Meeting Minutes

Lewis River Aquatic Technical Subgroup

To: Lewis River Aquatic Technical Subgroup Date: July 26, 2023

From: Larissa Rohrbach, ATS Coordinator, Anchor QEA, LLC

Re: Final Minutes of the June 29, 2023, Lewis River Aquatic Technical Subgroup Meeting

The Lewis River Aquatic Technical Subgroup (ATS) meeting was held virtually on June 29, 2023, from 9:00 a.m. to 12:30 p.m. Attendees are listed in Section IV of these meeting minutes.

Action Item Summary

- See Work Plan.
- Erik Lesko will provide written responses to WDFW's Steelhead Abundance and Composition Strategy Review memo, including a formal identification of potential alternative approaches, by the end of July.
- Erik Lesko will provide genetics monitoring plan materials to Kale Bentley, and identify whether additional discussion is needed by July 3.
- Erik Lesko will inquire whether a total dissolved gas and/or dissolved oxygen meter available that could be used for monitoring this August.
- Erik Lesko will inquire with contractors whether smolt trap reporting can be completed earlier than in past years, by August or September.
- ATS members will review the PacifiCorp's Annual Report comment-response matrix and identify issues from the Hatchery and Supplementation Program Annual Operations Report that require ATS discussion.

Agreements or Recommendations

- None.

Review Items

- Memorandum from Erin Peterson and Kale Bentley on the "*Review of the monitoring approach used for "lower" NF Lewis adult winter steelhead.*"
- PacifiCorp's Annual Report comment-response matrix section on the Hatchery and Supplementation Program.

Finalized Documents

- None.

I. Welcome (Rohrbach/Lesko)

A. Announcements

- None.

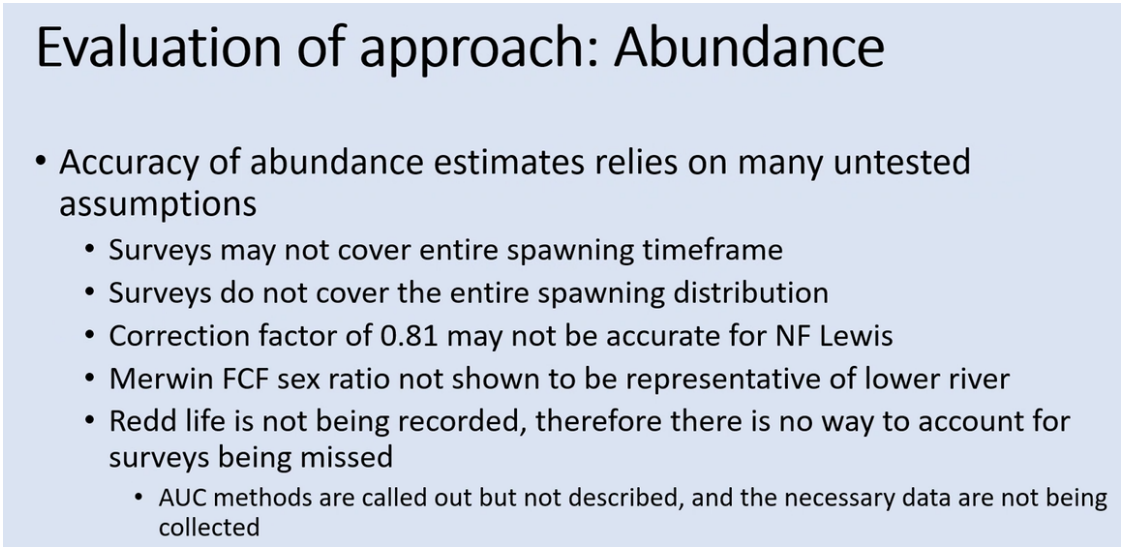
B. Review Agenda

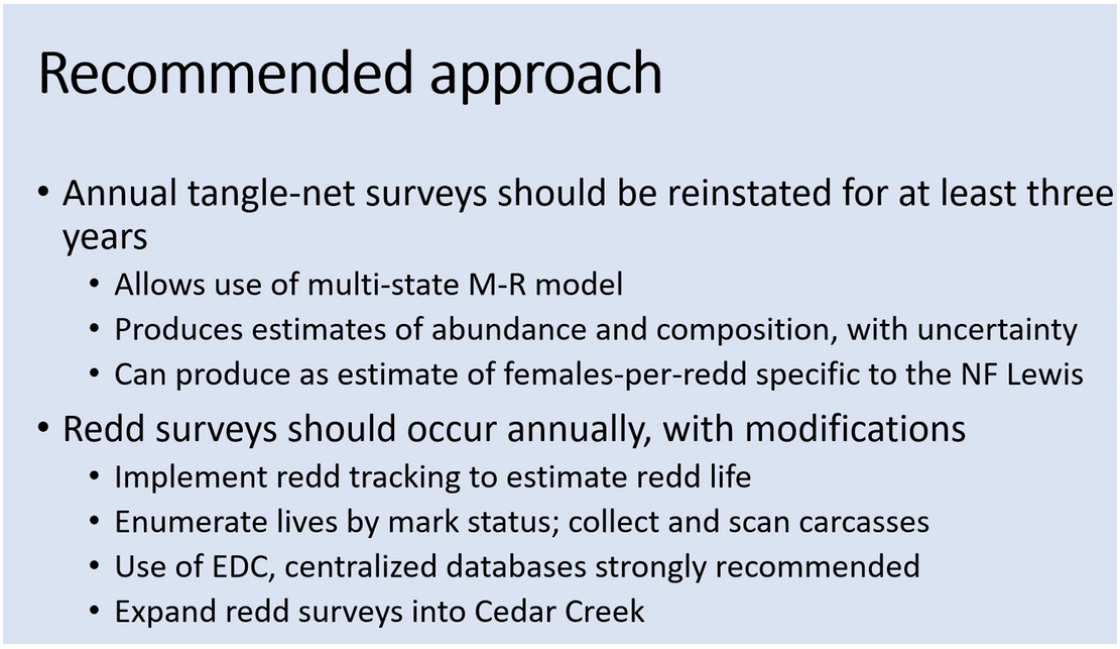
- Rohrbach reviewed the agenda and no changes were requested.

