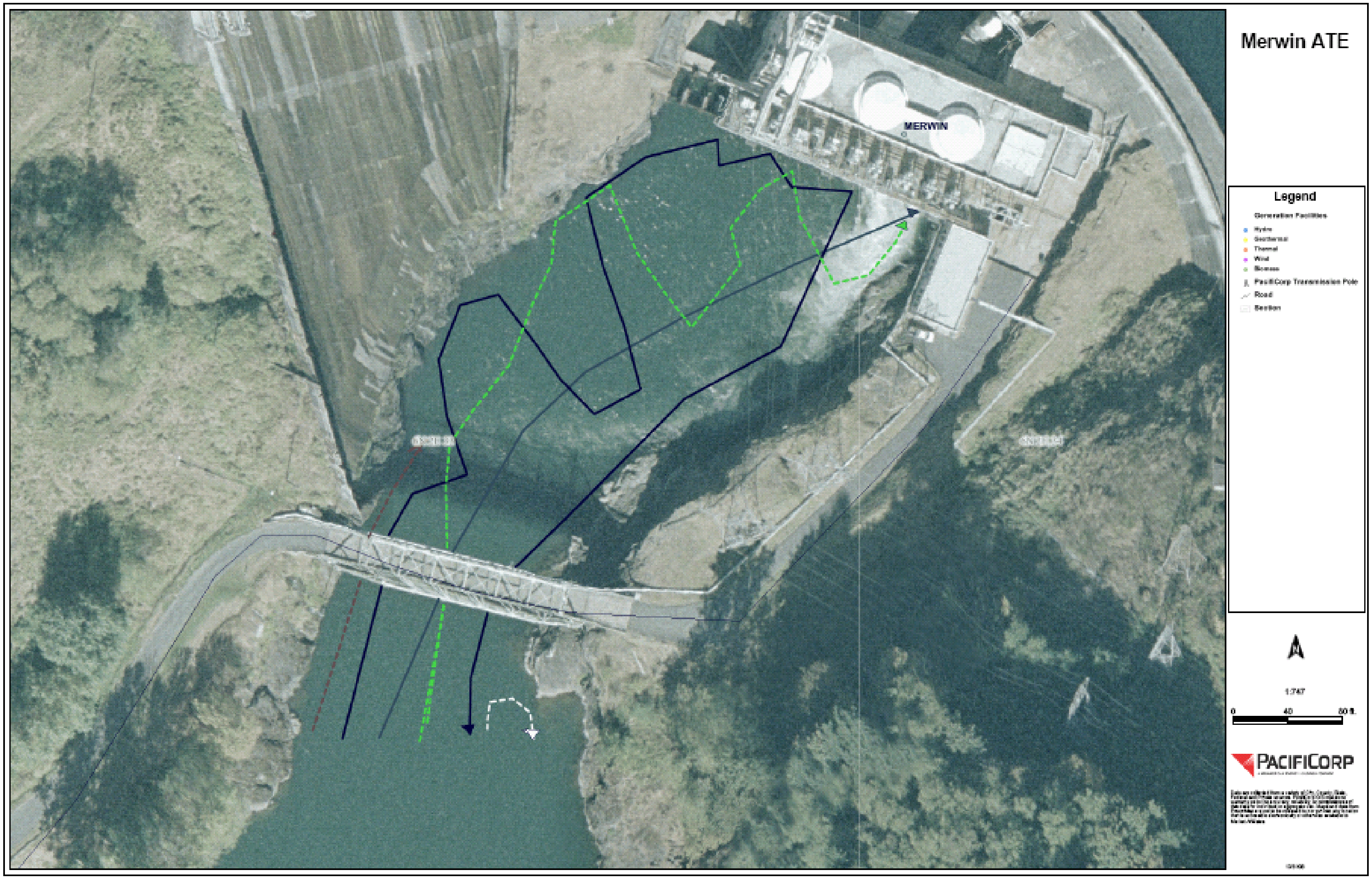

Figure C-1. Merwin Adult Trap Efficiency.

