TODD KIM, Assistant Attorney General
SETH M. BARSKY, Chief
S. JAY GOVINDAN, Assistant Chief
MICHAEL R. EITEL, Senior Trial Attorney
KAITLYN POIRIER, Trial Attorney (TN Bar # 034394)
U.S. Department of Justice
Environment & Natural Resources Division
Wildlife & Marine Resources Section
Ben Franklin Station, P.O. Box 7611
Washington, D.C. 20044-7611
Telephone: (202) 307-6623
Facsimile: (202) 305-0275
Email: kaitlyn.poirier@usdoj.gov; michael.eitel@usdoj.gov

Attorneys for Federal Defendants

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF OREGON

PORTLAND DIVISION

NORTHWEST ENVIRONMENTAL DEFENSE CENTER, et al.,

Plaintiffs,

v.

U.S. ARMY CORPS OF ENGINEERS, et al.,

Defendants,

and

CITY OF SALEM and MARION COUNTY,

Defendant-Intervenors.

Case No.: 3:18-cv-00437-HZ

NOTICE OF THE EXPERT PANEL'S LONG-TERM RM&E PLAN

Federal Defendants provide notice that the expert panel has completed the long-term RM&E plan. The long-term RM&E plan is attached to this notice as Attachment 1.

Dated: February 18, 2022

Respectfully submitted,

TODD KIM, Assistant Attorney General
SETH M. BARSKY, Chief
S. JAY GOVINDAN, Assistant Chief

/s/ *Kaitlyn Poirier*
KAITLYN POIRIER, Trial Attorney (TN Bar # 034394)
U.S. Department of Justice
Environment & Natural Resources Division
Wildlife & Marine Resources Section
Ben Franklin Station, P.O. Box 7611
Washington, D.C. 20044-7611
Telephone: (202) 307-6623
Facsimile: (202) 305-0275
Email: kaitlyn.poirier@usdoj.gov

Attorneys for Federal Defendants

CERTIFICATE OF SERVICE

I hereby certify that on February 18, 2022, a true and correct copy of the above document was electronically filed with the Clerk of Court using CM/ECF. Copies of the document will be served upon interested counsel via the Notices of Electronic Filing that are generated by CM/ECF.

/s/ *Kaitlyn Poirier*
KAITLYN POIRIER, Trial Attorney (TN Bar # 034394)
U.S. Department of Justice
Environment & Natural Resources Division
Wildlife & Marine Resources Section
Ben Franklin Station, P.O. Box 7611
Washington, D.C. 20044-7611
Telephone: (202) 307-6623
Facsimile: (202) 305-0275
Email: kaitlyn.poirier@usdoj.gov

Attorney for Federal Defendants

Willamette Project Interim Injunction Measures Research Monitoring and Evaluation Plan

Introduction

On September 1, 2021, the U.S. District Court for the District of Oregon issued an interim injunction that directs the Corps to implement interim injunction measures intended to improve conditions for fish passage and water quality in the Willamette Valley Project (WVP) to avoid irreparable harm to Endangered Species Act (ESA)-listed salmonids during the interim period until the completion of the reinitiated consultation.

The Court assigned an Expert Panel comprised of two of Plaintiffs' experts, two NMFS biologists, two Corps employees, and two "ad hoc" Federal experts to define the implementation plans of specific measures. As required by the injunction, the Expert Panel's proposed measures must "provide meaningful research, monitoring, and evaluation ("RM&E") of the interim measures." Further, the injunction mandates that the Corps "fund and/or carry out RM&E to evaluate the effects of the interim measures on UWR Chinook salmon and UWR steelhead." The Court ordered that the Expert Panel submit its "long term" plan for the RM&E to accompany the interim injunctive measures for the remainder of the duration of the injunction by February 18, 2022. The Expert Panel intends for this RM&E plan to supersede the measure-specific RM&E that was included in the implementation plans submitted by the Expert Panel to date. This RM&E plan will be in effect for the duration of the injunction, anticipated to extend through 2024.

Water quality monitoring and evaluation is an ongoing program at the WVP. Water temperatures and TDG concentrations downstream from project dams can affect aquatic resources, including Chinook salmon and steelhead, and are monitored continuously and operations adjusted in real-time as needed to meet established water quality objectives. Such adaptive management is common to the measures adopted under the Interim Injunction. Where actions taken under the Interim Injunction are likely to alter downstream water temperatures or TDG concentrations, monitoring to describe effects and plans to evaluate them are presented below. All water quality data collected will be made available on the Corps' dataquery website: https://www.nwd-wc.usace.army.mil/dd/common/dataquery/www/. Water quality analyses will be included in the bi-annual status reports.

The bi-annual status reports and other final reports of research and studies completed under this monitoring plan will be made publicly available on the Corps website at: https://www.nwp.usace.army.mil/Locations/Willamette-Valley/Injunction/.

The foundation of the "long term" plan developed by the Expert Panel is an overall monitoring framework (Appendix). In each subbasin the panel modified the overall framework based on the interim injunction measures being implemented and fish species/life history stages present. For those injunction measures for which implementation plans have yet to be drafted detailed RM&E plans will be incorporated as part of the implementation plans and will be guided by the monitoring set forth in this plan.

The Expert Panel recognizes that the Corps may not be able to carry out some aspects of the RM&E set forth in this plan due to lack of funding, the availability of fish, tags, and other necessary equipment, factors outside the Corps' control, or for other reasons (such as prioritizing flood control operations, etc.). If the Corps determines it is likely not able to carry out RM&E set forth in this plan, then the Corps will notify Plaintiffs to explain why the agency likely cannot carry out the RM&E and confer about alternative monitoring options that might be available. If the Corps determines it is likely not able to carry out RM&E set forth in this plan, then the Corps will offer to hold a meeting, yearly or biannually as needed, where the Corps will notify Plaintiffs to explain why the agency likely cannot carry out the RM&E and confer about alternative monitoring options that might be available. If the Corps cannot carry out the RM&E set forth in this plan or decides to implement alternative monitoring options after conferral with Plaintiffs, the Corps and NMFS will not be required to file a motion to modify the Court's order adopting this RM&E plan. Instead, the Corps and NMFS will file a notice with the Court in a timely manner explaining the change(s). The Corps will also identify and explain any changes to this RM&E plan in the next biannual status report it files with the Court following that determination.

The description of measures for each Basin are based on the implementation plans submitted by the expert panel and approved by the Court. For the specific details of each measure, see the Court approved versions of the plans.

North Santiam Basin

Injunction Number: 9, 10 a-c (Interim Measure #5, #6, and #7)

Project: Detroit and Big Cliff Dams (Late summer, fall, and winter operations)

Measure Description: Fall juvenile passage and temperature and TDG control at Detroit and Big Cliff dams.

Interim Measure 5 (as modified 21 September 2021): This measure was implemented to improve downstream fish passage conditions and downstream water temperature at Detroit Dam during the fall drawdown and winter months when downstream fish passage rates are high. Operations prioritize flow releases through a non-turbine outlet during the fall/winter once the Detroit Reservoir elevation was less than 100 feet over the turbine intakes (El. 1450 -1500 ft.) at which point all flow will pass through the Upper and/or Lower Regulating Outlet (RO) structures at night, from dusk until dawn, with no turbine operation (no power generation) during this period except for Station Service if needed for emergencies. This measure would continue until refill begins in the spring.

Injunction Measure 10(a): To reduce downstream water temperatures during the fall while Chinook salmon are spawning and their eggs incubating, the Corps will provide downstream water temperature management throughout late spring and summer at Detroit and Big Cliff Dams through strategic use of the spillway, turbines and upper and lower ROs. Spillway operations will start when the reservoir reaches spillway crest elevation (El. 1541.0 ft) and continue until the reservoir is drafted below the spillway crest. From there, a combination of turbine and upper and lower RO discharges will be implemented until water temperature management is no longer possible due to reservoir turnover. With adaptive management, the spill ratio will be adjusted so water temperatures (as measured at the USGS gage downstream of Big Cliff) can best meet targets.

Interim Measure 6: Beginning in 2020, the Corps will operate multiple spillway gates at Big Cliff Dam to spread total flow across the spillway and reduce TDG levels below Big Cliff Dam. The operation occurs when the Corps is operating the Big Cliff spillway (e.g., high flow events over the 3200 cfs turbine capacity). The Corps will monitor TDG downstream and identify the extent that TDG criteria is met under this operation.

Biological Goal

The overall goal is to establish self-sustaining populations of spring Chinook salmon and winter steelhead upstream of Detroit Dam. One of the objectives of this measure is to provide volitional passage for juvenile Chinook salmon at Detroit Dam during fall and early winter with high passage efficiency, and high immediate and long-term survival. Winter steelhead are not currently present above Detroit Dam. In addition, the management of water releases from Detroit and Big Cliff dams is intended to maintain downstream temperatures within specified temperature criteria, while maintaining acceptable level of TDG.

The target fish for the fall passage operations would be subyearling Chinook salmon that entered the reservoir in the previous winter–spring and reared through summer in the reservoir, and subyearling Chinook salmon that enter the reservoir in summer and fall. Temperature and TDG management will minimize negative effects for juvenile Chinook salmon moving downstream from above the Project and for egg through adult life stages of Chinook salmon and winter steelhead in the river below Big Cliff Dam.

Management Purpose

Determine if changes in dam operation improve downstream fish passage conditions at Detroit and Big Cliff dams compared to previous operations as a result of implementing this operation. Similarly, determine how temperature and TDG conditions changed with increased releases of water from upper and lower ROs. RM&E should be prioritized to understand active outmigration versus reservoir use. Passive Integrated Transponder (PIT) tags is the preferred tool/technology for this RM&E because PIT tags can be used in smaller size fish, have a longer lifespan, and can be used to track both "movers" and "stayers". Finally PIT tags can be detected at sites downstream to determine long-term survival and can be detected in returning adults at Willamette Falls (where 100% of the adults can be interrogated in the adult fishway), at Bennett Dam, and in the Minto adult trap. Active tags could be used to determine migration through the reservoir, fish behavior in the immediate vicinity of the dam, and to identify specific passage routes and survival rates.

The metrics of interest include juvenile spring Chinook salmon migration timing into the reservoir, migration timing through the reservoir, passage timing, passage size and condition, passage rate and survival.

Objectives and Methods for Juvenile Fish Passage

1. Passage timing
    a. Operate rotary screw traps upstream of the reservoir, in both the Breitenbush and North Santiam tributaries, and downstream of Big Cliff dam.
    b. Estimate the number of juvenile salmon caught in each trap.
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
        ii. Use wild subyearlings captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates (separate from dam passage efficiency fish).
        iii. Sum weekly estimates to derive total abundance during peak migration.
        iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.
        v. Compare abundance of fish entering the reservoir and abundance leaving.
        vi. Compare entry and passage abundance to previous estimates.
    c. PIT tag all subyearling salmon ($\geq$65 mm) caught in the rotary screw trap upstream of the reservoir beginning in July to measure passage timing at the dam (and to provide information on passage rates and passage survival).
    d. When practicable incorporate naturally produced subyearling salmon into an ongoing active tag study in the basin to provide information on passage rates, passage routes, and passage survival.

e. Compare passage timing for PIT-tagged fish relative to time and size when they entered the reservoir or were captured in the reservoir.
f. Evaluate reservoir behavior and passage timing for fish with active tags.
g. Compare passage timing for tagged and untagged fish to that under previous operating conditions.

2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through the Detroit and Big Cliff dams.
   a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants. The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam (ensure all PIT-tagged fish are measured). Collect and catalogue scales of Chinook salmon migrants to provide reference sample for stream-reared juvenile salmon.
   b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions.
   c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
   d. When fish are available, hold a sample of juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week, 10% whichever is smaller); note that this direct measure of delayed mortality supplements assessments through tagging and downstream sampling. Fish for the test could be held at the Minto Adult Facility and would be monitored and recorded for 24–48 hours.
3. Passage rate and survival
   a. Estimate passage rate and survival of fish tagged with PIT and active tags at traps upstream (1c –1d) and compare results to previous years.
   b. Tag and release experimental groups of surrogate fish or juvenile hatchery salmon with active and/or PIT tags upstream and downstream of dam. Note that final numbers will be developed when a study plan is written and will depend on availability of surrogate fish and active tags.
      i. Release 4,000 PIT-tagged juvenile salmon in the Detroit Reservoir prior to reaching elevation 1520 ft, along with 2,000 PIT-tagged juvenile salmon downstream of Big Cliff] Dam (numbers will be adjusted based on surrogate fish availability).
      ii. Some of PIT-tagged surrogate salmon above will be active-tagged (based on tag availability).
      iii. Supplemental releases of PIT-tagged juvenile hatchery fish as available:
         1. 6,000 in Detroit Reservoir prior to reaching elevation 1520 ft.
         2. 6,000 downstream of Big Cliff Dam (control group – could be two release dates: prior to reaching elevation 1520 ft. and at 1465 ft.).
4. Outplant success and origin of juvenile salmon.
   a. Collect tissue samples of juvenile Chinook salmon collected in the Breitenbush and North Santiam traps upstream of the reservoir.
   b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
   c. Collect tissue samples of juvenile salmon collected in traps downstream of dam.
   d. Analyze samples to determine parentage of juveniles (outplant origin v. below dam origin).

e. Collect tissue samples (non-lethally) from naturally-produced *O. mykiss* in upstream and downstream traps for genetic analysis.
5. Estimate route-specific and overall dam passage survival of juvenile Chinook salmon passing Detroit Dam. [Only possible using active tags or installing PIT tag infrastructure at Detroit]
6. Estimate reach survival following passage at Big Cliff dam downstream to Stayton Island and to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays (e.g., Minto Dam).
7. Estimate reach survival of active-tagged fish (if released in reservoir) after passage at Detroit/Big Cliff Dam by deploying arrays downstream.
8. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.

Objectives for Downstream Water Quality

The measures described above are expected to have both beneficial and adverse water quality effects. Use of Detroit Dam's LROs can benefit downstream water temperatures by discharging the coolest water available during Chinook incubation (October and November). Water is also spilled through the UROs to pass fish and manage downstream water temperatures. However, spills through both the upper and lower ROs generate elevated TDG concentrations, an adverse water quality effect. The Corps currently employs an adaptive management program to operate the Detroit/Big Cliff complex to best meet water quality and other objectives. Hence, spill releases to pass fish and reduce downstream water temperatures may complicate adaptive management and may increase the frequency, duration, and magnitude of exceedances of the state water quality standard (110% of the saturation concentration) and higher levels known to harm salmon and steelhead downstream.

1. Data from USGS Station no. 14181500 North Santiam River at Niagara, OR will be used to monitor TDG and evaluate the effectiveness of the operational measures taken to reduce it.
2. Identify the frequency and duration of TDG in excess of 110%, 115% 120%, and 125% of the saturation concentration and discuss the effectiveness of the operational measure taken to reduce it.
3. Data from USGS Station no. 14181500 North Santiam River at Niagara, OR will be used to monitor water temperatures and to evaluate the effectiveness of temperature management operations, including use of the LRO.
4. Provide data summaries and analyses identifying the frequency and duration of mean daily water temperatures outside of established temperature targets.
5. These monitoring results and evaluations will be presented in the publicly available bi-annual status reports.

The river reach between the Minto trap and Big Cliff Dam currently serves as a wild fish refuge. TDG concentrations decline in the downstream direction as the gas dissipates. Because the Niagara gage is located about 3 miles downstream from Big Cliff Dam, TDG concentrations within this river reach are likely higher than those measured at the gage.

1. To identify the effects of these operations on TDG concentrations in the river reach between Big Cliff Dam and the Niagara gage, the Corps will install a hydrolab in the Big Cliff tailrace and will

use these data to estimate the rate of TDG dissipation between the tailrace and the Niagara gage.

Project: Detroit and Big Cliff Dams (Spring Operation)

Measure Description

Interim Measure 7: The purpose of this operation is to provide downstream fish passage in the spring and water temperature management throughout late spring and summer at Detroit and Big Cliff Dams through strategic use of the spillway, turbines and regulating outlets. Spillway operations will start when the reservoir reaches spillway crest elevation (El. 1541.0 ft) and continue until the reservoir is drafted below the spillway crest. From there, a combination of turbine and regulating outlet (RO) discharges will be implemented until water temperature management is no longer possible due to reservoir turnover. With adaptive management, the spill ratio will be adjusted so water temperatures (as measured at the USGS gage downstream of Big Cliff) can best meet targets.

Total dissolved gas (TDG) conditions downstream of Detroit and Big Cliff dams will also be used to shape spill operations, and elevated TDG should be avoided when sensitive life stages of listed species (e.g., sac-fry) are present below Detroit and Big Cliff dams.

Biological Goal

The overall goal is to establish self-sustaining populations of spring-run Chinook salmon and winter steelhead upstream of Detroit Dam. The objective of this measure is to provide volitional passage for juvenile Chinook salmon at Detroit and Big Cliff dams in spring with high passage efficiency, and high immediate and long-term survival. Winter steelhead are not currently present above Detroit Dam.

The primary target fish for the spring operations would be Chinook salmon fry and subyearlings that enter the reservoir in late winter and spring, and yearlings that either enter the reservoir in late winter and spring (small number) or entered the reservoir in the previous winter-fall and remained through the winter. Temperature and TDG conditions produced by operations at Detroit and Big Cliff dams would affect those juvenile Chinook salmon that move downstream from above Detroit Dam and also those juvenile and adult Chinook salmon and steelhead found in the river below Big Cliff Dam.

Management Purpose

Determine if downstream fish passage conditions at Detroit and Big Cliff dams have improved compared to previous operations as a result of implementing this operation. Additionally, monitor the effectiveness of temperature management operations on downstream conditions for Chinook and winter steelhead life-history stages: incubating eggs and alevins, juveniles, and adults. RM&E should be prioritized to understand active outmigration versus reservoir use. Because the focus of spring spill operations is to provide passage for salmon fry and small juveniles (<65 mm), use of PIT tags and active tags would be limited to estimating passage of larger fish (yearlings entering the reservoir and reservoir residents that remained through fall and winter)[1]

[1] See Figures 1 and 2 in the Supplemental Information section of Appendix for the lengths and timing of juveniles sampled emigrating from the Breitenbush and North Santiam rivers.

The biological metrics of interest include spring Chinook juvenile passage timing, passage size and condition, passage rate and survival.