II. ATS Meeting Topics

A. Adult Steelhead Abundance and Composition Monitoring Strategies (Peterson)

Erin Peterson presented the key highlights of the memorandum that was originally distributed to the ATS on May 31, 2023 (*Review of the monitoring approach used for "lower" NF Lewis adult winter steelhead;* Attachment A). Peterson presented the approach currently being implemented to estimate steelhead abundance, currently untested assumptions of the approach, and recommendations for expanding and refining adult steelhead abundance and composition monitoring (focused especially on pHOS monitoring). The following slides contained key conclusions:





Erik Lesko asked what the requirement would be to monitor pHOS at this stage of the reintroduction of this population. Peterson answered that monitoring pHOS in the population is part of H&S Plan Objectives, described in the Annual Operating Plan (AOP). Bentley answered that although there isn't a specific threshold for program phase or size, but that pHOS should be monitored to understand the status of the population. Melton said pHOS will be used as one metric for estimating the impact on the wild population in formal Consultation on the hatchery program. Lesko asked Melton if there is a recommendation for monitoring pHOS at this stage of the species reintroduction and recovery. Melton said the Hatchery Scientific Review Group (HSRG) recommends a pHOS target for the given program stage; in the biological opinion that NMFS will write for the hatchery program, there may be an opinion developed to adjust the HSRG-recommended pHOS, but there is a need to keep track of pHOS to understand the program composition relative to targets. Steve Manlow noted that this Lewis River steelhead program is operating under the broader lower Columbia salmon and steelhead recovery plan and harvest restoration plan, which does have pHOS targets; monitoring progress toward those targets is a requirement under those plans as well.

Lesko said he and Jeremiah Doyle had been implementing tangle-netting since 2009 to capture fish for broodstock, and adults captured and returned to the river were PIT-tagged as part of that effort. PacifiCorp stopped tangle-netting because sufficient broodstock are being captured at the Merwin Trap, and the tangle-netting has adverse impacts on the wild spawning population. We are directly impacting the spawning activities, fish are sometimes dropping eggs into the boats. It is also biased toward males who have hooked noses, which biases the sex ratios assumed for the model. Bentley agreed that any activity where live fish are being handled has an impact, but that impact should be weighed against the potential benefit of the monitoring. He said that impact should be reviewed to

understand the level of that impact and work on ways to potentially mitigate for that. Secondly, regarding the bias toward males in the sample, there are ways to account for that. Lesko said they have considered using some tangle-netting early in the season, combined with hook and line sampling later in the season. Doyle said the impact is real; we call this tangle-netting but it is effectively quick set gill netting. This population is inherently small; we can assess the impact of the sampling, but we need to consider doing the monitoring work in the least damaging way possible. Doyle continued that capture efficiency declines with increasing flows and reduced water clarity; above 7,500 cfs the fish can't be captured, and the only time the flows are lower than this threshold is when these fish are actually on the spawning ground.

Peterson and Bentley said they understand that attempting to capture adult steelhead on a large river in the winter is a difficult task. She said WDFW does understand the need to consider the impact on the resource, which is why one recommendation was to reduce the frequency of the sampling. Currently, WDFW has no alternative to tangle-netting to propose. Bentley asked what alternative could be considered. Doyle said hook and line has been successful and can be expanded to cover the entire duration of the run; it could be a more effective approach than the male-biased tangle-netting. Bentley agreed that hook and line capture could be an approach considered. Keely Murdoch said that bias in tangle-netting is something that can be corrected for; we would also need to understand if there is any size or gender bias in hook and line sampling as well.

Anja Huff said tangle-netting is being done in other basins for monitoring. The Nisqually Tribe evaluated whether tangle-netting was causing an adverse effect on survival in their brood. The method used was more of a drift net. They found no mortality and found the tangle-netting to be a gentler approach than others. They were also able to mark natural origin fish that were later observed on the spawning ground in good condition. Lesko said he agrees; PacifiCorp staff has not observed a lot of direct mortality, but are more concerned about removing fish that are actively spawning.

Bentley acknowledged the anecdotal sharing of information on the impacts to the fish, and asked if PacifiCorp could share more consistent or quantitative estimates of impacts.

Bentley asked Melton said how NMFS would estimate potential impacts of the monitoring activity against the risk of the hatchery program on the wild population. He asked, from NMFS' perspective, how would the costs and benefits of those two things be weighted. Melton replied that it depends on what the population status is at that time; this would be estimated broadly across multiple years as the population composition changes. Melton acknowledged when there are impacts on the natural fish, there is a need to understand the value of the information obtained. For instance, hatchery origin returns (HOR) that spawn naturally may actually be acting as a buffer to the other impacts of the hatchery program or monitoring activities. If, over time, there is a correlation between

pHOS observed in the river and at the traps, perhaps that assessing population composition at the trap is another metric that could be used as a surrogate. At this time, without knowing a lot about the approach, NMFS would be more accepting of some impacts to the wild fish to better understand the population status. Bentley said, based on a couple of years of mark-recapture modeling; the capture efficiency was around 5%; meaning that roughly 5% of fish on the spawning ground were being handled.

Doyle said if NMFS supports the work they would continue, but it's difficult professionally to carry out the work that is having an obvious effect on spawners. Bryce Glaser said that's why allowable take limits are developed for the hatchery programs; there are impacts, and we try to balance those proportionately across the population. Also, at this time the monitoring is focused in the lower river, but the more the natural-origin population grows upstream of the dam, the less the impact of some take downstream.