Appendix D

Ocean Recruits Analysis

APPENDIX D - OCEAN RECRUITS ANALYSIS AND FORMULAS

There are three possible options for calculating Ocean Recruits for the H&S Plan:

1. Catch Plus Escapement (CPE)
2. Adult Equivalent Run Size (AER)
3. Age 2 recruitment

The calculations used for completing each of the three analyses are performed as follows:

1. Catch plus escapement, $(C+E)_Y$, for brood year Y is computed as:

$(C+E)_Y = Xesc_Y + Xterm_Y + Xcol_Y + Xocean_Y$, where

$Xesc_Y, Xterm_Y, Xcol_Y, and\_Xocean_Y$ are brood year escapement; terminal, mainstem, and ocean harvest based on expanded CWT recoveries.

2. Adult equivalent return, $(AER)_Y$ for brood year Y is computed as:

$(AER)_Y = \sum_{age=1}^{NN} R_{Y,age}$, where

$R_N = C_N + Xocean_N(1+oi_N)(1-n_N)^{(na_N-1)}$, and

$C_N = R_{N+1} + B_N/(1-mm_N) + Xcol_N(1+ci_N)$, and

$B_N = A_N + Xterm_N(1+ti_N)$, and

$A_N = Xesc_N/(1-ps_N)$, and $R_{NN+1} = 0$

Symbols are defined in Figure D-1 below.

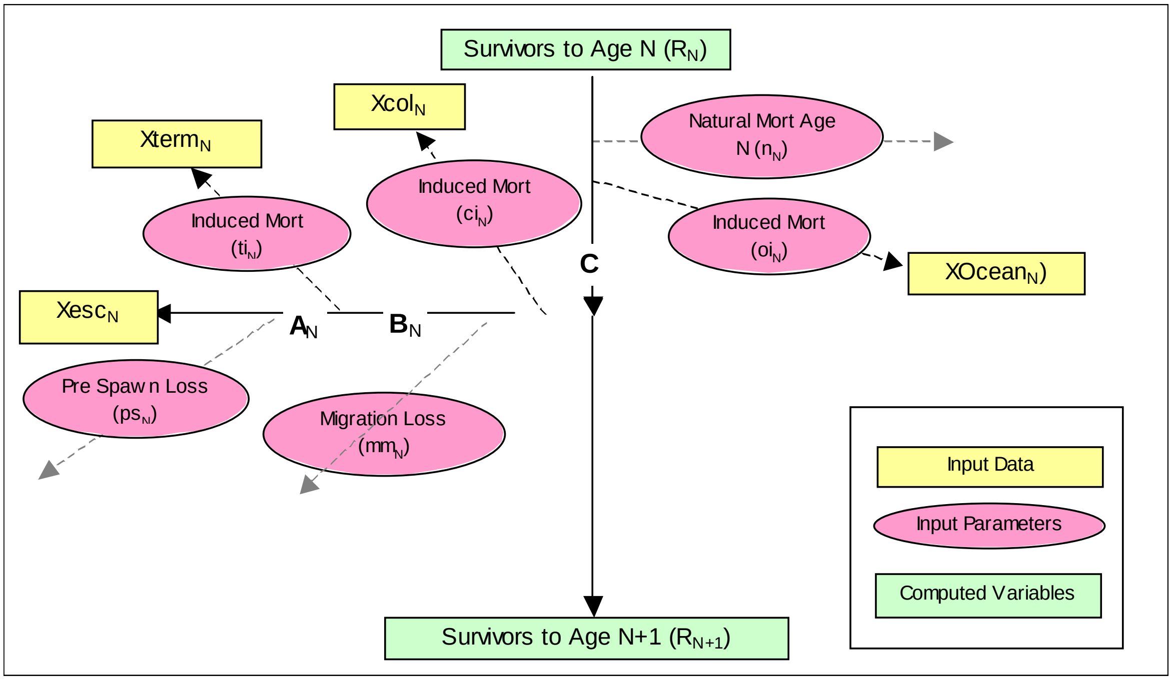

Figure D-1. Age 2 recruitment, A2R, is computed as R_2 in AER equation above.

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