<u>Objectives and Methods for Juvenile Fish Passage</u>

1. Migration and Passage timing
   a. Operate rotary screw traps upstream of the reservoir, in both the Breitenbush and North Santiam tributaries, and downstream of Big Cliff dam.
   b. Estimate the number of juvenile salmon caught in each trap.
      i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
      ii. Use wild subyearlings captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates.
      iii. Sum weekly estimates to derive total abundance during peak migration.
      iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.
      v. Compare abundance of fish entering the reservoir and abundance leaving.
      vi. Compare entry and passage abundance to previous estimates.
   c. Beginning in spring 2023, if possible, mark or tag up to 1,000 fry per week in February–April (Note: Goal is to have monthly or bi-weekly batches (a single batch is still important)). Multiple mark or tagging techniques for juveniles <65mm need to be assessed for applicability to this study.
      i. Monitor tag injury, tag retention, and mortality by holding a sample of fish for observation.
      ii. Scan fish caught in traps downstream of the dam for tags.
      iii. Continue to mark or tag fry and subyearlings in May and June to study passage timing during spill.
   d. PIT tag all yearling salmon caught in the rotary screw trap(s) upstream of the reservoir to measure passage timing at the dam (and to provide information on passage rates and passage survival).
   e. When practicable incorporate naturally produced subyearling salmon into an ongoing active tag study in the basin to provide information on passage rates, passage routes, and passage survival.
   f. Compare passage timing for PIT-tagged fish relative to time and size when they entered the reservoir or were captured in the reservoir, and relative to spill operations.
   g. Evaluate reservoir behavior and passage timing for fish with active tags relative to spill operations (if used).
   h. Based on observations in 2022, make a determination of need to sample nearshore distribution of juvenile salmon within the reservoir. Sampling should follow the timing and location of previous studies to provide a basis for comparing fry and subyearling distribution relative to reservoir conditions. (Note: 2022 study design and possible pilot study with 2023 implementation based on study design and results of pilot study, if conducted.) Study should include some of the activities listed below.

i. Enumerate and measure juvenile salmon caught in traps. Record data on location, date, and condition including copepod infestation.
ii. Scan fish for blank wire tags and PIT tags.
iii. Enumerate and measure any captured fish with a batch mark, noting date and location (*see* 3bi).
iv. Fish <65 mm could be marked with elastomer tags, using different colors or body locations to delineate either location within the reservoir or month. Tag color and/or body location would be distinct from those used under activity 3bi.
v. Fish $\geq$65 mm will be given a PIT tag and associated data will be collected on fish length, date, location, etc.
vi. Calculate longitudinal distribution using methods of Monzyk et al. (2015 and other reports).
vii. Compare distribution to previous years and previous operating conditions.
viii. Investigate methods for estimating an abundance index of juvenile salmon within longitudinal reservoir zones (methods need to account for open population with fish entering and exiting the reservoir during certain times of year).

i. Compare passage timing for marked fish relative to time and size when they entered the reservoir.
j. Compare passage timing for marked and unmarked fish to that under previous operating conditions.

2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through the Detroit/Big Cliff Project.
   a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants. The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam.
   b. Compare size of fish caught in upstream and downstream traps, and reservoir traps (if utilized) to data collected under previous operating conditions.
   c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, gas bubble disease, etc.
   d. When fish are available, hold juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week). Fish for the test could be held at the Minto Adult Collection facility and would be monitored and recorded for 24–48 hours.
   e. Collect and catalogue scales from a sample of juvenile salmon captured in the upstream trap(s) to provide a brood year reference collection for identifying stream-reared yearlings in returning adult salmon, and to verify the age class of captured fish, with selective sampling at sizes where age classes may overlap.
3. Passage rate and survival. Juvenile salmon for experimental release may be limited due to the current numbers of surrogate fish being reared and hatchery production constraints. Spring spill operations will continue at least through the summer of 2024. Because experimental releases of fish will be important for evaluating the effect of spill operations on passage of fry and subyearling salmon and of yearling salmon, the Corps will work with ODFW, OSU, and/or contractors each year to provide sufficient numbers of surrogate fish and well as sufficient sampling gear and traps for future studies.

a. Estimate passage rate using expanded trap catches and marked and unmarked fish (1b–e). Incorporate information from nearshore sampling within the reservoir to supplement passage rate estimates, if conducted. Compare results to previous years.
b. Mark and release experimental groups of Chinook juvenile hatchery salmon < 65mm upstream and downstream of dam. (Specific number and methodology will be developed and may not be implemented until spring 2023.) Below is an example approach.
    i. Release 5,000–10,000 batch-marked surrogate fry or hatchery production fry in the upper end of the reservoir in February prior to start of the refill, and 5,000–10,000 batch-marked fry in the upper end of the reservoir in late March prior reaching the target elevation of 1541 ft. for beginning of spill.
    ii. Investigate batch marks for use with fry and smaller subyearlings. Priority would be for marks that allow identification of individual release groups. Mark fish in a hatchery setting 2–3 weeks prior to release. Mark extra fish to account for mortality. Hold a sample of fish to monitor long-term mortality or injury from tagging, and to document long-term visibility of tags or marks.
    iii. Evaluate passage rate of each batch-marked group by capture in downstream traps. Supplement with data on longitudinal distribution of juvenile salmon in the reservoir (1d) to determine the effect of spring operations on the distribution of juvenile salmon.
    iv. An alternative batch mark would be with parentage-based genetic marking.
    v. Evaluate passage rate of each batch-marked group by capture in downstream traps. Supplement with data on longitudinal distribution of juvenile salmon in the reservoir (if reservoir monitoring is implemented) to determine the effect of spring operations on the distribution of juvenile salmon.
c. Tag and release experimental groups of surrogate or juvenile hatchery Chinook salmon (>65 mm) upstream and downstream of dam. Specific number to be released in spring 2022 and future years will depend on availability of both surrogate fish and other juvenile hatchery salmon.
    i. Release 4,000 PIT-tagged juvenile salmon in the Detroit Reservoir (not the forebay) prior to reaching spillway crest (elevation 1541), along with 2,000 PIT-tagged juvenile salmon downstream of Big Cliff Dam (numbers will be adjusted based on surrogate fish availability).
    ii. Some of PIT-tagged surrogate salmon above will be active-tagged (based on tag availability).
    iii. Fish released upstream of the dam would be released at or near the head of the reservoir.

4. Outplant success and origin of juvenile salmon.
    a. Collect tissue samples of juvenile salmon and *O. mykiss* collected in the Breitenbush and North Santiam traps upstream of the reservoir.
    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location). Purpose of *O. mykiss* sampling is to determine what, if any, genetic relationship there is between *O. mykiss* upstream of the dams and winter steelhead downstream of the dams.
    c. Collect tissue samples of juvenile salmon and *O. mykiss* collected in traps downstream of dam.
    d. Analyze samples to determine parentage of juveniles (outplant origin v. below dam origin).

5. Estimate route-specific and overall dam passage survival of juvenile Chinook Salmon passing Detroit/Big Cliff Dam. [Only possible using active tags or installing PIT tag infrastructure at Detroit]
6. Estimate reach survival following passage at Detroit/Big Cliff Dam downstream to Stayton Island and to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays (e.g., Minto).
7. Estimate reach survival of active-tagged fish after passage at Detroit/Big Cliff Dam by deploying arrays downstream.
8. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.

Objectives for Downstream Water Quality

The purpose of this operation is to provide downstream fish passage in the spring and water temperature management throughout late spring and summer at Detroit and Big Cliff Dams through strategic use of the spillway, turbines and regulating outlets.

Reducing the amount of warm surface water captured in Detroit Reservoir through surface spill during the spring and summer is aimed at preventing subsequent entrainment of trapped warmer water in the fall as the reservoir is drawn down. This is one of the purposes of this measure. However, spill releases over the Detroit Dam spillway generate TDG in excess of the saturation concentration and can exceed the state standard of 110% of the saturation concentration. Spill may be reduced or curtailed and/or powerhouse discharge increased to reduce TDG generation as measured at the Niagara gage. Reducing spill would reduce fish passage and warm water releases potentially making subsequent water temperature management more difficult. A balance between water temperature management and TDG abatement will be necessary.

1. Data from USGS Station no. 14181500 North Santiam River at Niagara, OR will be used to monitor TDG and evaluate the effectiveness of the operational measures taken to reduce it.
2. Data from USGS Station no. 14181500 North Santiam River at Niagara, OR will be used to monitor water temperatures and to evaluate the effectiveness of measures taken to meet downstream temperature targets.
3. These monitoring results and evaluations will be presented in the semi-annual status reports. Reports will be posted where they are available to the public.
4. Determine relationship between Detroit/Big Cliff operations and downstream water temperature regimes.

South Santiam Basin

Green Peter

Injunction Number: 11
Project: Green Peter Dam – Outplanting Plan

Measure Description
Create an outplanting plan, including any improvements and/or development of adult fish release sites necessary to accomplish adult outplanting.

Biological Goal
Provide access to the Middle Santiam subbasin to improve and recover South Santiam UWR Chinook salmon and steelhead. Because the abundance of winter steelhead is extremely low, the initial focus of reintroduction will be UWR Chinook salmon. Outplanting adult Chinook salmon with subsequent provision for juvenile passage through the project (Injunction Number 12) would contribute to long-term recovery of salmon in the South Santiam basin.

Management Purpose
Reintroduction of Chinook salmon in the watershed above Green Peter Dam with the goal of eventually producing more adults returning to the Foster Dam fish trap through outplanting (i.e., a cohort replacement rate greater than 1). Although it will not be possible to demonstrate success in terms of adult returns during the three years of operation under the injunctive order, monitoring juvenile outmigration and collecting tissue samples for genetic analysis will provide interim data for adaptive management. Demonstration of the overall effectiveness of this measure will require quantitative and qualitative evaluation of adult returns outside the period of the injunctive order, but metrics have been identified to provide information about the outplanting measure.

The metrics to evaluate the effectiveness of the outplanting program and factors affecting outplanting success include condition of outplanted adult hatchery spring Chinook prior to release, pre-spawning mortality of outplanted fish, distribution of fish from release sites, water quality at release sites, spawning location and success of outplanted fish, factors affecting spawning success such as outplanting location and date, and production of juvenile salmon from outplanted adults.

Objectives and Methods for Outplanting Adults

1. Identify potential outplanting studies that could be incorporated into the outplanting program. Potential studies could include holding adult Chinook in cooler and pathogen-free water and releasing them later in the spawning season and releasing adult Chinook in lower and upper parts of streams based on locations of spawning gravel. Review previous survey data on location of spawning gravel in Middle Santiam River and Quartzville Creek. Determine the need for passive or active tags for the studies and, if needed, be prepared to carry out such studies by April 1, 2022 (*from* Outplanting Plan #3 in Green Peter Outplanting Plan, 2021-11-05).
2. The target outplant number is 700–800 dependent on run size, with more adult Chinook to be outplanted early. The example in the Outplanting Plan was for 20% of total to be outplanted in May, 60% in June, and remainder in July–September. Per the Outplanting Plan, preliminary outplanting numbers and dates will be made in coordination with ODFW biologists and South Santiam Hatchery manager including any experimental releases and would be based on returns

to Willamette Falls and Lebanon Dam (if counting station is completed). The final outplanting numbers will be coordinated with the Willamette Fish Passage O&M Coordination Team (WFPOM) .

3. Collect data on adult salmon prior to release including but not limited to condition factor, sex, pathogen load, and external injuries.
4. Tag all outplanted fish with individually number Floy tags, Radio tags and/or PIT tags including outplanted fish for experimental studies (*see* #1). Cross reference tag numbers with each outplant group and with each experimental release group to identify individual fish with specific outplanting information.
5. Collect tissue samples and scales from fish to be outplanted. Cross reference and catalogue samples with tag numbers tied to specific release strategies for pedigree analysis to evaluate production of progeny relative to release groups.
6. Monitor outplanted fish at release sites immediately after release and within one week.
7. Conduct spawning surveys of Quartzville Creek and Middle Santiam River to count redds and to document the location and success of spawners (contingent on gaining access). Surveys should begin by mid-July to document pre-spawning mortality of early releases.
8. Sample for carcasses and estimate pre-spawning mortality. Collect Floy tag numbers or record evidence of lost tags based on scarring or holes at the base of the dorsal fin. Collect active tags and scan fish for passive tags and cross-reference tag number with other data.
9. Collect otoliths and scales from any untagged carcasses to identify possible adfluvial Chinook spawners based on absence of induced thermal marks and growth patterns on scales (Romer and Monzyk 2014).
10. Determine spawning success and location of redds relative to release site and date. Spawning success will also be evaluated relative to fish return rates (run timing) and outplant timing (from tags) to determine the month or time when spawning success was highest.
11. Collect data to assess potential factors affecting spawning success including but not limited to temperature, condition of fish, location, date, handling, transport time, pre-existing disease, injury.
12. Summarize and analyze data on outplant success and factors affecting success. Review the need for additional studies under Objective 1 and finalize plans for studies to insure timely implementation relative to outplant plans. Determine need to modify the outplanting plan and finalize modifications prior to adult returns.
13. All studies conducted on outplanting success will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.
14. Operate rotary screw trap(s) near the reservoir to evaluate the production of fry and other migratory life histories. Collect tissue samples from juvenile fish for preliminary pedigree analysis of successful spawners (*see* Injunction Number 12).

Injunction Number: 12(a)

Project: Green Peter Dam (Spring Passage)

<u>Measure Description</u>

Provide spill in spring for juvenile salmon passage. Beginning in the spring of 2022, start spilling once the reservoir reaches El. 971 ft. and spill continuously until May 1 or for at least 30 days, whichever is longer. At least two different spill strategies will be tested in a block study: (1) continuous (24/7) spill through a minimum gate opening of 1.5 ft. and (2) nighttime spill through a 3–4 ft. gate opening one hour before sunset to one hour after sunrise.

Operations in spring 2023 are summarized in the implementation plan. These operations are based on limited information and may be modified by the mutual agreement of the Corps and NMFS as warranted by the information collected in the 2022 monitoring plan and in accordance with the objectives and biological goal of the spring passage operations.

Biological Goal

Provide sufficient juvenile reservoir and dam passage survival to support self-sustaining UWR Chinook salmon and steelhead populations in the habitat upstream of Green Peter Dam. Because the winter steelhead population in the South Santiam watershed is currently at low levels, the initial phase of the Green Peter spring operation will be to provide for volitional passage for juvenile salmon produced by outplanted adult Chinook salmon.

Management Purpose

Operate Green Peter Dam in a manner that reduces reservoir holding time and increases downstream passage survival for juvenile Chinook salmon. Outplanting upstream of Green Peter Dam will begin in 2022 by releasing adult Chinook salmon collected at the Foster Dam adult fish facility. Therefore, no naturally-produced progeny will be present, but spill operations will be implemented in spring 2022 and experimental releases of juvenile hatchery salmon will be used to collect preliminary information. Preliminary information will be used to plan future spring operations and to plan future monitoring studies when progeny of outplanted adult salmon migrate downstream.

The metrics of interest during the 2022 spill test include passage timing through the reservoir, forebay behavior, dam passage rates, and passage survival. Long-term metrics may also include timing and life history of migrants entering the reservoir, residence time, growth, and predation in the reservoir.

Objectives and Methods for Juvenile Fish Passage

Full-scale evaluation of the spillway operation for fish passage will begin in spring of 2023 when progeny of outplanted adult Chinook salmon above Green Peter in 2022 begin to migrate downstream. However, a baseline active tag (radio telemetry) fish passage study coupled with rotary screw trapping downstream of Green Peter will be conducted during spring of 2022 to evaluate the initial spill operation. The results from the baseline study during 2022 will be used to inform the 2023 spillway operation and to design the full-scale fish passage study.

The full-scale study to evaluate the spillway operation will be conducted annually for a minimum of two years, 2023-2024, to account for interannual variability in fish migration timing and behavior and environmental and operational conditions (e.g., hydrology, dam operations).

1. Passage timing – implementation would begin in 2023
    a. Operate rotary screw traps upstream of the reservoir and downstream of the dam.
    b. Estimate the number of juvenile salmon caught in each trap.
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.

ii. Use wild subyearlings captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates.
iii. Sum weekly estimates to derive total abundance during peak migration.
iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.
v. Compare abundance of fish entering the reservoir and abundance leaving.

c. Beginning in spring 2023, if possible, mark or tag up to 1,000 fry per week in February–April (Note: Goal is to have monthly or bi-weekly batches; a single batch is still useful). Number will depend on trap catch.
   i. Hold a subsample of fish to monitor mark or tag injury, tag retention, and mortality.
   ii. Scan fish caught in traps downstream of the dam for mark or tags.

d. Design a study in 2022 to characterize life history characteristics of juvenile salmon in Green Peter Reservoir. A pilot study would begin in late spring 2022, if possible, with the full study to begin in 2023. The study should include distribution and movement of juvenile salmon, relative growth of juvenile salmon, copepod infestation, and species composition and predation (including relative abundance of predators). *See* Monzyk et al. 2015 and other reports for example of reservoir studies and methodology. The study should be designed to detect differences in juvenile salmon behavior relative to operational measures. Studies should include the following:
   i. Enumerate and measure juvenile salmon caught in traps. Record data on location, date, and condition including copepod infestation.
   ii. Examine or scan fish for marks, blank wire tags, or PIT tags from upstream trap or other traps within the reservoir.
   iii. Enumerate and measure any captured fish with a batch mark or tag, noting date and location.
   iv. Mark small fish (<65 mm) to delineate variables such as location or date (e.g., elastomer tags, using different colors or body locations). The mark should be distinct from those used for controlled experimental releases under Objective 3.
   v. Fish $\geq$65 mm will be tagged with a PIT tag and associated data will be collected on fish length, date, location, etc.
   vi. Calculate longitudinal distribution (e.g., methods of Monzyk et al. 2015 and other reports).
   vii. Compare distribution relative to operating conditions.
   viii. Investigate methods for estimating an abundance index of juvenile salmon within longitudinal reservoir zones (methods need to account for open population with fish entering and exiting the reservoir during certain times of year).

e. Compare passage timing at the dam for marked fish relative to time and size when they entered the reservoir.

f. Compare passage timing for marked and unmarked fish to that under previous operating conditions.

2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through the Green Peter Dam starting in 2023.
   a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants (Ensure all PIT-tagged fish are measured). The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam. Collect and catalogue scales of Chinook salmon migrants to provide reference sample for stream-reared juvenile salmon (will begin in 2024 when two age classes of progeny from outplanted adults would be present).
   b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions (if operations are modified after initial phase).
   c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
   d. When fish are available, hold juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week). Fish for the test could be held at South Santiam Hatchery or Foster adult facility and would be monitored and recorded for 24–48 hours.
3. Passage rate and survival
   a. Estimate passage rate using expanded trap catches and marked and unmarked fish (1b and 1c); analyze relative to operations. Incorporate information from sampling within the reservoir to supplement passage rate estimates. These activities will begin in 2023.
   b. PIT tag and release experimental groups of surrogate Chinook salmon or juvenile hatchery salmon upstream and downstream of dam in spring 2022 to obtain preliminary data. Specific number and methodology will be developed. Below is an example approach.
      i. Release fish near the head of the reservoir in early to mid-March 2022 to study travel time through the reservoir (including small juvenile Chinook salmon if available), and to investigate spill operations that will provide attraction flow and effective passage. Releases would be structured to answer specific questions and multiple releases (e.g., mid-reservoir) may be needed depending on the study objective and need for replicates. Exact numbers to be released will depend on availability of fish from ODFW production groups and surrogate fish.[2]
      ii. Release test groups of surrogate fish to study the effects of different spill operations below. Groups should be sufficiently marked to allow analysis of the differences between the individual operations.
         1. continuous spill and a gate opening of 1.5 feet.
         2. nighttime spill from dusk to dawn (open the spillgate 1.5 feet for daylight hours and 2 feet from dusk to dawn).