Murdoch also asked, regarding redd surveys to estimate abundance, whether there has been a recommendation on any sort of estimate of observer efficiency adjustment. Peterson said that observer efficiency was considered to be rolled up in the assumptions noted; Bentley agreed that is something that needs to be evaluated and improved upon instead of using a constant developed about 40 years ago which is currently used to expand on numbers.

Lesko said the model uses tagged fish that are migrating, but later in the season, more of those fish are likely to be in-river spawners and would not appear in the trap. Lesko asked how important it is mark fish later in the season; which is a question for Dalton Hance (USFS; developer of the steelhead pHOS model). Bentley said it would be important to re-evaluate the whole analysis now that there is a new transition plan for moving fish into the upper basin. Bentley said potentially there is alternative information that could be used to substitute for directly handling those fish later in the season, for instance if the transition from the river to the trap don't change very much later in the spawning season, but it's difficult to make a decision on the approach without testing the assumptions. Peterson said the suggested approaches for steelhead monitoring are just recommendations, and encouraged others on the ATS to consider alternative approaches.

Lesko asked how monitoring may change as the program potentially moves to a stepping-stone approach with changes to harvest and 75,000 more juvenile steelhead added to the program. Glaser said harvest is not being added; the proposal is to transition to an earlier harvest period during the same period that this monitoring would occur. Any harvest would be mark-selective so there would not be harvest on the wild fish. Bentley said the overlap in spawn timing between NOR and HORs will increase, which could be an increase in impacts to pHOS, and therefore emphasizes the need to be monitoring and evaluating the genetic impacts going forward.

Lesko said PacifiCorp will provide written comments to the strategy review memo, including a formal identification of potential alternative approaches. Lesko will discuss the topic with Dalton Hance to understand how the timing of steelhead marking and recapture might work within the model. Lesko said he has appreciated this discussion which allows PacifiCorp to better understand the concerns and respond with some options for alternative approaches. Bentley said WDFW would request some written description of suggested alternatives to compare against the recommendations provided in order to weigh the risks and benefits of alternative approaches against each other and then move forward collaboratively on an improved strategy. The goal will be to improve the strategy to be able to implement something better in the next season (beginning in February 2024). It is important to capture this type of baseline information in the years prior to implementation of the transition plan.

Lesko agreed to provide a response to the ATS by the end of July.

B. Update: Genetic Monitoring Strategy (Lesko)

Lesko said materials from Cramer Fish Science and PacifiCorp will be sent to Kale Bentley and Todd Seamons (WDFW Geneticist) next week and he will set up a meeting to discuss the additional work.

Bentley said the only timely issue is the steelhead sampling to be done in the upper basin this summer paired with coho salmon sampling occurring this summer. Before going forward, there is a need to document how the sample sites are align with capturing the steelhead genetic baseline in the context of reintroduction planning. Juvenile Coho salmon survey sites were selected using a Generalized Random Tessellation Stratified approach for the reintroduction plan. Bentley suggested mapping the Coho salmon sampling distribution to be mindful that all the distribution of *Oncorhynchus mykiss* (resident and anadromous) will be covered.

Lesko will send those materials out by Monday, July 3. A meeting between Lesko and Bentley is already planned on July 11 to review steelhead transition plan assumptions. Steelhead genetic sampling can be discussed further then is there is a need to modify the field crew's plans.

C. Update: Hatchery Practices and Pathology (Hatchery and Fish Health Staff)

<u>Fish Health (Sean Roon)</u>

Roon has not received a response from the Washington Animal Diagnostic Disease Laboratory on histology for gas bubble trauma in samples collected in summer of 2022. Roon sent some previously-archived samples to a new researcher at USGS can do the histology. Roon said he can plan on re-sampling for histology this year. Rohrbach asked if that would be paired with total dissolved gas (TDG) measurements. Roon said they have a hand-held TDG monitor but that no TDG monitoring is planned for this summer.

Lesko said a dissolved oxygen (DO) deficit was identified through the testing last year that could be a potential stressor at end of pond 14. Mike Chamberlain is also taking some measurements. Lesko suggested he may want to add some continuous monitoring next year. Roon asked if there is a DO probe that could be used or borrowed. Roon said the hatcheries typically have the hand-held probe but nothing for continuous monitoring. Lesko said he would look into whether there is a TDG and/or DO meter that could be used for monitoring this August.

2023 Disease Issues

Fish have thus far been healthy this year; there have been no signs of bacterial kidney disease (BKD) in the Chinook salmon. Kokanee have also been very healthy, showing no signs of BKD. WDFW is experimenting with a 28-day trial feeding with aquamycin and survival of treated and non-treated fish will be monitored. Gross signs of BKD will be recorded, and tissue samples will be collected for PCR measurement. The results of that work can be shared with the ATS once more data are available.

Broodstock Collection In-season Updates (Hatchery Staff)

Aaron Roberts said spring Chinook salmon broodstock collection has been carried out as expected. It has been a good season and the program has been meeting the collection curve to date, nearly at 90% of the collection curve. Mike Chamberlain said they are on track for summer steelhead broodstock collection. Collection has been slow but they are meeting targets. 75 pairs are being held at Lewis River Hatchery as backup. Chamberlain said there have been single digit mortality rates for all groups so far. Coho salmon are currently being marked; they are approximately 2/3 finished with 2 million total marked fish. The marking effort should be complete in approximately 3 weeks.

Karchesky asked if the steelhead at Lewis River Hatchery are being held in anticipation of the outage at Merwin Trap next week. Chamberlain said yes and asked if the trap is coming back online earlier than September. Karchesky said yes, the work will now be split between 2023 and 2024, so the outage will occur over 2 to 3 weeks during July only. Next year's outage may take slightly longer, but it won't be necessary to extend into September. The work was split between seasons because the project was large enough that it would be difficult for not only the fish management but also the contractor to manage and to source materials.

Other In-Season Changes (All)

Josua Holowatz gave a fisheries update. He said spring Chinook salmon angling typically closes April 30, but due to a strong run, it is currently still open below Colvin Creek. Field staff working with Mike Chamberlain at Lewis River Hatchery typically move the anchor for the corkline boundary at Lewis Hatchery, however the anchor is sedimented in so that closure area is smaller than it should be at the

ladder. In the future they may need to use piece of equipment to remedy that and will think about a more permanent fix for discussion with this group in the future.

Holowatz said he is preparing for the Habitat Preparation Plan (HPP) and Yale Fishery this fall. WDFW are likely to set restrictions as was done last year, with size restrictions for kokanee and Coho salmon. The fishery will be implemented in response to the HPP, which was guided by this group.

Bryce Glaser said the HPP requires an annual update. Lesko said it would need to be brought to the ACC for their approval. Karchesky said the only change to consider in the next HPP is whether adults will be PIT tagged or not. Doyle said yes, fish would be PIT tagged, and Lesko said that will be the same as last year. There will be no weir in Cougar Creek, but there will be several PIT tag antennas.

D. Annual Operations Report Comment Responses

Lesko said the Annual Operating Report is due to FERC tomorrow. He said there were many comments made in the body of the report and technical comments were received on the appendices. A comment-response matrix will be submitted with the document. All comments are being collated in one matrix, organized by section. Bryce Glaser thanked Lesko for creating a comment matrix and asked that a clearer process for submitting the comments be developed in the future; Lesko agreed that PacifiCorp will create a better process in the future. Lesko said next year they are likely to submit the report a bit earlier to allow more time to address the comments as they come in. PacifiCorp will make the document easier to navigate in the future as well; there is currently a lot of redundancy in the body of the report that can be streamlined.

Bentley asked if the responses will be brought to the ATS meeting for discussion; Lesko agreed that comments topics can be brought to the ATS as future discussions. Bentley said WDFW would follow up as needed. Bentley asked, in reviewing the WDFW comments, if there were any that PacifiCorp identified that should be followed with discussion. Lesko said on the Hatchery and Supplementation section there were many comments that relate to reporting, in line with what has been laid out in the Annual Operating Plan, but there is no mechanism for making that change during the current reporting process. Lesko said that questions about methods and biases should be topics addressed by the ATS. He has not met with the rest of the PacifiCorp team to summarize key issues yet. Bentley said if there are strategies that are incomplete, or need work, and information is top of mind after reviewing the report, it would be appropriate to act on it now.

Lesko suggested reviewing the comment response matrix as well as Appendix A of the H&S Report and identify issues that require ATS discussion, and all agreed.

III. ATS Administration (Rohrbach)

A. Review ATS Work Plan Priorities

- Rohrbach reviewed the most recent version of the ATS Work Plan which was distributed with today's agenda. The status of work plan items and action items were updated in the meeting.

B. Review Next Meeting Topics (Rohrbach)

Due to scheduling and work load conflicts the July 27 meeting will be cancelled.

The next meeting will be August 31. The meeting will be held in person, at the WDFW Region 5 Headquarters, 5525 S 11th St. Ridgefield WA, Room 102A&B.

An option to join the meeting virtually will be provided.

The ATS identified the following potential items to discuss at the next meeting:

- Steelhead abundance and composition monitoring alternatives
- Habitat Preparation Plan review
- Integrated Population Model framework review (USGS; Karchesky will confirm with USGS)
- Genetic monitoring plan update
- Updates on dissolved oxygen monitoring; smolt trap reporting

IV. List of Attendees

Name	Affiliation
Larissa Rohrbach	Anchor QEA
Jeremiah Doyle	PacifiCorp
Chris Karchesky	PacifiCorp
Erik Lesko	PacifiCorp
Amanda Farrar	Cowlitz PUD
Christina Donehower	Cowlitz Tribe
Steve Manlow	LCFRB
Kathryn Blair	NMFS
Emi Melton	NMFS
Mike Chamberlain	WDFW
Bryce Glaser	WDFW
Kale Bentley	WDFW
Josua Holowatz	WDFW
Anja Huff	WDFW

Name	Affiliation
Erin Peterson	WDFW
Sean Roon	WDFW
Sam Gibbons	WDFW
Keely Murdoch	Yakama Nation

memo

Washington Department of Fish and Wildlife

To: Lewis ATS

From: Erin Peterson and Kale Bentley, WDFW

Date: May 31, 2023

Subject: Review of the monitoring approach used for "lower" NF Lewis adult winter steelhead

Summary

Winter steelhead in the lower NF Lewis River below Merwin Dam are currently being monitored using redd-based surveys that rely on many untested assumptions. Additionally, estimates of composition (e.g., pHOS) have not been generated since 2018, and major spawning tributaries such as Cedar Creek have not been surveyed in many years. Therefore, the current approach is not meeting objectives related to estimating abundance and composition as outlined in the H&S Plan. Based on an evaluation of the current and alternative approaches, WDFW has provided a list of recommendations, which include reinstating the mark-recapture tangle net surveys in the lower river, updating redd survey protocols, and extending redd surveys into tributaries. Overall, our goal with these recommendations is to identify the most cost-effective approach for monitoring winter steelhead in the lower NF Lewis that also meets the objectives defined in the H&S Plan.

Problem statement

The Lewis River Hydroelectric Projects Settlement Agreement (SA), and the resulting Hatchery and Supplementation (H&S) Plan and Annual Operating Plan (AOP), requires that estimates of abundance and composition be generated for adult salmon and winter steelhead downstream of Merwin Dam. Additionally, the genetic risks of in-basin hatchery programs on natural-origin populations must be assessed, which includes generating several metrics including pHOS and PNI. Together, these estimates must be generated annually, and the methods used to derive them should strive to meet recovery monitoring recommendations (e.g., unbiased estimates with quantified uncertainty).