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[2] The size of juvenile hatchery Chinook salmon at South Santiam Hatchery is expected to be: 45 mm; 0.9 g (500 fish/lb) in mid-March; 60 mm; 2.2–2.3 g (200 fish/lb) in late April; 66 mm; 2.9–3.0 g (150 fish/lb) in early May. 5,000 juvenile fish would be available from the South Santiam production group (personal communication with R. Couture & B. Boyd, ODFW); additional fish should be available from the extra eggs taken to produce surrogate fish for the injunction measure studies.

iii. Because no naturally produced fry or small subyearlings will be present in the reservoir in 2022, any fry or small subyearling captured immediately downstream of Green Peter Dam would be from an experimental release group. Therefore, relatively simple identifiers could be used such as adipose clips with addition of half-length wire tag for a second group. Other batch marks could also be used.
iv. Releases of larger fish (≥ 65 mm) would be PIT-tagged and released, if available, to provide specific information on passage timing, effectiveness, and survival. All tag data would be uploaded to the PTAGIS regional database.
v. Additional releases of juvenile Chinook salmon could be made in April to provide more information about the effectiveness of spill with larger fish. All fish in subsequent tests should be individually tagged to distinguish them from fish of earlier release(s).
vi. Release active-tagged juvenile Chinook salmon upstream of Green Peter Dam to evaluate the different spill operations during spring 2022. Track movement through the reservoir and passage at Green Peter Dam. Coordinate release and tracking with similar operations at Foster Dam.
vii. Operate a screw trap downstream of Green Peter Dam to recapture test fish. Conduct trap efficiency tests using fish captured in the trap or using surrogate fish if number of captured fish is too low. Data collected from captured fish would include numbers, size (measure fork length of all fish or a representative sample of sizes), and condition of fish noting injuries or physical conditions such as de-scaling or loss of protective mucous. Collect tissue samples on all *O. mykiss* for future genetic analysis. If a sufficient number of fish are available, holding mortality should be assessed to determine extent of delayed mortality. Depending on the marking program for surrogate fish released upstream of the dam, fish caught in the downstream trap would be scanned for the presence of a tag or examined for an external mark.
viii. Other data collected at the trap downstream of the dam will be species composition and size or age class of other species.

c. PIT tag and release experimental groups of surrogate Chinook salmon or juvenile hatchery salmon upstream and downstream of dam in spring 2023 and future years to evaluate effectiveness of spring operations for Chinook salmon fry and small juvenile salmon. Specific number and methodology will be developed. Below is an example approach.
   i. Release fish near the head of the reservoir to study travel time through the reservoir (including fry or small juvenile Chinook salmon if available).
   ii. Release 5,000–10,000 batch-marked surrogate fry or hatchery production fry in the upper end of the reservoir prior to the start of each spill operation block, beginning in early March. If spill begins early and fry are available, a study group could be released in February. However, releases would be made only if they could be marked to distinguish them from later release groups.
   iii. Investigate batch mark methods for use with fry and small subyearlings. Priority would be for marks that allow identification of individual release groups. Mark fish in a hatchery setting 2–3 weeks prior to release. Mark extra fish to account for

mortality. Hold a sample of fish to monitor long-term mortality or injury from tagging, and to document long-term visibility of tags or marks.

    iv. Evaluate passage rate of each batch-marked group by capture in downstream traps. Supplement with data on longitudinal distribution of juvenile salmon in the reservoir (1d) to determine the effect of spring operations on the distribution of juvenile salmon.

  d. Tag and release experimental groups of surrogate Chinook salmon or juvenile hatchery salmon (≥65 mm) upstream and downstream of dam. Specific number to be released in spring 2023 and future years will depend on availability of both surrogate fish (salmon and steelhead) and other juvenile hatchery salmon.

    i. Release PIT-tagged juvenile salmon to evaluate effect of spring operations on larger juvenile fish in the reservoir (stream-reared and reservoir-reared yearlings). If available, conduct separate releases prior to beginning of each spill operation (e.g., continuous spill and nighttime only spill). Note that spill operations may be modified depending on results of previous years. Numbers below are an example and will be finalized based on surrogate fish availability:

      1. 2,000 at head of reservoir.
      2. 2,000 in forebay.
      3. 1,000 downstream of dam (release of this group depends on detection capability downstream such as at Foster Dam or Lebanon Dam.

    ii. If available, supplement PIT-tagged releases with release of active-tagged juvenile hatchery salmon in head of reservoir and forebay, with priority for a release prior to continuous spill period if availability of fish is limited.

4. Outplant success and origin of juvenile salmon
  a. Collect tissue samples of juvenile salmon and *O. mykiss* collected in trap(s) upstream of the reservoir.
  b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location). Purpose of *O. mykiss* sampling is to determine what, if any, genetic relationship there is between *O. mykiss* upstream of the dams and winter steelhead downstream of the dams.
  c. Collect tissue samples of juvenile salmon and *O. mykiss* collected in traps downstream of dam.
  d. Analyze samples to determine parentage of juveniles (outplant origin v. below dam origin).
5. Estimate route-specific and/or overall dam passage survival of juvenile Chinook salmon passing Green Peter Dam with data from fish with active tags (if released) and PIT tags.
6. Estimate reach survival of PIT-tagged fish following passage at Green Peter Dam downstream to Foster and Lebanon dams and to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.
7. Estimate reach survival of active-tagged fish after passage at Green Peter Dam by deploying receiver arrays downstream (e.g., Foster Dam and Lebanon Dam) during spring 2022.

8. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.
9. Design a study to investigate the life history of the progeny of outplanted adult Chinook salmon in streams upstream of the reservoir, and to tag juvenile salmon. The study could be planned in 2023 and conducted in 2024 when two age classes of outplant progeny should be present in streams. The study should include the following activities:
   a. Sample juvenile fish upstream of reservoir (pole seine, snorkel seine, electrofishing, in-stream fyke nets)
   b. Collect data on size and age classes of juvenile salmon
   c. Collect data to estimate egg to fry or fingerling survival and associated environmental variables (flow, temperature, sediment load)
   d. Collect and catalogue scales for reference of stream-rearing fish
   e. Collect and catalogue tissue samples for early analysis of outplant success (which adults produced stream-rearing juveniles)
   f. Establish standard sites for repeat sampling to monitor instream movement/migration and growth (sites near redds and downstream of spawning areas if there is spatial segregation)
   g. Collect data on habitat preferences and availability and identify potential habitat improvement projects to increase carrying capacity
   h. PIT tag juvenile salmon $\geq$ 65 mm

<u>Objectives for Downstream Water Quality</u>

Spring spill operations at Green Peter may increase TDG concentrations and affect water temperatures in Foster Reservoir and the South Santiam River downstream. To monitor and evaluate these effects, existing USGS stations and additional temporary monitoring stations will be employed. Green Peter powerhouse operations will be used as needed to ameliorate adverse TDG and water temperatures downstream. Fish passage spill operations at both Green Peter and Foster dams will be managed to avoid exceeding the state standard for TDG at the USGS gage near Foster (Station No. 14187200). Operations at both Green Peter and Foster Dams affect water temperatures and TDG concentrations in the South Santiam River downstream.

1. Install a TDG sensor at the existing Green Peter Dam tailwater gauge (Station No. 14186200) to monitor TDG starting in the spring 2022.
2. Using these data and data from USGS Station No. 14187200 located in the South Santiam River near Foster, determine the:
   a. relationship between Green Peter/Foster operations and TDG production and update USACE TDG Model. These data will be presented in the future status reports
   b. Determine relationship between Green Peter/Foster operations and downstream water temperature regimes. The existing USGS gaging stations in the Green Peter Dam tailwater (Station No. 14186200) and the South Santiam near Foster Dam (Station No. 14187200) collect water temperature data. The Corps will use these data to evaluate the effect of spring spill operations on downstream water temperatures, if any, and will present the results in each status report following initiation of the spring spill operation (Fall 2023).

Foster

Injunction Number: 13a
Project: Foster Dam (Fall Spill)

Measure Description
Starting after Labor Day weekend, Foster Reservoir will be drawn down to a forebay elevation of 620–625 ft. by October 01. From October 1–December 15 the Foster spillway will be operated from one hour before sunset to one-half hour after sunrise; turbine unit 1 (only) will be operated at station service to reduce/balance TDG levels created by the spill operation. Spill gates should be opened to a 1 ft. gate opening; outflow amounts will be dictated by reservoir elevation. Flows will be spread across multiple gates if necessary. During the day, the Foster turbine units will be operated from one-half hour after sunrise to one hour before sunset, with full generation. The spillway will not be used to discharge water during this time unless required for flood risk management.

Biological Goal
The overall goal is to establish self-sustaining populations of spring Chinook salmon and winter steelhead upstream of Foster Dam. The goal of this spill operation is to provide improved downstream fish passage and survival for juvenile spring Chinook salmon and steelhead through Foster Reservoir and past Foster Dam.

The target fish for the fall operations would be salmon fry and subyearlings that entered the reservoir in the previous winter–spring and reared through summer in the reservoir, and subyearlings that enter the reservoir in summer and fall. Juvenile winter steelhead (age 0 and age 1) are present in the reservoir and have been observed in high numbers in the forebay. Although few steelhead were caught downstream of the dam in previous years, fall spill operations could provide passage opportunities for these fish. Passage would also be provided for juvenile salmon migrating past Green Peter Dam.

Management Purpose
Operate Foster Dam in a manner that reduces reservoir holding time and increases downstream passage survival for juvenile salmonids. The metrics of interest for biological monitoring include juvenile Chinook salmon and steelhead passage timing, forebay behavior and distribution, route distribution, passage rates and passage survival.

Objectives and Methods for Juvenile Fish Passage
A full-scale study of passage at Foster Dam (all life stages) is not possible because of the inability to capture juvenile salmonids downstream of the dam. Therefore, a plan to increase monitoring capabilities in the South Santiam River will be developed and implemented (*see* Measure Number 13b). Below are objectives for evaluating passage at Foster Dam.

1. Passage timing – *contingent on development of capture capability at or downstream of Foster Dam*
    a. Operate rotary screw traps upstream of the reservoir and alternative downstream traps if available.

b. Estimate the number of juvenile salmonids caught in each trap. *Note that numbers of juvenile Chinook salmon caught in the upstream trap were very low in previous studies, therefore estimates of passage timing for juvenile Chinook may have to be derived from experimental releases of fish. Efficiency estimates were not made for juvenile steelhead but catch number was relatively high in summer through early winter.*
    i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
    ii. Use wild salmonids captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates (separate from dam passage efficiency fish).
    iii. Sum weekly estimates to derive total abundance during peak migration.
    iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.
    v. Compare abundance of fish entering the reservoir and abundance leaving.
    vi. Compare entry and passage abundance to previous estimates.
c. PIT tag all salmon and steelhead ($\geq$65 mm) caught in the rotary screw trap upstream of Foster reservoir beginning in summer to measure passage timing at the dam (and to provide information on passage rates and passage survival).
d. When practicable incorporate naturally produced subyearling salmon into an ongoing active tag study in the basin to provide information on passage rates, passage routes, and passage survival.
e. Compare passage timing for PIT-tagged fish relative to time and size when they entered the reservoir.
f. Compare passage timing for tagged and untagged fish to that under previous operating conditions.

2. Passage size and condition: estimate size and condition for juvenile salmon and steelhead passing through Foster Dam – *contingent on development of capture capability at or downstream of Foster Dam*
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants (ensure all PIT-tagged fish are measured). The purpose of this metric is to provide information about the life history of the juvenile salmon and steelhead passing the dam. Collect and catalogue scales of salmon and steelhead migrants to provide reference sample for stream-reared juvenile salmon and steelhead.
    b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions.
    c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
    d. When fish are available, hold a sample of juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week); note that this direct measure of delayed mortality supplements assessments through tagging and

downstream sampling. Fish for the test could be held at the South Santiam Hatchery or Foster adult collection facility and would be monitored and recorded for 24–48 hours.

3. Passage rate and survival
    a. Estimate passage rate and survival of tagged fish with (1c –1d) and compare results to previous years.
    b. Tag and release experimental groups of surrogate salmon or steelhead, or juvenile hatchery salmon upstream and downstream of dam. Note that final numbers will be developed when a study plan is written and will depend on availability of surrogate fish and other juvenile hatchery salmon.
        i. Release 2,000 PIT-tagged juvenile salmon into Foster Reservoir in late August to early September, along with 1,000 PIT-tagged juvenile salmon downstream of Foster Dam (numbers will be adjusted based on surrogate fish availability).
        ii. Release 2,000 PIT-tagged juvenile salmon into Foster Reservoir in early to mid-October during fall nighttime spill, along with 1,000 PIT-tagged juvenile salmon downstream of Foster Dam (numbers will be adjusted based on surrogate fish availability).
        iii. Supplemental releases of PIT-tagged juvenile hatchery fish as available:
            1. 3,000 into reservoir in October during fall nighttime spill.
            2. 3,000 downstream of dam in October.
        iv. Supplement releases of PIT-tagged salmon with release of active-tagged juvenile salmon and steelhead (if available).
            1. Release one group prior to or shortly after initiation of drawdown (scheduled for after Labor Day) to evaluate passage during drawdown.
            2. Release one group after drawdown is completed (scheduled for October 1) to evaluate passage at low pool.
        v. Because the number of adult winter steelhead is limited due to low run size, the number of surrogate steelhead for studies can be low or nonexistent in some years. To address this shortage, investigate the potential to collect age 0 steelhead at the South Santiam trap upstream of Foster Reservoir to hold and use as surrogate steelhead for tagging studies. Feasibility and logistics on collection, number, transport, rearing location (e.g., South Santiam Hatchery) will be coordinated between ODFW, Corps and contractor, NOAA, and others as needed. Collection of juvenile steelhead would be implemented in July 2022.
4. Outplant success and origin of juvenile salmon and steelhead.
    a. Collect tissue samples of juvenile salmon and steelhead collected in the trap upstream of the reservoir.
    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
    c. Collect tissue samples of juvenile salmon and steelhead collected in traps at or downstream of dam – *contingent on development of methodology to capture fish*.
    d. Analyze samples to determine parentage of juveniles (outplant origin v. below dam origin).
5. Estimate route-specific and overall dam passage survival of juvenile Chinook salmon and steelhead passing Foster Dam with active-tagged fish.

   a. Approach patterns, behavior, and timing into Foster Dam forebay.
   b. Estimates of route-specific (nighttime spillway v turbine passage) diel passage and survival.
   c. Compare timing and survival to previous studies.
6. Estimate reach survival of PIT-tagged fish following passage at Foster Dam downstream to Lebanon Dam and to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.
7. Estimate reach survival of active-tagged fish (if released in reservoir) after passage at Foster Dam by deploying arrays downstream.
8. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.

<u>Objectives for Downstream Water Quality</u>

Fall spill at Foster could increase downstream TDG concentrations and may increase downstream water temperatures. Water temperature and TDG in the South Santiam River downstream from Foster Dam are continuously monitored at USGS Station No. 14187200. During voluntary spill operations, spill is limited and/or power generation increased to avoid adverse downstream TDG conditions. Spill is also blended with powerhouse discharge as needed to meet downstream temperature objectives. Modifying project operations in real time to meet specific objectives is accomplished through adaptive management.

1. Determine relationship between Green Peter/Foster operations and TDG production. Update USACE TDG Model to reflect conditions.
2. Determine relationship between Green Peter/Foster operations and downstream water temperature regimes.
3. Summaries of these data and analyses will be provided in future status reports.

Injunction Number: 13b
Project: Foster Dam (Spring Spill)

<u>Measure Description</u>
Starting 01 February maintain Foster Reservoir at minimum conservation pool (El. 613 ft.) prioritizing spillway operation from one hour before sunset to one-half hour after sunrise. During the day (one-half hour after sunrise to one hour before sunset, the Foster turbine units will be operated with full generation. The spillway will not be used to discharge water during this time unless required for flood risk management. On 15 May the Corps will begin refilling Foster Reservoir using stored water from Green Peter Reservoir and South Santiam River inflow targeting full pool of Foster Reservoir by Memorial Day Weekend. From May 16 – June 15, operations at Foster Dam will continue as described above.

<u>Biological Goal</u>
The overall goal is to establish self-sustaining populations of spring Chinook salmon and winter steelhead upstream of Foster Dam. The goal of the spring spill operation measure is to provide

improved downstream fish passage and survival for juvenile spring Chinook salmon and steelhead through Foster Reservoir and past Foster Dam.

The target fish for the spring operations would be salmon fry and subyearlings that enter the reservoir in winter–spring and juvenile salmon that reared through fall-winter in the reservoir. Juvenile winter steelhead pass the dam in the spring as age 2 smolts. Age 1 juvenile steelhead are also present in the reservoir and may benefit from passage measures. Passage would also be provided for juvenile salmon migrating past Green Peter Dam.

Management Purpose

Operate Foster Dam in a manner that reduces reservoir holding time and increases downstream passage survival for juvenile salmon and steelhead. A primary objective of the delayed refill operation is to provide conditions for volitional passage of juvenile Chinook (especially fry, including fry that pass Green Peter Dam) as well as winter steelhead. The metrics of interest for biological monitoring include juvenile Chinook salmon and steelhead passage timing, forebay behavior and distribution, route distribution, passage rates and passage survival.

Objectives and Methods for Juvenile Fish Passage

A full-scale study of passage at Foster Dam is not possible because of the inability to capture juvenile salmonids downstream of the dam. Therefore, a plan to increase monitoring capabilities in the South Santiam River will be developed and implemented (*see* Objective 9). Below are objectives for evaluating passage at Foster Dam.

1. Passage timing – *contingent on development of capture capability at or downstream of Foster Dam*
    a. Operate rotary screw traps upstream of the reservoir and downstream of the dam.
    b. Estimate the number of juvenile salmonids caught in each trap. *Note that numbers of juvenile Chinook salmon caught in the upstream trap were variable but generally low in previous studies, therefore estimates of passage timing for juvenile Chinook may have to be derived from experimental releases of fish. Efficiency estimates were not made for juvenile steelhead but catch number was relatively high in winter and spring in some years.*
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
        ii. Use wild salmonids captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates (separate from dam passage efficiency fish).
        iii. Sum weekly estimates to derive total abundance during peak migration.
        iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.
        v. Compare abundance of fish entering the reservoir and abundance leaving.

        vi. Compare entry and passage abundance to previous estimates.
    c. PIT tag all salmon and steelhead ($\geq$65 mm) caught in the rotary screw trap upstream of the reservoir beginning in summer to measure passage timing at the dam (and to provide information on passage rates and passage survival).
    d. When practicable incorporate naturally produced subyearling salmon into an ongoing active tag study in the basin to provide information on passage rates, passage routes, and passage survival.
    e. Compare passage timing for PIT-tagged fish relative to time and size when they entered the reservoir.
    f. Compare passage timing for tagged and untagged fish to that under previous operating conditions.
2. Passage size and condition: estimate size and condition for juvenile salmon and steelhead passing through Foster Dam – *contingent on development of capture capability at or downstream of Foster Dam*
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants (ensure all PIT-tagged fish are measured). The purpose of this metric is to provide information about the life history of the juvenile salmon and steelhead passing the dam.
    b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions.
    c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
    d. When fish are available, hold a sample of juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week); note that this direct measure of delayed mortality supplements assessments through tagging and downstream sampling. Fish for the test could be held at the South Santiam Hatchery or Foster adult collection facility and would be monitored and recorded for 24–48 hours.
    e. Collect and catalogue scales from a sample of juvenile salmon and steelhead captured in the upstream trap(s) to provide a brood year reference collection for identifying stream-reared yearling salmon and age 1 and age 2 steelhead in returning adults, and to verify the age class of captured fish, with selective sampling at sizes where age classes may overlap.
3. Passage rate and survival
    a. Estimate passage rate and survival of tagged fish with PIT tags (1c –1d) and compare results to previous years.
    b. Tag and release experimental groups of surrogate salmon or steelhead, or juvenile hatchery salmon upstream and downstream of dam. Note that final numbers will be developed when a study plan is written and will depend on availability of surrogate fish and other juvenile hatchery salmon.
        i. Release 2,000 PIT-tagged juvenile salmon into Foster Reservoir in late April prior to refill, along with 1,000 PIT-tagged juvenile salmon downstream of Foster Dam (numbers will be adjusted based on surrogate fish availability).

ii. Release 2,000 PIT-tagged juvenile salmon into Foster Reservoir in mid-May to early June after refill, along with 1,000 PIT-tagged juvenile salmon downstream of Foster Dam (numbers will be adjusted based on surrogate fish availability).
iii. Supplemental releases of PIT-tagged juvenile hatchery fish as available:
    1. 3,000 into reservoir in mid to late April prior to refill.
    2. 3,000 downstream of dam in late April.
iv. Supplement any releases of PIT-tagged salmon with release of the spring 2022 active-tagged juvenile salmon and steelhead.
    1. Release one group prior to start of refill (scheduled for May 15).
    2. Release one group after refill.
v. Because the number of adult winter steelhead is limited due to low run size, the number of surrogate steelhead for studies can be low or nonexistent in some years. To address this shortage, investigate the potential to collect age 0 steelhead at the South Santiam trap upstream of Foster Reservoir to hold and use as surrogate steelhead for tagging studies. Feasibility and logistics on collection, number, transport, rearing location (e.g., South Santiam Hatchery) will be coordinated between ODFW, Corps and contractor, NOAA, and others as needed. Collection of juvenile steelhead would be implemented in July 2022.

4. Outplant success and origin of juvenile salmon and steelhead.
    a. Collect tissue samples of juvenile salmon and steelhead collected in the trap upstream of the reservoir.
    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
    c. Collect tissue samples of juvenile salmon and steelhead collected in traps at or downstream of dam – *contingent on development of methodology*.
    d. Analyze samples to determine parentage of juveniles (outplant origin v. below dam origin).
5. During spring 2022, estimate route-specific and overall dam passage survival of juvenile Chinook salmon and steelhead passing Foster Dam with active-tagged fish.
    a. Approach patterns, behavior, and timing into Foster Dam forebay.
    b. Estimates of route-specific (nighttime spillway v turbine passage) diel passage and survival.
    c. Compare timing and survival to previous studies.
6. Estimate reach survival of PIT-tagged fish following passage at Foster Dam downstream to Lebanon Dam and to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.
7. During spring 2022, estimate reach survival of active-tagged fish (released in reservoir) after passage at Foster Dam by deploying receiver arrays downstream.
8. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.
9. Because monitoring infrastructure is lacking in the South Santiam subbasin to assess the effectiveness of this and other operations (including those at Green Peter Dam), development of

monitoring infrastructure is a high priority so that the operations at Foster and Green Peter dams can be adequately evaluated.

   a. Identify monitoring needs in 2022.
   b. Outline a strategy for designing and implementing needed improvements and additions.
   c. Install PIT tag detection system at Lebanon Dam in 2022.
   d. Identify a timeline for installing PIT tag antenna(s) at Foster Dam.
   e. Research alternative sampling methods (to rotary screw trap) to adequately assess effectiveness of passage measures at Foster Dam (e.g., sampler within spillway, surface flow collector at spillway)

10. Incorporate a study to capture and tag juvenile *O. mykiss* in the South Santiam River and spawning tributaries upstream of the reservoir. This study will supplement the capture and tagging of juvenile *O. mykiss* in the rotary screw trap upstream of Foster Reservoir (*see* Objective 1c).
    a. Review methods of Monzyk et al. 2017 as basis for study design and modify as needed (e.g., sample sizes, time and duration of sampling, location of sampling, location of screw trap, etc.)
    b. Develop study plans in 2022 and implement the study in 2023, if possible.
11. The Corps will coordinate with PNNL biologists to develop a pilot field study for using micro acoustic tags (ELAT) in juvenile Chinook and winter steelhead down to 59 mm. In conjunction with planned active tag studies.

<u>Objectives for Downstream Water Quality</u>

Fall spill at Foster Dam could increase downstream TDG concentrations and may increase downstream water temperatures. Water temperature and TDG in the South Santiam River downstream from Foster Dam are continuously monitored at USGS Station No. 14187200. During voluntary spill operations, spill is limited and/or power generation increased to avoid adverse downstream TDG conditions. Spill is also blended with powerhouse discharge as needed to meet downstream temperature objectives. Mechanisms for modifying project operations to meet specific objectives is accomplished through adaptive management as described in the Corps' annual Willamette Fish Operations Plan. http://pweb.crohms.org/tmt/documents/FPOM/2010/Willamette_Coordination/WFOP/

1. The Corps will provide a brief synopsis of water temperature and TDG monitoring results and an evaluation of the effectiveness of adaptive management in meeting the established targets in its bi-annual status reports to the court.
2. Determine relationship between Green Peter/Foster operations and TDG production. Update USACE TDG Model to reflect conditions.

McKenzie Basin

Injunction Number: 14
Project: Cougar Dam (Fall/Winter Operation)

<u>Measure Description</u>

Draw Cougar Reservoir down to elevation 1505 ft. from early November through December 15. Once Cougar Reservoir is drawdown to El. 1571 ft. and below, operate the regulating outlets (ROs) at night, generate during the day. From El. 1532 ft. to El. 1505 ft., the ROs will be prioritized at all times to discharge water from the reservoir. On December 16, begin refilling Cougar Reservoir and use the ROs during nighttime hours until El. 1532 ft. is reached. The diversion tunnel will not be used during this special operation.

Biological Goal

The overall goal is to establish a self-sustaining population of spring Chinook salmon upstream of Cougar Dam. The objective of this measure is to provide volitional passage for juvenile Chinook salmon at Cougar Dam during fall and early winter with high passage efficiency, and high immediate and long-term survival.

The target fish for the fall operations would be salmon fry and subyearlings that entered the reservoir in the previous winter–spring and reared through summer in the reservoir, and subyearlings that enter the reservoir in summer and fall. The number and proportion of salmon fry that remain and rear in the reservoir will depend on the passage effectiveness of spring operations under Measure 15.

Management Purpose

Determine if downstream fish passage conditions at Cougar Dam have improved compared to previous operations as a result of implementing this operation. RM&E should be prioritized to understand active outmigration versus reservoir use. PIT tags are recommended for this RM&E because PIT tags can be used to tag smaller fish, have a longer lifespan, and can be used to track both “movers” and “stayers”. Finally PIT tags can be detected at sites downstream to determine long-term survival and can be detected in returning adults at Willamette Falls (where 100% of the adults can be interrogated in the adult fishway), at Leaburg Dam, and in the Cougar Dam adult trap. Active tags could be used to determine migration through the reservoir, fish behavior in the immediate vicinity of the dam, and to identify specific passage routes.

The metrics of interest include spring Chinook juvenile passage timing, passage size and condition, passage rate and survival.

Objectives and Methods for Juvenile Fish Passage

1. Passage timing
    a. Operate rotary screw traps upstream of the reservoir and downstream of the dam.
    b. Estimate the number of juvenile salmon caught in each trap.
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
        ii. Use wild subyearlings captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates (separate from fish used to assess dam passage efficiency).
        iii. Sum weekly estimates to derive total abundance during peak migration.
        iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential

method for approximating abundance during periods of relatively low migration.

v. Compare abundance of fish entering the reservoir and abundance leaving.
vi. Compare entry and passage abundance to previous estimates.

c. PIT tag all subyearling salmon (≥65 mm) caught in the rotary screw trap upstream of the reservoir beginning in July to measure passage timing at the dam (and to provide information on passage rates and passage survival).[3]
d. Tag a subsample of subyearling salmon captured in the upstream trap with active tags if tags and researchers are available from a concurrent active tag study in the basin.
e. Compare passage timing for PIT-tagged fish relative to time and size when they entered the reservoir or were captured in the reservoir.
f. Evaluate reservoir behavior and passage timing for fish with active tags.
g. Compare passage timing for tagged and untagged fish to that under previous operating conditions.

2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through the Cougar Dam regulating outlet and through the turbine.
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants (all PIT-tagged fish should be measured). The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam. Collect and catalogue scales of salmon migrants to provide reference sample for stream-reared juvenile salmon.
    b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions.
    c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
    d. When fish are available, hold a sample of juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week); note that this direct measure of delayed mortality supplements assessments through tagging and downstream sampling. Fish for the test could be held at the Cougar adult collection facility and would be monitored and recorded for 24–48 hours.
3. Passage rate and survival
    a. Estimate passage rate and survival of fish with PIT and active tags (1c –1d) and compare results to previous years.
    b. Tag and release experimental groups of surrogate fish or juvenile hatchery salmon upstream and downstream of dam. Note: final numbers will be developed when a study plan is written and will depend on availability of surrogate fish and other juvenile hatchery salmon.

[3] The mean number of subyearlings ≥65 mm entering the reservoir in 2010–2016 as estimated from graphs of trap catch and length data was about 25 (15–40) in July, 95 (20–175) in August, 120 (15–220) in September, 60 (15–115) in October, and 20 (0–40) in November. The mean estimated total of subyearlings ≥65 mm in 2010–2016 was about 315 (65–435). *See also* Figure 1 in Supplemental Information section in Appendix.

    i. Release 2,000 PIT-tagged juvenile salmon in the Cougar forebay in mid to late October, along with 1,000 PIT-tagged juvenile salmon downstream of Cougar Dam (numbers will be adjusted based on surrogate fish availability).
    ii. Release 2,000 PIT-tagged juvenile salmon in the Cougar forebay in mid-November when reservoir is at full drawdown, along with 1,000 PIT-tagged juvenile salmon downstream of Cougar Dam (numbers will be adjusted based on surrogate fish availability).
    iii. If fish are available, release additional PIT-tagged salmon at the head of the reservoir; 1,000 each in mid to late October and in mid-November.
    iv. Supplemental releases of PIT-tagged juvenile hatchery fish as available:
        1. 3,000 at head of reservoir prior to drawdown.
        2. 3,000 each in forebay in mid-October and mid-November.
        3. 3,000 each downstream of dam in mid-October and mid-November.
    v. Supplement releases of PIT-tagged salmon with release of active-tagged juvenile hatchery fish (if available) in head of reservoir and//or other reservoir locations.
4. Outplant success and origin of juvenile salmon.
    a. Collect tissue samples of juvenile salmon collected in the South Fork trap upstream of the reservoir.
    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
    c. Collect tissue samples of juvenile salmon collected in traps downstream of dam.
    d. Analyze samples to determine parentage of juveniles (outplant origin v. below dam origin).
5. Estimate route-specific and overall dam passage survival of juvenile Chinook salmon passing Cougar Dam.
6. Estimate reach survival of PIT-tagged fish following passage at Cougar Dam downstream to Walterville Canal and to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.
7. Estimate reach survival of active-tagged fish (if released in reservoir) after passage at Cougar Dam by deploying receiver arrays downstream.
8. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.

<u>Objectives for Downstream Water Quality</u>

Spilling water through Cougar Dam's ROs may increase TDG concentrations and alter water temperatures in the South Fork McKenzie River downstream. The USGS station No. 14159500 downstream from the project continuously monitors these and other water quality characteristics.

1. The collect water temperature and TDG data from USGS station No. 14159500 and evaluate the effects of this spill operation.
2. Determine relationship between Cougar operations and downstream water temperature and TDG regimes.

Other Considerations
The Corps will continue working with the USFWS and Bull Trout Working Group to determine and implement monitoring to assess bull trout impacts and benefits from these operations.

Injunction Number: 15
Project: Cougar Dam (Spring Operation)

Measure Description
After the winter drawdown of Cougar Reservoir (IM 14), initiate reservoir refill to the minimum conservation pool El. 1532 on December 16. Hold the reservoir to El. 1532 ft. until 01-March. On 01-March, begin to draft Cougar Reservoir to El. 1520 ft., targeting this elevation on 01-April. The intent is to provide an increased downstream flow signal that encourages outmigration of fish from the reservoir. Delay refill from 1520 ft. as long as possible, while maintaining a high likelihood of reaching El. 1571 ft. by July 1. Use adaptive management to determine the refill starting date. The decision on when to initiate refill will be made by the Federal agencies' Flow and Water Quality Management Team (FWQMT) considering hydrologic data from April and May, including snowpack, average weekly inflows, and extended Water Supply forecasts from the NW River Forecast Center, and fish migration data from trapping upstream and downstream of the reservoir and dam.

Biological Goal
The overall goal is to establish a self-sustaining population of spring Chinook salmon upstream of Cougar Dam. The objective of this measure is to provide volitional passage for juvenile salmon at Cougar Dam in spring with high passage efficiency, and high immediate and long-term survival.

The target fish for the spring operations would be salmon fry and subyearlings that enter the reservoir in late winter and spring, and yearlings that either enter the reservoir in late winter and spring (small number) or entered the reservoir in the previous winter-fall and remained through the winter. The number and proportion of juvenile salmon in the latter group will depend on the passage effectiveness of fall-winter operations under Measure 14.

Management Purpose
Determine if downstream fish passage conditions at Cougar Dam have improved compared to previous operations as a result of implementing this operation. Results will used to determine whether structural improvements/modification to Cougar's regulating outlets will be necessary to ensure safer fish passage. RM&E should be prioritized to understand active outmigration versus reservoir use. Because a focus of the spring operations is to provide passage for salmon fry and small juveniles (<65 mm), use of PIT tags and active tags would be limited to estimating passage of larger fish (yearlings entering the reservoir and reservoir residents that remained through fall and winter). *See* Supplemental Information in Appendix for estimated numbers and lengths of fish.

The metrics of interest include spring Chinook juvenile passage timing, passage size and condition, passage rate and survival.

Objectives and Methods for Juvenile Fish Passage

1. Passage timing
    a. Operate rotary screw traps upstream of the reservoir and downstream of the dam.
    b. Estimate the number of juvenile salmon caught in each trap.
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
        ii. Use wild subyearlings captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates.
        iii. Sum weekly estimates to derive total abundance during peak migration.
        iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.
        v. Compare abundance of fish entering the reservoir and abundance leaving.
        vi. Compare entry and passage abundance to previous estimates.
    c. PIT tag all subyearling salmon (≥65 mm) caught in the rotary screw trap(s) upstream of the reservoir beginning in July to measure passage timing at the dam (and to provide information on passage rates and passage survival).
    d. If possible, mark or tag up to 1,000 fry per week in February–April (Note: Goal is to have monthly or bi-weekly batches; a single batch is still important)
        i. Monitor tag injury, tag retention, and mortality by holding a sample of fish for observation.
        ii. Scan fish caught in traps downstream of the dam for tags.
        iii. Continue to tag fry and subyearlings in May and June to study passage timing during and shortly after refill (*see also* tagging under Measure 14).
    e. Based on observations in 2022, make a determination of need to sample nearshore distribution of juvenile salmon within the reservoir using floating box traps and small Oneida Lake traps (*see* Monzyk et al. 2015 and other reports). Sampling should follow the timing and location of previous studies to provide a basis for comparing fry and subyearling distribution relative to reservoir operations.
        i. Enumerate and measure juvenile salmon caught in traps. Record data on location, date, and condition including copepod infestation.
        ii. Scan fish for blank wire tags and PIT tags.
        iii. Enumerate and measure any captured fish with a batch mark, noting date and location (*see* 3bi).
        iv. Fish <65 mm could be marked with elastomer tags, using different colors or body locations to delineate either location within the reservoir or month or other mark or tag. Tag color and/or body location would be distinct from those used under activity 3bi.
        v. Fish ≥65 mm will be given a PIT tag and associated data will be collected on fish length, date, location, etc.
        vi. Calculate longitudinal distribution using methods of Monzyk et al. (2015 and other reports).

        vii. Compare distribution to previous years and previous operating conditions.
        viii. Investigate methods for estimating an abundance index of juvenile salmon within longitudinal reservoir zones (methods need to account for open population with fish entering and exiting the reservoir during certain times of year).
    f. Compare passage timing for marked fish relative to time and size when they entered the reservoir.
    g. Compare passage timing for marked and unmarked fish to that under previous operating conditions.
2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through the Cougar Dam regulating outlet and through the turbine.
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants (ensure all PIT-tagged fish are measured). The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam.
    b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions.
    c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
    d. When fish are available, hold juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week). Fish for the test could be held at the Cougar adult collection facility and would be monitored and recorded for 24–48 hours.
    e. Collect and catalogue scales from a sample of juvenile salmon captured in the upstream trap(s) to provide a brood year reference collection for identifying stream-reared yearling salmon in returning adults, and to verify the age class of captured fish, with selective sampling at sizes where age classes may overlap.
3. Passage rate and survival
    a. Estimate passage rate using expanded trap catches and marked and unmarked fish (1b – 1d). Incorporate information from nearshore sampling within the reservoir to supplement passage rate estimates if conducted. Compare results to previous years.
    b. Tag and release experimental groups of surrogate Chinook salmon or juvenile hatchery salmon upstream and downstream of dam (Specific number and methodology will be developed and may not be implemented until spring 2023. Below is an example approach.).
        i. Release 5,000–10,000 batch-marked surrogate fry or hatchery production fry in the upper end of the reservoir prior to March 01 start of the drawdown, and 5,000–10,000 batch-marked fry in the upper end of the reservoir in late March prior reaching the target elevation of 1520 ft.
        ii. Investigate batch marks for use with fry and small subyearlings. Priority would be for marks that allow identification of individual release groups. Mark fish in a hatchery setting 2–3 weeks prior to release. Mark extra fish to account for mortality. Hold a sample of fish to monitor long-term mortality or injury from tagging, and to document long-term visibility of tags or marks.

        iii. Evaluate passage rate of each batch-marked group by capture in downstream traps. Supplement with data on longitudinal distribution of juvenile salmon in the reservoir (1d) to determine the effect of spring operations on the distribution of juvenile salmon.
    c. Tag and release experimental groups of surrogate Chinook salmon or juvenile hatchery salmon (≥65 mm) upstream and downstream of dam. Specific number to be released in spring 2022 and future years will depend on availability of both surrogate fish and other juvenile hatchery salmon.
        i. Release PIT-tagged juvenile salmon to evaluate effect of spring operations on larger juvenile salmon in the reservoir (stream-reared and reservoir-reared yearlings). If available, conduct two separate releases prior to beginning of drawdown and prior to full drawdown as follows for each (priority given to earlier release if availability of fish is limited) (numbers will be adjusted based on surrogate fish availability):
            1. 2,000 at head of reservoir.
            2. 2,000 in forebay.
            3. 1,000 downstream of dam.
    a. When practicable incorporate naturally produced subyearling salmon into an ongoing active tag study in the basin to provide information on passage rates, passage routes, and passage survival.
4. Outplant success and origin of juvenile salmon.
    a. Collect tissue samples of juvenile salmon collected in the South Fork trap upstream of the reservoir.
    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
    c. Collect tissue samples of juvenile salmon collected in traps downstream of dam.
    d. Analyze samples to determine parentage of juveniles (outplant origin v. below dam origin).
5. Estimate route-specific and overall dam passage survival of juvenile Chinook Salmon passing Cougar Dam with data from fish with active tags (if released) and PIT tags.
6. Estimate reach survival of PIT-tagged fish following passage at Cougar Dam downstream to Walterville Canal and to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.
7. Estimate reach survival of active-tagged fish after passage at Cougar Dam by deploying receiver arrays downstream.
8. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.

<u>Objectives for Downstream Water Quality</u>

Delaying refill could push the date of refill out, changing temperature tower operations. This may affect downstream water temperatures and the ability to manage water temperature releases.

1. Determine relationship between delayed refill operations and downstream water temperature regimes.

Other Considerations

The Corps will continue working with the USFWS and Bull Trout Working Group to determine and implement monitoring to assess bull trout impacts and benefits from these operations.

Middle Fork Willamette Basin

Fall Creek

Injunction Number: 19

Project: Fall Creek (Fall/Winter Operation)

Measure Description

Draw down the reservoir to ensure that Fall Creek Reservoir hits streambed by December 01. Hold at this elevation through January 15. During the drawdown process, open a single-gate to 7.5 ft. This will result in a high outflow over the drawdown period. Use high flow ramp rates, if necessary, during this drawdown operation. Once at streambed, open the RO gate all the way open (10 feet) to allow stream flow through. On January 16, begin refill to El. 700 ft. and hold at this elevation (+/- 3 ft.) for the spring passage operation (Injunction Number 20), except as needed to provide downstream flood damage reduction or sediment management.[4]

Biological Goal

The overall goal is to establish a self-sustaining population of spring Chinook salmon upstream of Fall Creek Dam. The goal of this drawdown operation is to provide downstream fish passage and high survival for juvenile spring Chinook salmon through Fall Creek Reservoir and past Fall Creek Dam.