The monitoring approach that is currently used for winter steelhead (*Oncorhynchus mykiss*) does not meet the reporting requirements. Briefly, the approach used to generate adult abundance has several known issues and limitations that are undoubtedly leading to biased estimates that also lack quantified uncertainty. Additionally, estimates of composition and genetic risks are simply not being generated. Without unbiased and precise estimates of abundance and composition for North Fork (NF) Lewis winter steelhead, PacifiCorp and other agencies lack the necessary information to measure the status and trends of populations, track their progress toward recovery, and determine the efficacy of various recovery actions.

Objective

The purpose of this document is two-fold. First, it is to evaluate the efficacy of the current approach used to generate estimates of abundance, composition, and genetic risk for winter

steelhead in the NF Lewis. Second, it is to provide recommendations for future monitoring approaches that will improve estimates of abundance and allow for the generation of all required monitoring metrics.

Introduction and background

NFL winter steelhead are identified as one of 17 distinct independent winter-run populations within the Lower Columbia River ESU. The boundaries of the NF Lewis winter steelhead population include all mainstem and tributary habitat (excluding EF Lewis) from the mouth of the Lewis River to the headwaters above Swift Dam. Two winter steelhead hatchery programs operate within the NF Lewis Basin – one focused on harvest mitigation and the other focused on conservation. For monitoring purposes, the single NF Lewis winter steelhead population is divided into two primary components: below Merwin Dam (aka lower Lewis) and above Swift Dam (aka upper Lewis). Currently, winter steelhead do not occur between Merwin and Swift Dam.

Monitoring objectives related to NF Lewis winter steelhead are outlined in three separate plans. For upper Lewis winter steelhead, monitoring objectives and approaches are detailed in the Aquatic Monitoring and Evaluation (AM&E) Plan. For lower Lewis winter steelhead, monitoring objectives are outlined in the Hatchery and Supplementation (H&S) Plan and implemented using approaches detailed in the Annual Operating Plan (AOP). All three Plans are developed and updated by the ATS and are required per the NF Lewis River Settlement Agreement (Settlement Agreement; 2004).

One of the main focuses of the Plans is to generate annual estimates of abundance and composition for salmon and steelhead populations within the NF Lewis Basin. To generate a total, unbiased estimate of adult abundance and composition for NF Lewis winter steelhead, data and/or estimates from both the lower and upper Lewis must be combined (see Objective 22 of PacifiCorp 2022b). Adult abundance for upper Lewis winter steelhead is generated via census counts of fish collected at and transported from the Merwin Fish Collection Facility (FCF). Although the number of transported adults does not necessarily equate to spawner abundance due to pre-spawn mortality, the number of adults collected at Merwin represents an unbiased estimate of adult returns at a known point in space and time. Unlike the upper Lewis sub-component, the abundance of lower Lewis winter steelhead must be estimated using spawning ground survey data and a companion analysis. Due to known issues and limitations associated with the lower Lewis monitoring approach, the focus of this document is evaluating these methods and providing recommendations moving forward.

Current Monitoring Approach – Redd expansions

The current version of the H&S Plan (2020) and AOP (2023) includes one objective related to estimating adult abundance and composition of lower Lewis winter steelhead (Objective 5) and two objectives related to assessing hatchery risks (Objectives 7 and 8). Within the AOP, Strategy A describes methods for estimating adult abundance and composition in the lower NF Lewis, which includes the estimation of pHOS. Therefore, the Washington Department of Fish and

Wildlife (WDFW) has focused its evaluation on Strategy A and specifically Section II, which focuses on winter steelhead. The H&S Plan objectives addressed in Strategy A are:

- Objective 5.0: Estimate spawner abundance of late winter steelhead…downstream of Merwin Dam
- Objective 5.1: Determine the spatial and temporal distribution of spawning late winter steelhead… downstream of Merwin Dam
- Objective 8.0: Determine the percent hatchery-origin spawners (pHOS), proportionate natural influence (PNI), and pNOB (for integrated programs)

Below, we partition our evaluation into four parts and separate each part into two sub-components corresponding to adult abundance and composition, respectively. First, we briefly describe the current data collection and analysis approach. Second, we list the assumptions of the current approach. Third, we evaluate the assumptions and identify limitations (if present). Lastly, based on parts 1-3, we provide a conclusion by assessing whether the current approach is meeting the monitoring objectives.

Part 1: Description of Approach

ABUNDANCE

The total abundance of spawning adults is currently obtained using redd count data. Redd surveys occur weekly from April 1 – June 30 in the lower mainstem NF Lewis from Merwin Dam to the downstream end of Eagle Island. New redds are counted by an observer and their location is marked using a handheld GPS unit (NFL ATS 2023, Strategy A)

The total number of spawners for a given return year is calculated as:

$$N = (r * 0.81)s$$

where N is the total spawner escapement, r is the total number of new redds observed over the entire survey season, and s is the number of adults (i.e., spawners) per female. The total number of new redds is converted to the total number of females using a constant correction factor of 0.81 per Freymond and Foley (1986). This correction factor is often thought of as an estimate of redds per female but is actually a combination of observer efficiency and redds per female. The total number of females ($r * 0.81$) is expanded to the total number of spawners using the sex ratio observed at the Merwin FCF (NFL ATS 2023, Strategy A).

It should be noted that redd surveys and the resulting estimates of spawner abundance are only on the mainstem of the lower NF Lewis; tributaries to the lower Lewis are not surveyed, thus, a portion of the spawning population below Merwin Dam is not accounted for using the current methods.

COMPOSITION

Spawner composition referred to in Objective 5.0 of the H&S Plan refers specifically to the proportion of spawning adults that are hatchery-origin (i.e., pHOS). Objective 5.0 does not explicitly call for estimates of composition by age and sex. However, Objective 7, which is focused on assessing the genetic risks of Lewis hatchery programs on natural-origin populations, does require that the size and age of returning adults be monitored. Nonetheless, the current

AOP states that "[c]urrently, there is no strategy to assess [pHOS] of adult returning late winter steelhead on the spawning grounds (NFL ATS 2023)."