The target fish for the fall operations would be salmon fry and subyearlings that migrated downstream in the previous winter–spring and reared through summer in the reservoir, and subyearlings that enter the reservoir in summer and fall (before drawdown). The number and proportion of salmon fry that remain and rear in the reservoir will depend on the passage effectiveness of spring operations under Measure 20.

Management Purpose

Extend the opportunity for juvenile Chinook salmon to pass through the reservoir and past the dam in the late fall and early winter. The metrics of interest for biological monitoring include juvenile Chinook salmon passage timing, passage rates, and passage survival.

Objectives and Methods for Juvenile Fish Passage

1. Passage timing
    a. Operate rotary screw traps upstream of the reservoir and downstream of the dam.
    b. Estimate the number of juvenile salmon caught in each trap if trap catch is sufficient.
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
        ii. Use wild salmon captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates (separate from dam passage efficiency fish).
        iii. Sum weekly estimates to derive total abundance during peak migration.

[4] The Corps may need to provide flushing flows to clear the tailrace.

        iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.
        v. Compare abundance of fish entering the reservoir and abundance leaving.
        vi. Compare entry and passage abundance to previous estimates.
    c. PIT tag all salmon (≥65 mm) caught in the rotary screw trap upstream of Fall Creek Reservoir beginning in summer and fall to measure passage timing at the dam (and to provide information on passage rates and passage survival).
    d. Compare passage timing for PIT-tagged fish relative to time and size when they entered the reservoir.
    e. Compare passage timing for tagged and untagged fish to that under previous operating conditions.
2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through Fall Creek Dam
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants (ensure all PIT-tagged fish are measured). The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam. Collect and catalogue scales to provide reference sample for stream-reared juvenile salmon.
    b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions.
    c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
    d. When fish are available, hold a sample of juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week); note that this direct measure of delayed mortality supplements assessments through tagging and downstream sampling. Fish for the test could be held at the Fall Creek adult fish facility or other site and would be monitored and recorded for 24–48 hours.
3. Passage rate and survival
    a. Estimate passage rate and survival of PIT tagged fish (1c) and compare results to previous years.
    b. Tag and release experimental groups of surrogate salmon or juvenile hatchery salmon upstream and downstream of dam. Note that final numbers will be developed when a study plan is written and will depend on availability of surrogate fish and other juvenile hatchery salmon.
        i. Release 2,000 PIT-tagged juvenile salmon into Fall Creek Reservoir two to three weeks prior to the beginning of the drawdown, along with 1,000 PIT-tagged juvenile salmon downstream of Fall Creek Dam (numbers will be adjusted based on surrogate fish availability).
        ii. Release 2,000 PIT-tagged juvenile salmon into Fall Creek Reservoir or in lower Fall Creek midway between start of drawdown and stream bed elevation

(targeted for December 1), along with 1,000 PIT-tagged juvenile salmon downstream of Fall Creek Dam (numbers will be adjusted based on surrogate fish availability).

iii. Supplemental releases of PIT-tagged juvenile hatchery fish as available:
    1. 3,000 at head of reservoir prior to drawdown.
    2. 3,000 at head of reservoir or in lower Fall Creek midway between start of drawdown and full drawdown.

4. Outplant success and origin of juvenile salmon.
    a. Collect tissue samples of juvenile salmon collected in the trap upstream of the reservoir.
    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
    c. Collect tissue samples of juvenile salmon collected downstream of dam.
    d. Analyze samples to determine parentage of juveniles and compare to samples taken from migrants entering the reservoir.
5. Estimate overall dam passage survival of juvenile Chinook salmon passing Fall Creek Dam with PIT-tagged fish.
    a. Estimates of survival during drawdown phases based on experimental releases.
    b. Estimates of overall survival of juvenile salmon tagged at the upstream trap.
    c. Compare timing and survival to previous studies.
6. Estimate reach survival of PIT-tagged fish following passage at Fall Creek Dam downstream to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.
7. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.

Objectives for Downstream Water Quality and Channel Morphometry

The likely effects of this deeper draft include the release of both suspended sediment and bedload materials. The release of bedload materials in the past has temporarily affected downstream channel morphometry and associated fish habitat. The release of suspended sediments will increase turbidity and could cause short-term low DO or anoxic conditions. Substantial changes in channel morphometry are not expected because past evacuations of stored sediments have substantially reduced the sediment volume likely to be liberated by this operation. Suspended sediment concentrations, SSC, turbidity and DO effects have been extensively studied during previous drawdown operations (Schenk and Bragg 2021). In general, evaluating the water quality effects of this measure is a continuation of ongoing monitoring. To assess the significance of these effects:

1. Data collected from USGS Station No. 14151000 downstream from Fall Creek Dam will be used to identify the water quality effects of the extended drawdown, principally extended turbidity and DO effects, if any.
2. Fall Creek morphometry will be monitored by walking and photographing known (GPS stations) locations within the affected channel reach. Following the initial slug of sediment associated with the deep drawdown, the affected channel reach will be photographed routinely during the

remainder of the deep drawdown period to document effects. Nuisance sediment accumulations at the adult trap observed by fishery personnel will be reported.
3. A summary of these data and analyses will be provided in the bi-annual status reports.

Injunction Number: 20
Project: Fall Creek (Spring Operation)

Measure Description
Fall Creek Reservoir will refill from streambed level to El. 700 ft starting January 16 and will be held at that level until March 15, except as needed for flood control or sediment management.[5] Refill will begin on March 16 to El. 728 ft and maintained at that level or higher from April 15–May 15 to ensure operation of the adult trap. After May 15, sufficient discharge from the reservoir will be provided to operate the adult trap through September while refilling the reservoir to the extent possible.

Biological Goal
The overall goal is to establish a self-sustaining population of spring Chinook salmon upstream of Fall Creek Dam. The goal of this delayed refill operation is to provide downstream fish passage and high survival for juvenile spring Chinook salmon through Fall Creek Reservoir and past Fall Creek Dam.

The target fish for the spring operations would be salmon fry and subyearlings that migrate downstream in late winter and spring, and yearlings that migrate downstream from winter through spring.

Management Purpose
The primary objective of this measure is to provide safe and timely passage for young-of-year juvenile Chinook salmon that enter Fall Creek reservoir such that they may avoid extended reservoir residence and express their natural life-history strategy.

The metrics of interest include juvenile Chinook salmon passage timing with an emphasis on fry. Metrics such as passage survival and contribution to adult returns will be long-term. Other metrics such as forebay behavior (once the reservoir is raised to 728 and higher) and distribution, and route distribution may not be directly measured for fry migrants but techniques such as sonar could be used to investigate behavior.

Objectives and Methods for Juvenile Fish Passage
1. Passage timing
    a. Operate rotary screw traps upstream of the reservoir and downstream of the dam.
    b. Estimate the number of juvenile salmon caught in each trap if trap catch is sufficient.
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
        ii. Use wild salmon captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon

[5] In follow-on years, the reservoir may be held at lower elevations for longer periods of time and once more information has been collected.

although their behavior and size may introduce bias in the estimates (fish are separate from dam passage efficiency fish).

iii. Sum weekly estimates to derive total abundance during peak migration.

iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.

v. Compare abundance of fish entering the reservoir and abundance leaving.

vi. Compare entry and passage abundance to previous estimates.

c. If possible, mark or tag up to 1,000 fry per week in February–April (Note: Goal is to have monthly or bi-weekly batches; a single batch is still important). Multiple mark or tagging techniques for juveniles <65mm need to be assessed for applicability to this study.
    i. Monitor tag injury, tag retention, and mortality by holding a sample of fish for observation.
    ii. Scan fish caught in traps downstream of the dam for tags.
    iii. Continue to mark or tag fry and subyearlings in May and June to study passage timing during and shortly after full refill.

d. PIT tag all salmon (≥65 mm) caught in the rotary screw trap upstream of Fall Creek Reservoir in late winter and spring to measure passage timing at the dam (and to provide information on passage rates and passage survival).

2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through Fall Creek Dam
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants (ensure all PIT-tagged fish are measured). The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam. Collect and catalogue scales of yearling migrants to provide reference sample for stream-reared juvenile salmon.
    b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions.
    c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
    d. When fish are available, hold a sample of juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week); note that this direct measure of delayed mortality supplements assessments through tagging and downstream sampling. Fish for the test could be held at the Fall Creek adult fish facility or other site and would be monitored and recorded for 24–48 hours.

3. Passage rate and survival
    a. Estimate passage rate and survival of tagged fish (1c –1d) and compare results to previous years.
    b. Tag and release experimental groups of juvenile hatchery salmon <65 mm in upstream end of reservoir or in lower Fall Creek (Specific number and methodology will be developed and may not be implemented until spring 2023. Below is an <u>example</u> approach.).

        i. Release 5,000–10,000 batch-marked hatchery production fry in the upper end of the reservoir or in lower Fall Creek in February prior to start of refill, and 5,000–10,000 batch-marked fry in the upper end of the reservoir or in lower Fall Creek in late March or early April prior to reaching initial refill target of El. 728 ft.
        ii. Investigate batch marks for use with fry and smaller subyearlings. Priority would be for marks that allow identification of individual release groups. Mark fish in a hatchery setting 2–3 weeks prior to release. Mark extra fish to account for mortality. Hold a sample of fish to monitor long-term mortality or injury from tagging, and to document long-term visibility of tags or marks.
        iii. Evaluate passage rate of each batch-marked group by capture in the downstream trap.
        iv. An alternative batch mark would be with parentage-based genetic marking.
    c. Tag and release experimental groups of surrogate salmon or juvenile hatchery salmon >65 mm upstream and downstream of dam. Note that final numbers will be developed when a study plan is written and will depend on availability of surrogate fish and other juvenile hatchery salmon.
        i. Release 2,000 PIT-tagged juvenile salmon into Fall Creek Reservoir or lower Fall Creek in February prior to the beginning of the refill, along with 1,000 PIT-tagged juvenile salmon downstream of Fall Creek Dam (numbers will be adjusted based on surrogate fish availability).
        ii. Release 2,000 PIT-tagged juvenile salmon into Fall Creek Reservoir in late April to mid-May after refill is completed and adult fish ladder is operating, along with 1,000 PIT-tagged juvenile salmon downstream of Fall Creek Dam (numbers will be adjusted based on surrogate fish availability).
        iii. Supplemental releases of PIT-tagged juvenile hatchery fish as available:
            1. 3,000 at head of reservoir or in lower Fall Creek in February prior to refill.
            2. 3,000 at head of reservoir in late April to mid-May after initial refill.
4. Outplant success and origin of juvenile salmon.
    a. Collect tissue samples of juvenile salmon collected in the trap upstream of the reservoir.
    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
    c. Collect tissue samples of juvenile salmon collected downstream of dam.
    d. Analyze samples to determine parentage of juveniles and compare to samples taken from migrants entering the reservoir.
5. Estimate overall dam passage survival of juvenile Chinook salmon passing Fall Creek Dam with PIT-tagged fish.
    a. Estimates of survival during delayed refill phases based on experimental releases.
    b. Estimates of overall survival of juvenile salmon tagged at the upstream trap.
    c. Compare timing and survival to previous studies
6. Estimate reach survival of PIT-tagged fish following passage at Fall Creek Dam downstream to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.

7. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.

Objectives for Downstream Water Quality

1. Determine relationship between Fall Creek operations and downstream water temperature regimes for spring operations.
2. The elevation chosen to pass fish is not expected to modify suspended sediment or change DO below Fall Creek Dam, based on previous observations, thus turbidity and DO monitoring during the spring operation is not necessary.

Lookout Point

Injunction Number: 17
Project: Lookout Point Dam – Spring spill

Measure Description
Beginning 2022, the Corps shall conduct spring spill operations at Lookout Point Dam and Dexter Dam. Starting as early in March as possible, and once Lookout Point Reservoir elevation reaches 2.5 feet over spillway crest (El. 890 ft.), continuous, ungated will be maintained for as long as water conditions allow. Continuous (gated) spill will be maintained at Dexter Dam as long as downstream conditions allow. Spill operations will be implemented continuously (24/7) for at least 30 days at both projects. After the 30-day continual ungated spill operation, transition to a nighttime, gated spill operation with generation during the day at Lookout Point and Dexter for as long as water is available and downstream conditions allow.

Biological Goal
The overall goal is to establish a self-sustaining population of spring Chinook salmon upstream of Lookout Point Dam. The goal of this measure is to provide volitional passage for juvenile salmon at Lookout Point Dam in spring with high passage efficiency, and high immediate and long-term survival. Safe, timely, and effective passage includes minimizing juvenile residence time in Lookout Point reservoir. Objectives of the spring spill are twofold: first to reduce residence time in Lookout Point Reservoir. This will subsequently reduce the risks of predation and copepod infestation by increasing migration rates through the reservoir. Second, to increase passage survival at the dams. At a larger scale, an objective of the spring spill is to increase survival of juvenile salmon below Dexter Dam.

The target fish for the spring operations would be salmon fry, subyearlings, and stream-reared yearlings that enter the reservoir in late winter and spring; and subyearlings that entered the reservoir in the previous winter–fall and remained through the winter.

Management Purpose
Provide operations that minimize reservoir rearing time and reduce turbine passage for juvenile Chinook salmon at Lookout Point and Dexter dams. Determine if downstream fish passage conditions through Lookout Point Reservoir and at Lookout Point and Dexter dams have improved compared to previous operations as a result of implementing this operation. Compare passage of juvenile Chinook salmon

under 30-day continuous spill to that under nighttime spill. RM&E should be prioritized to understand active outmigration versus reservoir use. Because a focus of the spring operations is to provide passage for salmon fry and small juveniles (<65 mm), use of PIT tags and active tags would be limited to estimating passage of larger fish (yearlings entering the reservoir and reservoir residents that remained through fall and winter). *See* Supplemental Information in Appendix for estimated numbers and lengths of fish captured in previous years.

To address these objectives, general research questions are:

- What is the travel time of juvenile salmon from reservoir entry to the forebay during conditions of spring spill and how does it compare between continuous spill and nighttime spill, and to previous years with limited or no spill?
- What is the passage rate and passage survival of juvenile salmon during spring spill and how does it compare between continuous spill and nighttime spill, and to years with limited or no spill?

The metrics of interest include migration timing into the reservoir, migration timing through the reservoir, size at passage, dam passage rates and passage survival.

<u>Objectives and Methods for Juvenile Fish Passage</u>

1. Passage timing Passage
    a. Operate rotary screw traps upstream of the reservoir and downstream of the dam.
    b. Estimate the number of juvenile salmon caught in each trap. [6]
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
        i. Use wild subyearlings captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates.
        ii. Investigate the potential to develop an abundance index under different flows. Because previous efforts have been unsuccessful in estimating efficiency of traps upstream of Lookout Point Reservoir due to low recapture rates, an effort should be made to develop an alternative approach such as an index of abundance based on factors such as catch, size of fish, and flow.
        iii. Compare abundance of fish entering the reservoir and abundance leaving.
        iv. Compare entry timing and passage abundance under 30-day spill to that under nighttime spill.
        v. Compare entry timing and passage abundance to previous estimates.
    c. If possible, mark or tag up to 1,000 fry per week in February–April (Note: Goal is to have monthly or bi-weekly batches (a single batch is still important).
        i. Monitor tag injury, tag retention, and mortality by holding a sample of fish for observation.
        ii. Scan fish caught in traps downstream of the dam for tags.

[6] Trap efficiency was unable to be estimated during previous studies. Therefore, alternative methods of comparing trap catch between locations and among years may include factors such as number of outplanted fish and redds, flow, size of juvenile salmon caught in traps, etc.

    iii. Continue to tag fry and subyearlings in May and June to study passage timing during and shortly after refill (*see also* tagging under Measure 14).

d. PIT tag all yearling salmon (≥65 mm) caught in the rotary screw trap(s) upstream of the reservoir to measure passage timing at the dam (and to provide information on passage rates and passage survival).
e. When practicable incorporate naturally produced subyearling salmon into an ongoing active tag study in the basin to provide information on passage rates, passage routes, and passage survival.
f. Compare passage timing for PIT-tagged fish relative to time and size when they entered the reservoir or were captured in the reservoir, and relative to spill operations.
g. Evaluate reservoir behavior and passage timing for fish with active tags relative to spill operations.
h. Implement a study of longitudinal distribution of juvenile Chinook salmon within the reservoir. Sampling should follow the timing and location of previous studies to provide a basis for comparing fry and subyearling distribution relative to spill operations and reservoir conditions. (Note: 2022 study design and possible pilot study with implementation in 2023 based on 2022 design and study results, if available.) Study should include some of the activities listed below.
    i. Enumerate and measure juvenile salmon caught in traps. Record data on location, date, and condition including copepod infestation.
    ii. Scan fish for batch marks or tags (*see* 1c) and PIT tags (*see* 1d and 3bv–3bvi).
    iii. Enumerate and measure any captured fish with a batch mark, noting date and location (*see* 3bi and 3bii).
    iv. Fish <65 mm could be marked with elastomer tags or other mark, using different colors or body locations to delineate either location within the reservoir or month. Tag color and/or body location would be distinct from those used under activities 3bi and 3bii.
    v. Fish ≥65 mm could be PIT tagged and associated data will be collected on fish length, date, location, etc.
    vi. Calculate longitudinal distribution of juvenile salmon in the reservoir using methods of Monzyk et al. (2015 and other years).
    vii. Compare longitudinal distribution of juvenile salmon between 30-day continuous spill and nighttime spill.
    viii. Compare distribution to previous years and previous operating conditions.
    ix. Investigate methods for estimating an abundance index of juvenile salmon within longitudinal reservoir zones (methods need to account for open population with fish entering and exiting the reservoir during certain times of year).
i. Compare passage timing for marked fish relative to time and size when they entered the reservoir.
j. Compare passage timing for marked and unmarked fish under the 30-day continuous spill and nighttime spill operations.
k. Compare passage timing for marked and unmarked fish to that under previous operating conditions.

2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through the Lookout Point Dam under the different spill operations (30-day continuous spill v. nighttime spill).
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants. The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam. Ensure all PIT-tagged fish are measured.
    b. Compare size of fish caught in upstream and downstream traps, and in reservoir traps.
    c. Compare size of fish passing the dam under the 30-day continuous spill and nighttime spill, and to data collected under previous operating conditions.
    d. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
    e. When fish are available, hold juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week). Fish for the test could be held at the Dexter adult collection facility or at Willamette Hatchery and would be monitored and recorded for 24–48 hours.
    f. Collect and catalogue scales from a sample of juvenile salmon captured in the upstream trap(s) to provide a brood year reference collection for identifying stream-reared yearlings in returning adult salmon, and to verify the age class of captured fish, with selective sampling at sizes where age classes may overlap.
3. Passage rate and survival. Juvenile salmon for experimental releases maybe limited due to a reduced egg take at Willamette Hatchery in Fall of 2021. Spring spill operations will continue at least through the summer of 2024. Because experimental releases of fish will be important for evaluating the effect of spill operations on passage of fry and subyearling salmon and of yearling salmon, the Corps will work with ODFW, OSU, and/or contractors each year to provide sufficient numbers of surrogate fish and well as sufficient sampling gear and traps for future studies.
    a. Estimate passage rate using expanded trap catches and marked and unmarked fish (*see* 1b and 1c). Incorporate information from nearshore sampling within the reservoir to supplement passage rate estimates. Compare results between continuous spill and nighttime spill, and to previous years. Because relatively small numbers of juvenile salmon have been caught in rotary screw traps in previous years, the primary source of passage rate will likely be from experimental releases of surrogate Chinook salmon or juvenile hatchery salmon. Large releases of marked fish may be required because of generally low catch of juvenile salmon in traps downstream of Lookout Point Dam, and future studies might include genetically based tagging (*see* Supplemental Information in Appendix).
    b. Tag and release experimental groups of surrogate Chinook salmon or juvenile hatchery salmon upstream and downstream of dam. Specific number and methodology will be developed and may not be implemented until spring 2023. Below is an example approach (*see also* Supplemental Information in Appendix).
        i. Release 5,000–10,000 batch-marked surrogate fry or hatchery production fry in the upper end of the reservoir prior to the start of the 30-day continuous spill (early March).

ii. Release a second group of 5,000–10,000 batch-marked fry in the upper end of the reservoir after the 30-day spill period. The second group should be released at or near the beginning of the nighttime spill operations.
iii. Batch mark release groups with distinctly colored elastomer tags or other mark. Mark fish in a hatchery setting 2–3 weeks prior to release. Mark extra fish to account for mortality. Hold a sample of fish to monitor long-term mortality or injury from tagging, and to document long-term visibility of tags.
iv. An alternative batch mark would be with parentage-based genetic marking (*see* Supplemental Information in Appendix).
v. Evaluate passage rate of each batch-marked group by capture in downstream traps. Supplement with data on longitudinal distribution of juvenile salmon in the reservoir (*see* 1h) to determine the effect of spring operations on the distribution of juvenile salmon.
vi. PIT-tag all yearling salmon captured in the upstream trap(s) and in reservoir traps.
vii. Release PIT-tagged juvenile salmon to evaluate effect of spring operations on larger juvenile salmon in the reservoir (stream-reared and reservoir-reared yearlings). Specific number to be released in spring 2022 and future years will depend on availability of both surrogate fish and other juvenile hatchery salmon. If available, conduct two separate releases prior to beginning of the 30-day continuous spill and at the beginning of the nighttime spill as follows:
    1. 5,000 at head of reservoir.
    2. 5,000 in forebay.
    3. 2,000 downstream of dam.
viii. Supplement PIT-tagged releases with release of active-tagged juvenile hatchery salmon in head of reservoir and forebay if tags are available and can be coordinated with concurrent reservoir releases. Releases would be timed to evaluate the two spill operations.

4. Outplant success and origin of juvenile salmon.
    a. Collect tissue samples of juvenile salmon collected in the trap upstream of the reservoir for genetic analysis.
    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
    c. Collect tissue samples of juvenile salmon collected in traps downstream of dam.
    d. Analyze samples to determine parentage of juveniles relative to outplant time, location (within North Fork Middle Fork and between that tributary and upstream of Hills Creek reservoir), family group, etc.
    e. Analyze backlog of pedigree samples to allow updated analysis of outplanting success.
5. Estimate route-specific and overall dam passage survival of juvenile Chinook salmon passing Lookout Point Dam from fish with active and PIT tags.
6. Estimate reach survival of PIT-tagged fish following passage at Lookout Point and Dexter dams downstream to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.

7. Estimate reach survival of active-tagged fish after passage at Lookout Point and Dexter dams by deploying arrays downstream of Dexter Dam.
8. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public.

Objectives for Downstream Water Quality

Spill at Lookout Point and Dexter Dams increases TDG concentrations and affect water temperatures in the Middle Fork Willamette River downstream. These and other water quality characteristics are continuously monitored at USGS Station No. 14150000.

1. Continuously monitor water temperature and TDG at the USGS Station No. 14150000 throughout the juvenile passage spill operation and manage the operation in real time to minimize exceedances of the State water quality standard. The frequency that this target is exceeded and how efforts to meet the target affected the spill rate will be discussed in the status reports.
2. Determine relationship between Lookout Point/Dexter spill operations and downstream water temperature and total dissolved gas regimes.

Hills Creek

Injunction Number: 8d
Project: Hills Creek Dam

Measure Description
Beginning in fall 2020, the Corps will implement regulating outlet spill operations daily from 6:00 PM to 10:00 PM at Hills Creek Dam when the reservoir elevation is less than or equal to 50 feet over the turbine intakes (expected to occur by December 1) through March 1.

Biological Goal
The overall goal is to establish a self-sustaining population of spring Chinook salmon upstream of Hills Creek Dam. The goal of this drawdown operation is to provide downstream fish passage and high survival for juvenile spring Chinook salmon through Hills Creek reservoir and dam.

Management Purpose
Operate Hills Creek Dam in a manner that reduces reservoir holding time and increases passage survival for juvenile salmonids. The metrics of interest for biological monitoring include juvenile Chinook salmon passage timing, passage rates, and passage survival.

Adult Chinook salmon were not outplanted upstream of Hills Creek Dam in 2021. Therefore, effectiveness of the measure cannot be fully evaluated for this cohort in winter-spring 2022 (for fry) or winter-spring 2023 (for fall migrants, spring yearling migrants, and reservoir residents). However, juvenile salmon from previous outplants would be present and studies could be conducted in winter-spring 2023 with experimental releases. These studies should be conducted in a manner that will allow identification of juvenile salmon from Hills Creek Reservoir in traps upstream of Lookout Point Reservoir, traps within the reservoir, and traps downstream of Lookout Point Dam. The following are studies that could be done to evaluate the effectiveness of passage operations at Hills Creek Dam.

<u>Objectives and Methods for Juvenile Fish Passage</u>

1. Passage timing
    a. Operate rotary screw traps upstream of Hills Creek Reservoir and downstream of the dam.
    b. Estimate the number of juvenile salmon caught in each trap if trap catch is sufficient.
        i. Determine trap efficiencies at least once a month under a range of flows expected to occur during the measure.
        ii. Use wild salmon captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery salmon although their behavior and size may introduce bias in the estimates (these fish are separate from dam passage efficiency fish).
        iii. Sum weekly estimates to derive total abundance during peak migration.
        iv. Investigate the potential to develop an abundance index using numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration.
        v. Compare abundance of fish entering the reservoir and abundance leaving.
        vi. Compare entry and passage abundance to previous estimates.
    c. Based on outmigration data from trapping upstream of Hills Creek Reservoir and changes in operations to provide passage opportunities attuned to outmigration peaks, determine the need to sample within Hills Creek Reservoir to determine the seasonal distribution of juvenile salmon, growth rates of juvenile salmon, condition of juvenile salmon (e.g., copepod infestation), species composition within the reservoir, and potential predation (species and relative abundance of predators). Investigations would also study the effect of reservoir operations for juvenile salmon passage on the resident bull trout population. Reservoir studies should include the following:
        i. Enumerate and measure juvenile salmon caught in traps. Record data on location, date, and condition including copepod infestation.
        ii. Scan fish for marks or tags (from trapping or in-stream sampling upstream of the reservoir).
        iii. Enumerate and measure any captured fish with a batch mark, noting date and location.
        iv. Fish <65 mm could be marked with batch mark that would be distinct from those used for experimental releases in the reservoir.
        v. Fish $\geq$65 mm would be given a PIT tag and associated data will be collected on fish length, date, location, etc.
        vi. Calculate longitudinal distribution using methods of Monzyk et al. (2015 and other reports).

        vii. Compare distribution to any previous studies and under previous operating conditions.
        viii. Investigate methods for estimating an abundance index of juvenile salmon within longitudinal reservoir zones (methods need to account for open population with fish entering and exiting the reservoir during certain times of year).
    d. PIT tag all salmon (≥65 mm) caught in the rotary screw trap upstream of Hills Creek Reservoir beginning in summer and fall to measure passage timing at the dam (and to provide information on passage rates and passage survival).
    e. Compare passage timing for PIT-tagged fish relative to time and size when they entered the reservoir.
    f. Compare passage timing for tagged and untagged fish to that under previous operating conditions.

2. Passage size and condition: estimate size and condition for juvenile Chinook salmon passing through Hills Creek Dam
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide length frequency of outmigrants (ensure all PIT-tagged fish are measured). The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam. Collect and catalogue scales to provide reference sample for stream-reared juvenile salmon.
    b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions, if available.
    c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
    d. When fish are available, hold a sample of juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week); note that this direct measure of delayed mortality supplements assessments through tagging and downstream sampling. Fish for the test could be held at Willamette Hatchery and would be monitored and recorded for 24–48 hours.
3. Passage rate and survival
    a. Estimate passage rate and survival of fish with marks or tags from upstream traps (1c – 1d) and compare results to previous years.
    b. Tag and release experimental groups of small juvenile hatchery salmon upstream of Hills Creek Reservoir (specific number and methodology would be developed; below is an example approach).
        i. Release 5,000–10,000 batch-marked hatchery salmon fry in the upper end of the reservoir in late February or early March, timed with observed fry migration based on trapping data and during RO operations. Release a second group of 5,000–10,000 batch-marked fry in the upper end of the reservoir in late March–May to match peak to late fry migration and post-RO operations. Note that if operations are changed then releases would be timed to evaluate the effectiveness for juvenile salmon passage.

ii. Investigate batch marks for use with fry and small subyearlings. Priority would be for marks that allow identification of individual release groups. Mark fish in a hatchery setting 2–3 weeks prior to release. Mark extra fish to account for mortality. Hold a sample of fish to monitor long-term mortality or injury from tagging, and to document long-term visibility of tags or marks.
iii. Evaluate passage rate of each batch-marked group by capture in downstream traps, including trap(s) upstream of Lookout Point Reservoir. Supplement with data on longitudinal distribution of juvenile salmon in the reservoir (1c) to determine the effect of dam operations on the distribution of juvenile salmon.

c. Tag and release experimental groups of surrogate Chinook salmon (≥65 mm) upstream and downstream of Hills Creek dam. Specific number to be released would depend on availability of surrogate fish or other juvenile hatchery salmon. Release strategies would depend on the timing of operations designed to provide passage for juvenile salmon.
   i. Release PIT-tagged juvenile salmon to evaluate effect of Hills Creek Dam operations In winter–spring on passage of larger juvenile salmon in the reservoir (stream-reared and reservoir-reared subyearling fall migrants and spring yearling migrants). If available, conduct separate releases timed to operational stages. For example, one group would be released in November prior to beginning of RO operations and a second group would be released in early February during the late phase of RO operations. Below are example releases and numbers would be adjusted based on availability of test fish:
      1. 2,000 each at head of reservoir prior to and before end of passage operations
      2. 2,000 each in mid-reservoir or near forebay prior to and before end of passage operations
      3. 1,000 each downstream of dam prior to and before end of passage operations
   ii. When practicable incorporate naturally produced subyearling salmon into an ongoing active tag study in the basin to provide information on passage rates, passage routes, and passage survival.

   ii. Supplemental releases of PIT-tagged juvenile hatchery fish from production groups would be made as available to increase sample size for robust estimates:
      1. 3,000–5,000 each at head of reservoir prior to and before end of passage operations.
      2. 3,000–5000 each in mid-reservoir or forebay prior to and before end of passage operations.
      3. 3,000–5000 each downstream of dam prior to and before end of passage operations.

d. PIT-tag all juvenile salmon ≥ 65 mm captured in the downstream trap that do not have tags. Condition of fish will be noted at time of tagging (descaling, loss of protective mucous, copepod infestation).

4. Outplant success and origin of juvenile salmon.
   a. Collect tissue samples of juvenile salmon collected in the trap upstream of the reservoir.

    b. Analyze samples to determine parentage of juveniles (wild/hatchery, outplant time and location).
    c. Collect tissue samples of juvenile salmon collected in traps downstream of dam.
    d. Analyze samples to determine parentage of juveniles and compare to samples taken from migrants entering the reservoir.
5. Estimate diel passage and overall dam passage survival of juvenile Chinook salmon passing Hills Creek Dam with PIT-tagged fish.
    a. Estimates of survival during passage operations based on experimental releases.
    b. Estimates of overall survival of juvenile salmon tagged at the upstream trap.
6. Estimate route-specific and diel passage, and overall dam passage survival of juvenile Chinook salmon passing Hills Creek Dam with active-tagged fish (if available).
7. Estimate reach survival of PIT-tagged fish following passage at Hills Creek Dam downstream to Lookout Point Reservoir (upstream and in-reservoir traps), to Lookout Point Dam (below dam trap) and to Willamette Falls. Other reach survivals may be possible if additional PIT tag detection is implemented such as hydrofoil arrays or modular flexible arrays.
8. Estimate reach survival of active-tagged fish (if released in reservoir) after passage at Hills Creek Dam by deploying receiver arrays downstream (may be done in conjunction with active tag study in Lookout Point Reservoir).
9. All studies will be presented in detailed and timely reports of methods, results, and discussion with comprehensive appendices of data and analyses details. Reports will be posted where they are available to the public and easily accessible.

Other Considerations

The Corps will continue to work with the USFWS and Bull Trout Working Group to determine and implement monitoring to assess bull trout impacts and benefits from these operations.

Objectives for Downstream Water Quality

By spilling water, this action could elevate TDG in Hills Creek downstream. The USGS station downstream from Hills Creek Dam (Station No. 14145110) does not currently have a TDG meter. The Corps will fund USGS to add TDG data collection at that site in 2022. Monitoring will occur year-round and during spill operations to determine whether this measure causes exceedances to the State water quality standard, in which case the operation may be modified. A larger study may be appropriate if adverse TDG effects are identified.

1. A synopsis of the TDG and water temperature data collected, and adaptive management measures taken will be provided in the first semi-annual status report following measure implementation and annually thereafter.

Appendix

Template for guiding the development of monitoring plans

The following template was developed to outline a full-scale monitoring plan that would include all phases of establishing self-sustaining populations of salmon and steelhead upstream of dams in the upper Willamette River Basin (UWR). Establishment of populations upstream of dams is a critical component in the recovery of these federally listed species.

The Expert Panel used the template to develop monitoring plans for injunction measures, with modifications as needed to meet specifics of the measures and associated dam operations.

Overarching goal: Establish self-sustaining populations of spring Chinook salmon and winter steelhead in historic habitat upstream of UWR dams.

Long-term standards for reintroductions

1. Establish abundance targets for each population and for the aggregate population
    a. Historic number within each subbasins
    b. Proportion believed to be in habitat upstream of dams
    c. Recovery and self-sustaining targets for each population
    d. Intermediate targets used to gauge progress
2. Monitor adult returns
    a. Relative to targets (recovery and intermediate)
    b. Relative to UWR run and trend (Willamette Falls counts) to assess progress within each subbasin compared to the overall run and trend
    c. Relative to Clackamas run and trend as measure of progress compared to the lower Willamette River population
3. Confirm origin of adult returns via pedigree analysis to assess status of achieving self-sustaining populations
4. Monitor other population attributes to assess status of maintaining healthy and diverse populations to provide persistence and resilience. Compare attributes to historic data.
    a. Age composition – historic populations generally had higher proportion of older ages than in current returns
        i. Document with scale analysis
        ii. Collect samples throughout run and throughout range – compare among and within subbasins (within comparisons might be above and below dams, or among watersheds in a subbasin)
    b. Life history diversity
        i. Monitor adult and juvenile populations to assess presence or absence of known life history types
        ii. Monitor adult and juvenile populations to document expression of life histories as a result of various recovery measures
    c. Sex ratio – maintain historic range

Monitoring Template

The objective of the monitoring template is to identify and outline individual components of reintroduction phases to provide data necessary to assess success, to identify problems, to test hypotheses and assumptions, and to implement adaptive management. An important function of the template is to provide a framework for evaluating dam and reservoir operations that are intended to provide successful passage for juvenile salmon or steelhead. Additional monitoring is included to assess the passage and/or rearing of juvenile and adult salmon and steelhead downstream of UWR dams.

The template is organized by life stage starting with adults. It includes a list of components or factors that could be monitored, examples of methodology or techniques, and examples of strategies or objectives. Additional details of certain methodologies are appended.

A. **Adult outplants** - monitoring components for initial phase and established phase
   1. Return timing – maintain natural timing, reduce delay below dams/traps
   2. Condition – minimize thermal exposure, reduce pathogen load (by reducing delay below dams/traps; transporting fish regularly)
   3. Handling – reduce stress
   4. Transport – reduce stress
   5. Release – sites with good water quality, holding pools, ability to disperse for spawning
      a. Mark or tag outplants to identify release group by date, location, etc.
      b. Potential use of active tags in subsample of adults to track dispersal (control for potential effects of tags on survival and dispersal)
      c. Collect water quality data
   6. Holding before spawning – minimize harassment, provide good holding habitat
      a. Monitor release sites
      b. Identify habitat improvement projects to improve or create holding pools
   7. Spawning upstream of dams – distribution of adults and redds, success (mortality)
      a. Collect carcasses to document spawning success based on retention of eggs in females and mortality in males prior to spawning season (pre-spawning mortality)
      b. Document distribution and spawning success relative to outplant group (location, date) by recovering or tracking tagged fish
      c. Collect and catalogue tissue samples for pedigree analysis
   8. Spawning downstream of dams
      a. Collect and catalogue tissue samples for pedigree analysis (returning adults may remain downstream of dams)

B. **Progeny from outplants –** migration from stream to reservoir
   1. Life history
      a. Sample juvenile fish upstream of reservoir (pole seine, snorkel seine, electrofishing, in-stream fyke nets)
      b. Collect data on size and age classes of juvenile salmon and steelhead

   c. Collect data to estimate egg to fry or fingerling survival and associated environmental variables (flow, temperature, sediment load) and density (number of spawners)
   d. Collect and catalogue scales for reference of stream-rearing fish (to identify these in returning adults)
   e. Collect and catalogue tissue samples for early analysis of outplant success (which adults produced stream-rearing juveniles)
   f. Establish indicator sites for repeat sampling to monitor instream movement/migration and growth (sites near redds and downstream of spawning areas if there is spatial segregation)
   g. Collect data on habitat preferences and availability, identify potential habitat improvement projects to increase carrying capacity
   h. PIT tag juvenile salmon or steelhead >65 mm
2. Outmigrant timing and behavior
   a. Operate rotary screw traps near head of reservoir
   b. Estimate abundance with trap efficiency estimates or mark-recapture estimates if operating two spatially separated traps
      i. Determine efficiencies of traps weekly across range of flows. Tests should be conducted frequently enough to assess the effect of factors such as fish size and stream flow on efficiency, and at least monthly unless flow and fish size remained unchanged for extended periods of time.
      ii. Use wild salmon or steelhead captured in traps to estimate efficiency. If too few fish are caught, then efficiency could be estimated with juvenile hatchery fish although their behavior and size may introduce bias in the estimates
      iii. Sum weekly estimates to derive total abundance during peak migration
   c. Investigate development of abundance index for use when trap catch is too low for efficiency estimates using potential factors such as numbers of fish caught, size, and flow to supplement estimates derived from trap efficiencies, to provide an approximate index to determine timing, and to provide a potential method for approximating abundance during periods of relatively low migration
   d. Analyze potential factors affecting abundance – density of spawners; incubation, emergence, rearing conditions such as water temperature and flow
   e. Collect data on size and age classes of juvenile salmon and steelhead
   f. Collect and catalogue scales for reference of stream-rearing fish
   g. Collect and catalogue tissue samples for early analysis of outplant success (which outplants produced successful migrants)
   h. Scan fish for tags or marks put on upstream
   i. Tag or mark fish for juvenile passage studies.