Part 2: Critical Assumptions of Approach

To generate unbiased estimates, the assumption of the model must be met. For redd-based estimates of abundance and composition that rely on the enumeration of new redds, the following assumptions must be met (Parsons and Skalski 2009):

ABUNDANCE

- Surveys occur throughout the entire spawning run and encompass the entire spawning distribution.
- The species that created the redd is known with 100% certainty.
- There is no redd superimposition.
- False redds (features that appear similar to, but are not, redds) are not included in the redd count.
- Redd detectability (i.e., observer efficiency), the sex ratio of spawners, and the number of redds are accurately estimated.
- Survey frequency is less than the lifespan of a redd.

COMPOSITION

NA—composition of spawner origin (pHOS) is not being monitored.

Part 3: Evaluation of Approach

ABUNDANCE

Redd surveys are a common method used to estimate the abundance of salmon and steelhead. However, the accuracy of NF Lewis abundance estimates currently relies on many untested assumptions detailed below.

- The survey duration may not encompass the entire spawning time frame. Spawning may occur before April 1st. Data from nearby spawning areas in the Lower Columbia suggest that spawning of wild steelhead commences between mid-January and the beginning of March and early-timed hatchery spawners (part of the composition of the total spawning population) may begin spawning as early as late December.
- Surveys do not cover the entire spawning distribution. Specifically, surveys do not currently take place in any of the tributaries to the lower NF Lewis. Cedar Creek is a major tributary in this area that supports steelhead spawning, but monitoring of this population has been intermittent, and redd surveys currently do not occur on Cedar Creek (S. Gray, WDFW, *pers. comm*.).
- The constant correction factor of 0.81 that is currently used to convert redds to females is of unknown accuracy in the Lower Columbia region and has no measure of precision. The applicability of this correction factor is likely dependent on many factors, but stream/basin size is probably a strong predictor. The 0.81 correction factor was derived in Snow Creek, Washington, which has a total basin area ~1/3 the size of Cedar Creek. Therefore, the applicability of this factor to large rivers such as the NF Lewis is certainly

suspect as one would expect observer efficiency to be quite a bit less in large rivers versus small streams. It should be noted that while the accuracy of this correction factor is untested, it is widely used in Washington State and specifically throughout Southwest Washington by WDFW. The WDFW is aware of this deficiency and is working on solutions to address it.

- The sex ratio calculated using observations at the Merwin FCF is not fully described in the current AOP and has also not been shown to be representative of the sex ratio of spawners in the lower river.
- The survey approach and corresponding analysis are vulnerable to violating the assumption of redd lifespan. While the currently used redd survey interval of 7 days falls within the survey intervals recommended by other studies (e.g., McCormick and Ruzycki 2016), it requires that no survey be missed. The AOP states that if river conditions are not conducive to redd surveys (e.g., high flows limit visibility, surveys are canceled), an area under the curve (AUC) method will be used to estimate the abundance of redds. There are many different AUC methods, and while all versions use redd count data, it is fundamentally a different approach than simply enumerating new redds and requires different assumptions and/or data. For instance, a common AUC redd-based estimate uses counts of total redds, which are a combination of new and still visible redds, and an estimate of average redd life. There is no description of the AUC approach that would be used if the primary method of enumerating new redds is not a viable option and it is unclear whether the necessary data are available. Therefore, an AUC analysis approach does not appear to be a viable option.

COMPOSITION

Currently, an estimate of pHOS is not being generated for winter steelhead in the lower NF Lewis. As it pertains to mainstem surveys and estimates, there is no evidence to support the claim that tangle-netting was having a negative effect on adult steelhead, nor have any suitable alternatives to tangle-netting been proposed at this time.

Part 4: Conclusion

ABUNDANCE

Current abundance estimates for the lower NF Lewis basin are incomplete and rely on many untested assumptions. The current redd-based approach should be updated and/or alternative methods should be strongly (re)considered.

COMPOSITION

Acceptable alternatives for obtaining estimates of composition should be developed and implemented. These estimates should include pHOS as well as age and sex either in the form of proportioned abundance or summarized data that is stratified at the same spatial and temporal interval as abundance (e.g., by week and section).

Alternative Monitoring Approach – Mark-Recapture

There are many methods and gears that can be used to monitor steelhead abundance and composition (Parsons and Skalski 2009, Parsons and Skalski 2010). However, large rivers such

as the NF Lewis are inherently difficult places to work, especially during the winter months when flows are often high and conditions can change rapidly, and this makes many commonly used methods untenable in this system. Additionally, the iteroparous life history of winter steelhead eliminates the possibility of using carcass surveys, such as the surveys that are done for Chinook and coho salmon in the fall and winter months. Therefore, the focus of our alternatives evaluation will be revisiting the lower river M-R tangle netting surveys that were implemented to estimate pHOS in the lower mainstem using a multi-state M-R model previously adopted by the NFL ATS. Because this model can be used to estimate both abundance and composition, we combined these topics in our evaluation.

Part 1: Description of Approach

From approximately 2009 – 2015, tangle net surveys were conducted in lower NF Lewis with the primary goal of collecting natural-origin broodstock for the late winter steelhead integrated hatchery program. While tangle netting data could be used to calculate pHOS at the time and location of capture, this method cannot account for the proportion of fish that spawn naturally in the lower river versus the proportion that continue to migrate upriver and are captured at Merwin FCF. This approach also does not account for variation in sampling effort (i.e., capture efficiency) throughout the season. Given these limitations, beginning in 2016, tangle nets surveys were paired with mark-recapture (M-R) with the goal of generating an unbiased estimate of pHOS with measured uncertainty.