C. **Juvenile passage** – establish standards (reservoir-forebay; dam passage effectiveness and rate; dam passage survival; survival to Willamette River/Willamette Falls); *see* appended information on marking and tagging options

1. Passage timing – minimize residency; increase migration rate; assess measures to attract juvenile fish to forebay (drawdown, spill)
    a. Purpose: provide baseline information for evaluating effect of operations on passage; compare timing & size of fish entering the reservoir to that exiting.
    b. Primary method: rotary screw traps upstream of reservoir. Operate traps to collect fish entering reservoir (*see* **B.2**: mark, tag; numbers, timing, size).
    c. Operate traps downstream of dams to collect information on timing of juvenile salmon and steelhead exiting the reservoir (*see* **B.2**).
    d. Supplemental methods include sampling within reservoir (**C.1.e** below) and controlled experimental releases (in conjunction with passage rate and passage survival studies – *see* **C.3**)
    e. Sample within reservoir to determine longitudinal distribution relative to dam operations and to previous reservoir studies. Reservoir sampling is an important tool to evaluate the effect of operations on distribution and migration of juvenile salmon and steelhead <65 mm that are too small for PIT tags or active tags.
        i. Purpose: evaluate effect of operations on migration of juvenile salmon and steelhead through reservoirs; assess effectiveness in meeting objective of minimizing residence time in reservoir.
        ii. Enumerate and measure any captured fish with a batch mark, noting date and location (from trapping or in-stream sampling upstream of the reservoir).
        iii. Fish <65 mm could be marked with batch mark that would be distinct from those used for experimental releases in the reservoir.
        iv. Fish >65 mm can be marked with PIT tags
        v. Calculate longitudinal distribution (e.g., Monzyk et al. 2015).
        vi. Compare distribution relative to operations and to previous studies and operating conditions.
        vii. Investigate methods for estimating an abundance index of juvenile salmon or steelhead within longitudinal reservoir zones (methods need to account for open population with fish entering and exiting the reservoir during certain times of year).
        viii. Other data collected could include species composition within the reservoir and potential predation (species and relative abundance of predators). Other studies could investigate the effect of reservoir operations for juvenile salmon and steelhead passage on bull trout population, if present.
2. Passage size and condition – estimate size and condition for juvenile Chinook salmon passing through reservoirs and dams
    a. Measure (fork length) each fish caught in upstream and downstream traps or a randomized sample of fish throughout outmigration period to provide

length frequency of outmigrants. The purpose of this metric is to provide information about the life history of the juvenile salmon passing the dam. Collect and catalogue scales to provide reference sample for stream-reared juvenile salmon.

   b. Compare size of fish caught in upstream and downstream traps, and to data collected under previous operating conditions, if available.
   c. Record condition of captured fish outmigrating from the reservoir including degree of de-scaling, injuries, degree of copepod infestation, etc.
   d. When fish are available, hold a sample of juvenile salmon caught in the trap every week to directly assess delayed mortality (aim for 30–50 fish per week); note that this direct measure of delayed mortality supplements assessments through tagging and downstream sampling. Fish for the test could be held at a hatchery, adult trap facility, or other site and monitored and recorded for 24–48 hours.

3. Passage rate and survival through reservoirs and dams – assess passage effectiveness, rate, and survival
   a. Purpose: evaluate effect of operations on passage rate and survival of juvenile salmon and steelhead at dams.
   b. Estimate passage rate and survival of fish with marks or tags from upstream traps (upstream of reservoir and in-reservoir) and compare results to previous years and operating conditions.
      i. May or may not provide direct measure of passage rate/survival depending on release numbers and date relative to operational date
      ii. Provides data on effect of operations on naturally produced progeny of outplanted adult salmon or steelhead
   c. Primary method: Mark or tag and release experimental groups of salmon or steelhead upstream dams. Fish used for studies could be surrogate fish raised to approximate the size of naturally produced salmon or steelhead, or juvenile hatchery salmon from production groups or extra egg takes (note there is no hatchery winter steelhead program in the Willamette Basin). Specific numbers, release location, size of fish, and other study variables will depend on study questions related to operational measures, availability of marking or tagging options, availability of fish, physical attributes of reservoir and dams, ability to track or detect study fish, etc.
   d. Estimate survival of juvenile salmon and steelhead passing dams including (where applicable) route-specific estimates (e.g., spillway v. turbine), diel passage and associated survival, and delayed mortality.
   e. Assess factors affecting dam passage survival including route, size of fish, condition of fish, injury associated with passage, and other factors.
   f. Estimate reach survival downstream of dams based on PIT tags or active tags to assess long-term survival. If possible, reach survival should be evaluated to the Willamette River and to Willamette Falls. Ability to estimate reach survival will depend on the ability to track or detect tags downstream and efforts should be made to increase tag detection in the upper Willamette River Basin.

D. **Juvenile salmon and steelhead rearing, migration, and life history downstream of dams** – establish and implement monitoring protocols for investigating factors affecting long-term survival in reaches downstream of UWR projects with the objective to identify potential limiting factors, seasonal habitat use by different life histories, seasonal and reach survival, and potential to increase capacity and survival. Studies could include the following:
   1. Sample juvenile salmon and steelhead across a range of habitats and seasons. Sample in spawning tributaries below and mainstem habitats. Develop techniques to capture and tag (or mark) migrating juvenile salmon and steelhead including rotary screw traps or traps installed at small dams, diversion canals, or other locations.
   2. Collect information on marked or tagged fish originating from reservoir and dam studies.
   3. Collect information on growth, migration, habitat use, and survival.
   4. Collect biological information such as scales and tissue samples to identify life histories, origin, and provide reference collection for interpreting adult life history through scale analysis.
   5. Representatively collect otoliths from a subsample of juvenile salmon and develop methods to identify life histories in adults (from collection of otoliths during spawning surveys) that cannot be identified with scales. For example, adult salmon identified as yearling smolts may have variable juvenile life histories such as fry migrants that rear for one year in mainstream habitats, fall migrants that rear in winter in mainstem habitats, and spring migrants that rear most of their life in upper tributary habitats.
   6. PIT tag juvenile salmon and steelhead to determine rearing histories, instream migration, growth, outmigration timing past Willamette Falls, and survival (as an estimate or index).
   7. Capture migrant juvenile salmon and steelhead in spawning tributaries below dams (**D.1**), estimate relative abundance, and PIT tag to survival (as an estimate or survival index). For example, capture and tag fall juvenile salmon to mainstem habitats and estimate overwinter survival, compare with that of juvenile salmon migrating as yearling smolts in spring.

Tagging options

1. Active tag
   a. Uses – best suited for controlled experimental releases
      i. Passage timing
      ii. Diel passage
      iii. Passage route for some operations and dams
      iv. Reservoir migration
      v. Forebay behavior (dam approach behavior)
      vi. Passage rate and short-term survival (quantify number or proportion of fish NOT passing)
      vii. Downstream survival if arrays installed
   b. Limitations

        i. Costly (tags and installation/removal of arrays)
        ii. Larger size of fish – currently >90 mm
        iii. Battery life - 45–65 days for radio tags; 60 days for AT (JSATS)
        iv. Will require training, surgical insertion, holding fish for observation (trained personnel, extra time for tagging, holding fish for 24 hours for mortality and tag rejection)
        v. May not be applicable for tagging naturally produced fish at traps or instream sampling where the number of captured fish is highly variable, unless fish are captured and held offsite until adequate numbers are collected (which could affect migratory behavior). Use of active tags for naturally produced fish captured upstream of reservoirs would generally be done in conjunction with a planned active study in the subbasin using surrogate or juvenile hatchery fish, unless a specific study was planned for naturally produced fish.

2. PIT tag (passive integrated transponder)
    a. Uses – applicable for continuous tagging of naturally produced fish and controlled experimental release studies, assumes capture and manually scanning for tags or detection at installed antenna
        i. Passage timing
        ii. Reservoir migration
        iii. Passage rate and survival (short term and long term, including adult returns)
        iv. Downstream survival if detection systems installed
        v. Less costly than active tags
        vi. Better than active tags for studies requiring large release numbers
        vii. Requires less handling of fish than with active tags and minimal training for tagging and fish can be released immediately
        viii. Can be used in smaller fish than active tags – down to 65 mm for standard tags
        ix. Fish can be continuously tagged and released after capture in traps or other sampling methods
    b. Limitations
        i. Requires installation of PIT detection antennas with limitations on site requirements (e.g., volume and velocity of water)
        ii. Cannot provide route-specific passage information unless passage routes are separated and detection systems are available (e.g., turbine penstock intake v spillway antenna v regulating outlet antenna)
        iii. Point estimates only for reservoir migration, limited information on reservoir behavior or distribution unless in-reservoir sampling results in capture of tagged fish
        iv. No forebay or dam approach behavior unless antenna systems placed in reservoir near the dam

Options for marking small fish

(see Skalski et al. 2019 for review of methods; see Bangs et al. 2013 for field tests of freeze brand, VIE (elastomer), and small PIT tags.)

1. Half-length blank wire tag
    a. Inserted in snout, dorsal sinus, or other body location
    b. Limited application for a single release because specific location difficult to identify in small fish
    c. Would remain detectable without limit, including in returning adults
2. Caudal fin clip (also used for non-lethal tissue sample for genetics)
    a. Can alternate top lobe and bottom lobe for separate release groups
    b. Requires caution in clipping small fish
    c. Limited time that clip would remain visible; dependent on growth and quality of clip
3. Freeze brand
    a. Can be used on different parts or side of the body and with different brand orientations to provide identification of multiple release groups
    b. Limited time that brand would remain visible depending on branding quality, type of brand (simple pattern is best), and growth of fish
    c. Can remain visible and distinct for 4–6 weeks in small (40 mm) juvenile salmon, up to 4 months in larger fish
4. Dye
    a. Can use different colors to identify release groups
    b. Visibility can be very limited (days)
    c. Can cause mortality during immersion
5. Visible Implant Elastomer (VIE)
    a. Can use different colors and different body locations (base of dorsal or anal fins; between caudal fin rays) to identify multiple release groups
    b. Remains detectable for long (examples of 150–900 days)
    c. Requires training and tagging can be slow
6. Genetic mark (parentage-based spawning to produce identifiable juvenile fish) – *see* Kock et al. 2019a and 2019b
    a. Can be used for large releases of batch-marked fish
    b. Requires advanced planning for one-to-one spawning and rearing of separate groups
    c. Requires genetic analysis to identify captured fish by parentage groups (delay in getting results and expensive)
7. Small PIT tags (8 mm) – *see* Tiffan et al. 2019, 2021
    a. Identification of individual fish
    b. Relatively simple tagging technique
    c. Unlimited life (including adult returns)
    d. Generally, requires capture and hand-scanning because of limited read range at fixed antennas (may have better detection at some sites depending on characteristics such as volume and velocity of water)
    e. Has been used in juvenile salmon down to 45 mm with no effect on survival or growth; recommend 50 mm
8. Small active tags (PNNL acoustic tags [ELAT] developed for eel and lamprey,) – *see* Liss et al. 2021
    a. Identification of individual fish
    b. Provides detailed information on migration and behavior

c. Could provide survival estimates (short-term)
d. Limited battery life (30 days) could limit results on migration, behavior, and survival depending on objectives of the study and migratory behavior (e.g., active v. intermittent)
e. Has not been field tested for effects of tag on growth and survival

Supplemental Information

North Santiam Basin
Available information suggests that Chinook salmon emigrate from the tributaries into Detroit Reservoir late winter and spring. Juveniles enter from the Breitenbush River as fry primarily from February to April at 30 to 60 mm in length (Figure 1), and from the North Santiam as fry from April to June at 40 to 60 mm, subyearlings from June to December at 60 to 120 mm, and yearlings at 70 – 140 mm (Figure 2). Fry outmigration is later due to colder water temperatures in the North Santiam.

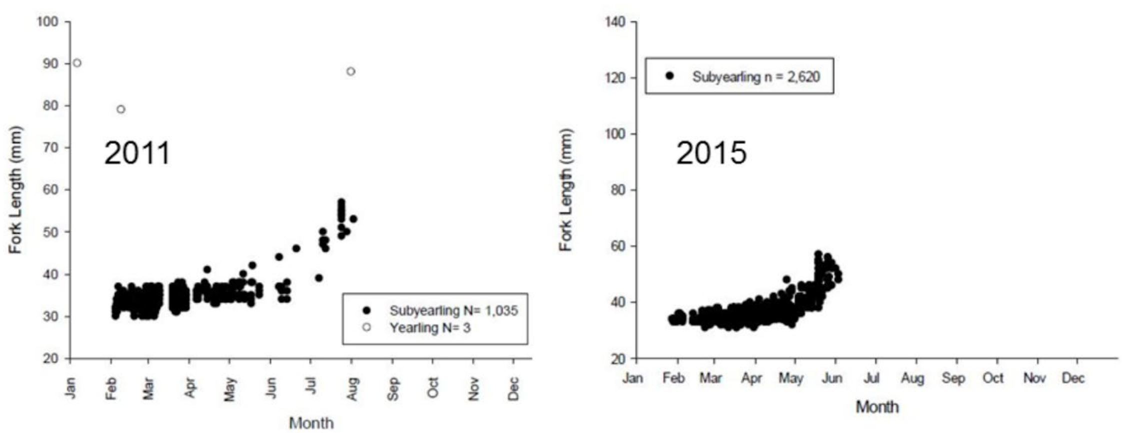


Figure 1. Graphs showing daily collection of juvenile Chinook salmon in rotary screw traps, by fork length (in millimeters [mm]) and year, upstream of Detroit Reservoir, Breitenbush River, Oregon, 2011 and 2015. Note the different y-axis scales on each of the two graphs. Graphs from Romer and others, 2012, 2016.

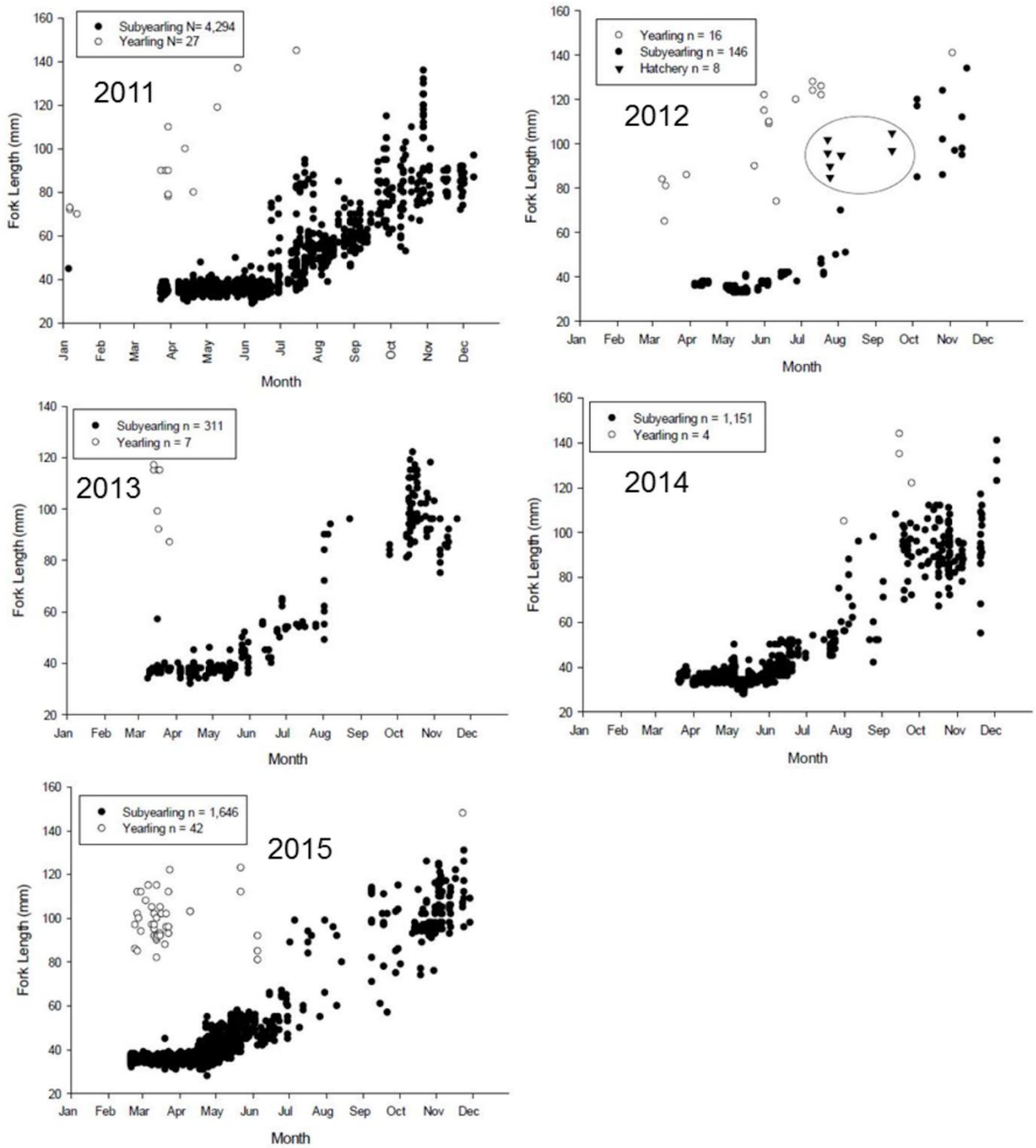
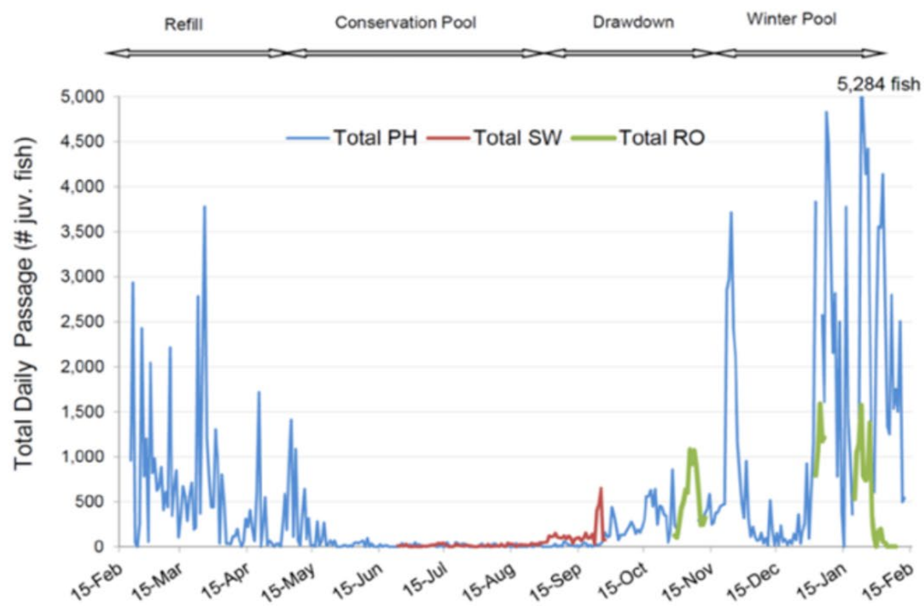


Figure 2. Graphs showing daily collection of juvenile Chinook salmon in rotary screw traps, by fork length (in millimeters [mm]) and year, upstream of Detroit Reservoir, North Santiam River, Oregon, 2011–15. Data in the circle indicate fish that were presumed to be of hatchery origin as noted by the original authors. Note the different y- axis scales on some graphs. Graphs from Romer and others, 2012, 2013, 2014, 2015, 2016.

Given that spring spill operations offer the most likely route for emigrating juveniles, monitoring would be prioritized during the spring emigration window, February through June or July (Figure 3). The release of active/PIT double-tagged fish in the headwater tributaries or the head of the reservoir would be especially useful if there are variations in the routes through which water is released at Detroit Dam during the spring refill/spill period. Under normal conditions, by early June Detroit Reservoir begins to stratify and this may create different flow conditions in the reservoir in the upper or lower water layers. Assessing how fish respond to this change may be important in identifying optimal operational passage strategies. It remains to be determined what minimum surface spill is needed to initiate downstream migration.