A full description of the M-R tangle-netting surveys can be found in Objective 2 of the 2020 Lewis ATS AOP (NFL ATS 2020). Briefly, live steelhead were captured during weekly tangle net surveys on or near spawning grounds during peak spawning months (March 1 to early May) throughout the lower river (top of Eagle Island to near Merwin Dam). Captured steelhead that were not collected for broodstock were PIT tagged, sampled for a variety of data including life stage (anadromous adult, residual), maturity (green, ripe, kelt), and origin (HOR, NOR), and released back into the river. Marked steelhead could be recaptured in the lower river or at Merwin FCF. Mark-recapture data were to be converted to estimates of abundance and pHOS using a multi-state M-R model (NFL ATS 2020). A full description of the M-R model, including model code, and results from 2016, 2018, and 2019 can be found in Hance (2018) and Hance and Perry (2022), respectively.

M-R tangle-netting was implemented for five years until it was discontinued by PacifiCorp ahead of the 2021 sampling season. PacifiCorp canceled the tangle netting and M-R surveys for a variety of reasons including that broodstock collection in the lower river was no longer needed and PacifiCorp was concerned that tangle netting may be negatively impacting natural-origin fish. This change was also justified by stating that NF Lewis winter steelhead are in the recolonization phase of recovery and that pHOS is not a primary metric used to monitor populations in that recovery phase (PacifiCorp 2022a, pg. 8).

Part 2: Critical Assumptions of Approach

Standard assumptions for M-R studies (found in Bentley et al. 2018) are:

1. Equal capture probability: Every fish present in the study system during a specific sampling event has the same probability of being captured, regardless of whether it is tagged or untagged.
2. Equal persistence: Every fish present in the study system during a specific event has the same probability of still being present in the system during the next sampling event, regardless of whether it is tagged or untagged.
3. Tag loss and recovery: Tagged fish do not lose their tags, and all tags are recognized and read properly upon recovery.
4. Instantaneous sampling: All samples are instantaneous (i.e., the sample time is negligible, and the fish is released immediately after being sampled).

Additional assumptions specific to the M-R multi-state model (found in NFL ATS 2020) include:

5. Fish assume one of the four ecological states throughout the survey period: potential population (necessary for the modeling process, but without ecological meaning), returning (pre-spawn, remaining in the lower river), lower-river spawner (has become a kelt), or up-river migrant (captured at Merwin FCF).
6. Fish transition between states but not all states are possible (e.g., a "lower-river spawner" cannot become a "returner").
7. Tangle-netting sites are representative of the spawning habitat available between Merwin Dam and the downstream end of Eagle Island.
8. Probability of capture is equal for all steelhead regardless of sample location (n=11), origin (i.e., hatchery or wild), sex, and potential to transition to "spawner" or "up-river migrant".
9. All marked fish spawn in the lower Lewis River unless they are captured at Merwin FCF and transported upstream or used for broodstock.
10. Recaptured kelts have spawned in the Lewis River unless they can be specifically identified as fish used for broodstock and then released from the hatchery.
11. The pHOS for the portion of the population that spawns outside the sampling period (e.g., in late May and June) is the same as the pHOS observed during the sampling period.

Part 3: Evaluation of Approach

The multi-state M-R model using tangle netting surveys will generate accurate (i.e., unbiased) estimates of abundance and composition if the assumptions outlined above are met. While all assumptions should be critically evaluated, not all assumptions are created equal in terms of their relative impact on the performance of a model. According to the developer of the multi-state M-R model, the most critical assumption is #3, and specifically the capture efficiency for PIT-tagged steelhead at Merwin FCF is 100% (Hance 2018). Based on previous analysis, there was no evidence that this assumption was violated but emphasis was put on the fact "that care should be taken to ensure that all fish are correctly identified and recorded (Hance 2018)." As for the other 10 assumptions, it is certainly possible that each one is not always met (e.g., #8). Hypothetically, each assumption could be assessed with additional data and/or analyses (e.g., tag retention study) or accounted for through model modifications (e.g., allowing for different

capture probabilities within a survey). However, the performance of a model (i.e., the model fit) can also be assessed using posterior predictive checks (Gelman et al. 2015). In the first year of data analysis, the posterior predictive checks "demonstrate[d] that the model [was] adequate for the main goal of estimating the [pHOS]" while acknowledging that the model could be modified and evaluated in the future with more formal model comparison techniques (Hance 2018).

Ultimately, the mark-recapture model was only used to estimate abundance and composition in two years (2016 and 2018). Data collection errors and discrepancies prevented the effective use of the model in 2019. Insufficient numbers of marks and recaptures were cited by PacificCorp as the reason that the model could not be used in 2017 or 2020 (PacifiCorp 2021). However, after further conversations with statisticians involved in the creation of the model, it appears that limited data availability does not impede running the model, but rather that issues arose due to inconsistent data recording and in-season changes to fish transport strategies in those years (D. Hance, *pers. comm*.). In fact, one of the distinct advantages of the mark-recapture model, besides its utility in generating estimates of both pHOS and abundance with associated estimates of precision, is that it is constructed using a Bayesian framework that allows existing information (e.g., estimates from previous years) to be incorporated via informative priors. Though further evaluation is warranted, the developer of the model indicates that estimates could be generated with as few as 20-30 lower river captures each year (D. Hance, *pers. comm.).*

The main limitation of the above approach is that it was never implemented in the tributaries. Therefore, sampling did not cover the entire spatial distribution of late winter steelhead spawning even when tangle netting was occurring.

Part 4: Conclusion

The sampling methods and mark-recapture model previously (prior to 2021) used to estimate steelhead abundance and composition should satisfy most of the assumptions inherent in mark-recapture studies. Additional work would still be needed to account for the portion of the population spawning in tributaries. This approach produces robust estimates for the mainstem portion of the population, which are required to satisfy the objectives of the H&S Plan (2020).

Additionally, the M-R tangle netting approach would provide invaluable information needed to evaluate the proposed modifications to the NF Lewis harvest mitigation winter steelhead hatchery program (WDFW 2023). If implemented, the existing early-timed, fully segregated program (Chamber's Creek stock derivative) will be eliminated and replaced with a broad-timed, stepping-stone program. This change will likely increase the temporal overlap of natural-origin adults and hatchery adults from the harvest mitigation program alongside the existing overlap of natural-origin adults with hatchery adults from the conservation program. While this change is expected to decrease the overall genetic risks related to hatcheries, monitoring the actual effects will be crucial. Based on the way these hatchery programs will be implemented, the only way to differentiate the three groups of adults (i.e., natural-origin and two hatchery-origin) will be through sampling the adipose-fin clip status and presence of a blank wire tag of individual fish, which will require that adults on the spawning grounds be handled.

Recommended Approach Moving Forward

Based on the information outlined above, we have formulated an approach for monitoring winter steelhead in the lower Lewis moving forward. If implemented successfully, our approach will result in the necessary information being obtained to meet the requirements specified in Objectives 5 and 8 in the H&S Plan (2020).

Our recommendations are listed separately for mainstem and tributary monitoring. Overall, we recommend modifying the redd-based surveys and reinstating the M-R tangle netting surveys for mainstem areas, and implementing redd-based surveys in tributaries, with an emphasis on Cedar Creek. We provide a list of methods that should be used to obtain and analyze the data.

Mainstem

APPROACH

Tangle net surveys should be reinstated on an annual basis for the next three years, following the methods outlined in the 2020 AOP (NFL ATS 2020). Data should be analyzed using the multi-state M-R model described by Hance and Perry (2020). After three years, the performance of the mark-recapture model should be evaluated, and at that point, it may be feasible to reduce tangle-netting to a semi-annual occurrence. Tangle-netting on a semi-annual basis would reduce fish handling and costs to the Utility, while still providing updated estimates of pHOS at least once per generation. Redd surveys should continue to be completed annually, with minor modifications to data collection and analysis (listed below).

UPDATES TO PREVIOUSLY DESCRIBED METHODS

- PacifiCorp should be using electronic data capture and a centralized database to collect and record spawning ground survey data. Hance and Perry (2020) made this recommendation specifically regarding the M-R dataset after highlighting numerous data quality issues that ultimately led to an entire year's worth of data being unanalyzable. We recommend all spawning ground data, including redd surveys, be collected electronically and stored using WDFW's fully functional platforms. Coordination is needed to ensure that data collected from both spawning ground surveys and Merwin FCF can be easily merged and formatted for analysis.
- Future protocols need to include more detailed information regarding how tangle-net sets are performed; currently, it is unclear how long (distance) sets are, and how many sets occur at a single site. Additionally, in the past, there have been capture locations listed that are not among the established tangle-netting sites presented in the 2020 AOP, Figure D2. The length of each sampling site should be clarified, and all captures should be associated with an established sampling site.
- The number of HOR fish that are PIT-tagged upon capture should not be limited to 100, as per protocols detailed in the 2020 AOP. Based on previously reported catch and estimate capture efficiencies, all maiden HOR and NOR fish should be PIT-tagged to maximize the number of fish available for recapture.
- Once tangle-netting surveys move to a semi-annual occurrence, the redd-based analysis should be updated to incorporate information from the M-R analysis. For instance, a

lower Lewis-specific estimate of females-per-redd could be derived using estimates of abundance and sex ratio data from the M-R analysis alongside estimates of apparent redds. This estimate of females-per-redd can be used to generate estimates of abundance in the lower NF Lewis in years when tangle-netting does not occur, in conjunction with updated redd estimates. This approach assumes that females-per-redd and sex ratio do not change substantially from year to year.

- PacifiCorp should implement redd tracking (WDFW 2022) as opposed to only enumerating new redds. Redd tracking involves monitoring all redds, which include new redds, still visible redds, and not visible redds. By enumerating total redds (i.e., new and still visible), an estimate of redd life (McCormick and Ruzycki 2016) and total apparent redds (Parsons and Skalski 2010) can be derived and paired to estimate total unique apparent redds. This approach alleviates issues associated with missed surveys that the current approach cannot address.
- During redd surveys, live spawners should be enumerated by ad-clip status. Any carcasses encountered should be scanned for PIT tags and have the ad-clip status recorded.
- The analysis protocol needs to be updated to describe how redd-based estimates of abundance and composition will be generated in more detail. Specifically, when will estimates be generated using the new redd only approach versus the AUC total redd approach? When an AUC approach is necessary, how will estimates be generated? How will estimates of composition be derived?
- WDFW is currently developing an analysis to generate estimates of total unique apparent redds (Harris et al., *in prep*) and an analysis to estimate pHOS for winter steelhead (Buehrens et al. 2023). Both approaches could potentially be applied to NF Lewis steelhead once finalized.

Tributaries

APPROACH

Redd surveys should be conducted on major spawning tributaries over the same timeframe that surveys are being conducted on the mainstem, following protocols similar to those of other salmonid spawning surveys that are conducted by foot (WDFW 2022). Until a more appropriate estimate of females-per-redd is generated, redd counts on tributaries should continue to be extrapolated by 0.81 females per redd.

UPDATES TO PREVIOUSLY DESCRIBED METHODS

- As described above, redd tracking should be implemented for tributary surveys.
- Live spawners should be enumerated by ad-clip status. Any carcasses encountered should be scanned for PIT tags and have the ad-clip status recorded.
- Methods for data collection and analysis should be formally documented in protocols and reviewed by the ATS prior to implementation, as soon as possible.

Next Steps

With this review complete, the ATS must now agree upon the monitoring method updates that will be implemented for winter steelhead in the lower NF Lewis. Again, the objective is to

ensure that the methods used align with the goals outlined in the H&S Plan moving forward. To facilitate a timely process, we request ATS members provide written feedback to WDFW. Ideally, feedback is received by Friday, June 23rd, allowing for a group discussion during the June ATS meeting scheduled for the 29th. We acknowledge that there are logistical details not covered in this review document, such as determining the responsible party for conducting tributary surveys. While these details are important, the ATS should first agree on a comprehensive approach, after which roles, timelines, and specific monitoring details can be further developed.

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