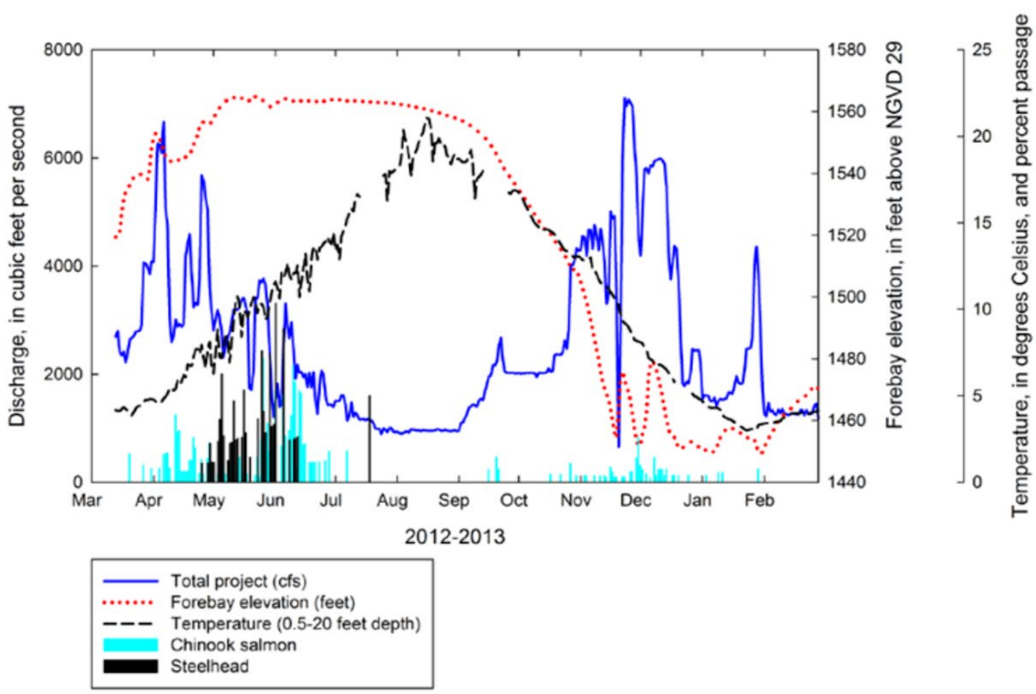


Figure 3. Graphs showing estimated total daily passage of smolt-size fish at powerhouse (PH), spillway (SW), and regulating outlet (RO) from February 20, 2011 through February 12, 2012 (top graph), and

daily mean dam operations and environmental conditions at Detroit Reservoir, Oregon, from March 13, 2012, through February 21, 2013, when fish were detected in the study area (bottom graph). Arrows at the top of the graph indicate the four distinct pool elevation periods. Fish passage in lower graph (blue and black vertical bars) are plotted as the percentage of fish passing out of the number of fish available to pass. NGVD 29, National Geodetic Vertical Datum of 1929. Top graph from Khan, Royer, and others, 2012. Bottom graph from Beeman, Hansel, and others, 2014.

Under the current Rule Curve for Detroit Reservoir, the reservoir would not be drafted below 1450' in the fall and winter (Figure 4). Monitoring juveniles during this period could be limited to screwtrap assessments of the species, number, size, and condition of juveniles collected below Big Cliff Dam. In addition, spawner and redd surveys in the North Santiam and Breitenbush rivers would be required to assess the spawning success of transported adults. The release of tagged juveniles during this period (fall) could be limited to assessments of passage timing survival and trap efficiency.

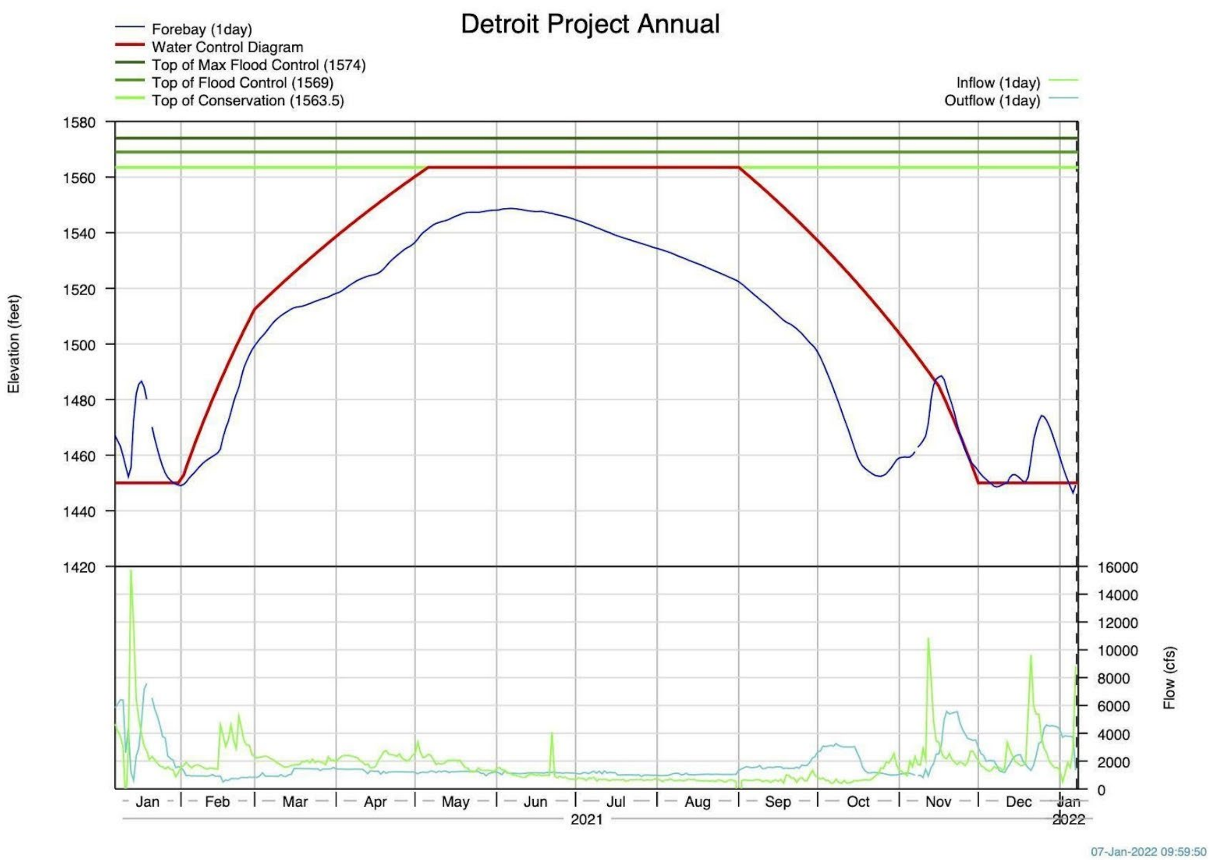


Figure 4. Rule curve and reservoir levels, inflow and outflow (January 2021 - January 2022) for Detroit Reservoir.

McKenzie Basin

Catch of subyearling spring Chinook in rotary screw traps in the South Fork McKenzie upstream of Cougar Reservoir is highly variable (Romer et al. 2011–2017). The weekly mean catch in March through June 2010–2016 was about 220–1583, with high weekly catches of about 3,000–4,800. Almost all of the subyearlings caught in the trap in March–June were less than 50 mm (Figure 1). Therefore, evaluation of spring operations on passage of subyearlings would have to be based on comparison of timing and size of fish caught in upstream and downstream traps, estimation of abundance of fish entering and exiting the reservoir, and potential use of marks such as elastomer or half-length blank tags to further estimate passage timing, rate, and survival. A controlled release of batch-marked hatchery fry at the head of the reservoir prior to beginning of the drawdown and prior to full drawdown would provide additional information on effect of spring operations on juvenile salmon passage. Sampling within the reservoir would provide additional information about the effect of spring operations on longitudinal distribution of fry and small subyearlings in the reservoir.

Information from the South Fork McKenzie trap in 2010–2016 indicates subyearlings entering the reservoir in February–April would not be large enough for PIT tags (≥50 mm for which the 8 mm PIT tags could be used). Juvenile Chinook ≥50 mm were present in May in very small numbers (13 in 2013 and 2 in 2015, representing about 0.5% of the catch).

The mean catch of subyearling salmon within Cougar Reservoir in 2012–2014 was about 4,000, 14,400, and 5,800, respectively. The respective monthly catch in 2013 and 2014 was 4,718 and 1,219 in April, 5,186 and 2,565 in May, and 4,450 and 1,977 in June. Juvenile salmon caught in box traps near shore were smaller in the upper reservoir than in the lower reservoir and were smaller than juvenile salmon caught in Oneida traps farther offshore (Table 1).

The Corps will coordinate with other agencies/entities conducting research or surveys downstream of Cougar Dam to ensure any juvenile salmon captured downstream is examined and scanned to detect marks or tags. Any recaptured juvenile salmon should have the mark or tag recorded along with fork length, date, location, and condition; and information should be relayed to the Corps or their contractor. For example, ODFW is conducting research in the restoration area of the South Fork McKenzie River downstream of the dam, and in the lower McKenzie River and Willamette River, and may encounter marked or tagged fish released under the activities of Measure 14 and 15. These recaptures would be in addition to passive detections of PIT tags that may occur in the lower end of the restoration area, Walterville Canal bypass, or the PGE Sullivan Plant bypass at Willamette Falls.

Up to 10,000 fry could be collected for rearing as surrogate fish at the OSU Fish Performance and Genetics Laboratory in Corvallis, Oregon. To collect these fish, a second trap can be operated upstream of Cougar Reservoir. In addition to increasing the overall capture of Chinook fry, a second trap operated upstream or downstream of another trap can be used to provide a mark-recapture estimate of Chinook fry entering the reservoir. Juvenile salmon captured in a second trap would also increase the number of tagged fish released at or near the head of the reservoir to study migration timing and passage timing and rate at the dam.

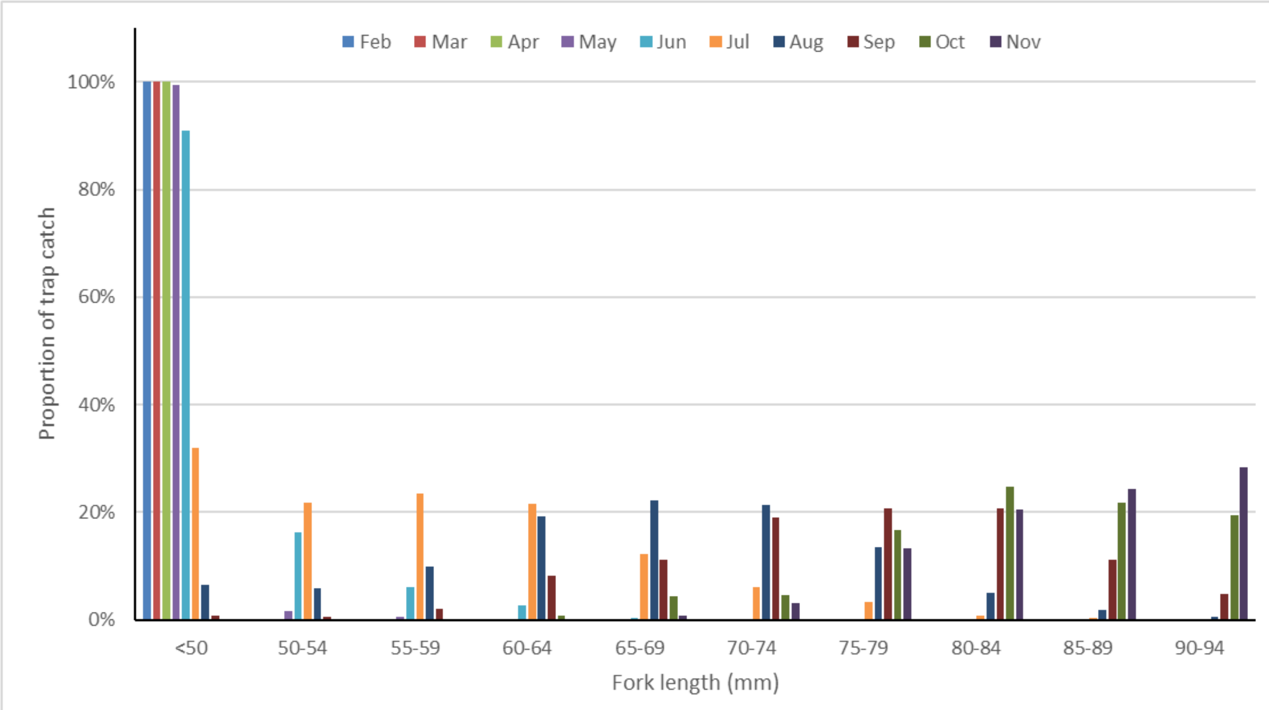


Figure 1. Mean length distribution of subyearling Chinook salmon captured in a rotary screw trap in the South Fork McKenzie River upstream of Cougar Reservoir, 2010–2016. Estimated from trap catch and length data in ODFW reports on outmigration above reservoirs.

Table 1. Mean fork length (SE) of Chinook salmon caught in Cougar Reservoir with floating box traps and small Oneida traps by reservoir section and month, 2013 and 2014. Data from Monzyk et al. (2014 and 2015).

			Section		
Year	Month	Gear type	Upper	Middle	Lower
2013	April	Box trap	36.4 (0.10)	36.8 (0.13)	37.0 (0.12)
	May	Box trap	38.3 (0.13)	38.9 (0.14)	40.3 (0.22)
	June	Box trap	44.9 (0.27)	48.3 (0.33)	48.8 (0.31)
		Small Oneida	49.9 (0.46)	52.5 (0.60)	53.9 (0.65)
2014	April	Box trap	36.2 (0.1)	36.2 (0.26)	37.8 (0.48)
	May	Box trap	40.1 (0.2)	41.5 (0.4)	41.2 (0.49)
		Small Oneida	45.0 (0.68)	45.8 (0.81)	52.1 (1.0)
	June	Box trap	46.9 (0.39)	46.2 (1.04)	50.7 (0.75)
		Small Oneida	54.9 (0.54)	54.6 (0.58)	60.0 (0.62)

Middle Fork Willamette Basin

Catch of fry and small subyearling Chinook salmon in rotary screw traps was highly variable and generally low in the Middle Fork Willamette upstream of the reservoir and downstream of Lookout Point Dam during previous studies (*see* Keefer et al. 2012; Romer et al. 2017 and other years; Kock et al.

2019a and 2019b). For example, the monthly catch of juvenile salmon in traps upstream of the reservoir during peak migration in March and April ranged from 15–940 in 2011–2016 (Table 1, *from* Romer et al. 2017 and other years). Factors such as number of fish outplanted and water conditions affect catch of juvenile salmon in traps upstream of the reservoir. Trap efficiency could not be estimated in 2011–2016 because of low recapture numbers, making it impossible to accurately estimate the abundances of naturally produced juveniles entering the reservoir. These limitations on determining trap efficiency are unavoidable and obtaining accurate abundance estimates of juvenile salmon entering the reservoir is unlikely because of the relatively low catch rates in the trap.

Because the number of naturally produced fry and subyearling salmon that could be marked and released from traps upstream of the reservoir is likely to be small, supplemental methods to evaluate the effect of spring spill operations will be needed. In addition, the planned blocks of spill operations of a 30-day continuous spill followed by nighttime only spill would require at least two distinctly marked groups. Marked releases of fry and small subyearlings could include visible batch marks such as elastomer tags, half-length blank wire tags, or genetically based tags based on one-to-one parentage spawning of hatchery fish (Kock et al. 2019a and 2019b). Each method has pros and cons. For example, elastomer tags and blank wire tags can be used to identify recaptured fish from a release group either visually or with a tag scanner, whereas parentage-based marking requires collection of tissue samples and genetic analysis to identify release groups. Ensuring adequate numbers of juvenile salmon for experimental releases will require careful planning. Planning should include contingencies to deal with potential shortages, such as taking extra eggs in a subbasin where there is a surplus of adult hatchery returns.

Hatchery salmon fry, surrogate fish, or hatchery production fish for experimental releases in 2022 will be limited because of the poor return of adult salmon to the Middle Fork Willamette in 2021. Hatchery fish from other subbasins could be used for experimental releases if they were sterile (e.g., triploidy) to ensure any adult returns could not spawn with Middle Fork Willamette origin salmon, but this alternative would require advance planning. Because of these limitations, sampling within Lookout Point Reservoir will be an important component for evaluating the effect of spill operations on the distribution of juvenile salmon within the reservoir in 2022 and possibly future years. In addition to documenting the longitudinal distribution of fish within the reservoir during each of the spill operations, catch data can be compared to previous years and previous operating conditions. Juvenile salmon caught in the trap can be scanned for tags and additional tags can be inserted to further study migration within the reservoir and dam passage.

The catch of subyearling Chinook salmon in Lookout Point Reservoir in 2012–2014 was about 1,500, 1,900, and 1,700, respectively. The respective monthly catch in 2013 and 2014 was 1,012 and 87 in March, 684 and 894 in April, and 182 and 713 in May. Juvenile salmon caught in box traps near shore were smaller in the upper reservoir than in the lower reservoir and were smaller than juvenile salmon caught in Oneida traps farther offshore (Table 2). Subyearling Chinook salmon were generally more widely distributed earlier in Lookout Point Reservoir than in Cougar Reservoir, and distribution in Lookout Point Reservoir appeared to be affected by inflow and reservoir conditions. For example, subyearling Chinook were more evenly distributed throughout Lookout Point Reservoir in March 2014 than in March 2013 when inflow was significantly higher (Monzyk et al. 2015). Similar results were reported by Kock et al. (2019b) when subyearling Chinook moved downstream within the reservoir earlier in 2017 (high water year) than in 2018 (normal water year). These data indicate that sampling within the reservoir can provide important information about the longitudinal distribution of subyearling Chinook salmon relative to reservoir conditions.

Table 1. Catch of juvenile spring Chinook salmon in rotary screw traps upstream of Lookout Point Reservoir, 2011–2016 (subyearlings by month and total catch of yearlings). Catch of subyearlings was approximated from graphs of trap catch in Romer et al. 2017 and other years. The trap location was in the Middle Fork Willamette River downstream of the North Fork Middle Fork confluence in 2011–2014 and in the North Fork Middle Fork in 2015–2016.

	Subyearling							
Year	January	February	March	April	May	June	July	Yearling
2011	142	15	253	283	141	8	7	15
2012		70	218	213	73	53	4	2
2013		130	940	553	155	76	5	66
2014			340	835	105	16	4	5
2015		10[a]	78	15	22	8		78
2016		155	195	127	6	5		

[a] Trap was installed on February 25.

Table 2. Mean fork length (SE) of Chinook salmon caught in Lookout Point Reservoir with floating box traps and small Oneida traps by reservoir section and month, 2013 and 2014. Data from Monzyk et al. (2014 and 2015).

			Section		
Year	Month	Gear type	Upper	Middle	Lower
2013	March	Box trap	37.7 (0.18)	40.7 (0.46)	44.2 (0.55)
	April	Box trap	38.3 (0.26)	40.5 (0.46)	46.9 (0.83)
	May	Box trap	41.1 (0.48)	42.3 (1.19)	50.6 (3.19)
		Small Oneida	54.0 (2.67)	--	--
	June	Box trap	59.0 (11.0)	66.5 (11.5)	62.0
		Small Oneida	65.7 (3.30)	--	--
2014	March	Box trap	39.2 (0.61)	38.4 (0.61)	40.6 (0.84)
	April	Box trap	38.5 (0.4)	41.6 (0.80)	49.6 (2.06)
		Small Oneida	43.0 (0.77)	48.4 (3.28)	53.1 (2.7)
	May	Box trap	43.9 (1.0)	44.0 (1.94)	45.5 (6.5)
		Small Oneida	53.5 (1.65)	54.6 (1.12)	58.9 (5.98)
	June	Small Oneida	--	--	71.5 (1.5)

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