November 17, 2020

TO: Flood Authority Members

FROM: Scott Boettcher, Staff

SUBJECT: Executive Committee Action Commenting on Draft NEPA Analysis

The purpose of this memo is to outline recent actions taken by the Flood Authority's Executive Committee since last Flood Authority meeting (September 17, 2020). We will discuss and seek concurrence at our next meeting (November 19, 2020). Please feel free to contact me with questions (360/480-6600, scottb@sbgh-partners.com).

Background:

1. On September 18, 2020, the U.S. Army Corps of Engineers released a Draft NEPA Analysis regarding the Chehalis River Basin Flood Control Zone District's proposed Chehalis River Basin Flood Damage Reduction Project (see here).

2. The Corps of Engineers established the following comment period for the Draft Analysis: September 18, 2020 to November 17, 2020.

3. The Flood Authority's Executive Committee took action to submit a comment letter to the Corps of Engineers on November 13, 2020 as the due date for comments to the Corps closed prior to the Flood Authority's next meeting (11-19-2020).

Recommendation:

Flood Authority Staff recommends the Flood Authority as a whole concur with the Executive Committee's action on the basis that the Executive Committee's letter (attached):

1. Was unanimously supported by all Executive Committee members; and

2. Is consistent with (a) previous comments made by the Flood Authority on the Washington State Department of Ecology's Draft SEPA Analysis (see here), and (b) local resolutions favoring a basin-wide solution adopted by Flood Authority member jurisdictions (see here).

NEPA Draft Environmental Impac ×

chehalisbasinstrategy.com/eis/nepa-draft-eis-comment-form/

Chehalis Basin Strategy

Reducing Flood Damage and Restoring Aquatic Species

HOME STRATEGY OFFICE OF CHEHALIS BASIN FLOOD PROTECTION HABITAT RESTORATION GET INVOLVED RESOURCES

NEPA Draft Environmental Impact Statement (EIS) Comment Form

Please fill out the form below to provide comments on the NEPA Draft EIS for the proposed Chehalis River Basin Flood Damage Reduction Project. The comment period will go through November 17, 2020.

Please be aware that any information (including personal identifying information) received through this web form may be made available to the public online and/or in hard copy. Do not submit any information that you do not want released to the public. Electronic file attachments should avoid the use of special characters and any form of encryption, and be free of any defects or viruses.

To provide your comments, please fill in the contact information below and enter text into the "Comments" text box. You can also upload up to two (2) file attachments (each file limited to 10 MB).

Please contact us to sign-up for email updates.

Name (optional)

Scott Boettcher

Organization (optional)

Chehalis River Basin Flood Authority

Email (optional)

SCOTTB@SBGH-PARTNERS.COM

County/State (optional)

WA

Comments

11-13-2020 -- Attached please find the Chehalis River Basin Flood Authority's comment letter on the U.S. Army Corps of Engineers Draft NEPA EIS. Please direct any questions to Scott Boettcher (Staff, Chehalis River Basin Flood Authority), 360/480-6600, scottb@sbgh-partners.com. Thank you.

Attach files using the buttons below:

Choose File No file chosen   Choose File CRBFA Letter...-13-2020.pdf

SUBMIT COMMENTS

November 13, 2020 **SENT Via Web Comment Form:**
https://chehalisbasinstrategy.com/eis/nepa-draft-eis-comment-form/

Chehalis River Basin Flood Damage Reduction Project
c/o Anchor QEA
6720 South Macadam Street, Suite 125
Portland, OR 97219

RE: Proposed Chehalis River Basin Flood Damage Reduction Project

Dear U.S. Army Corps of Engineers:

We are writing to comment on the Draft NEPA Environmental Impact Statement (EIS) issued by the U.S. Army Corps of Engineers (Corps) on September 18, 2020. We are writing in our capacity as Chair and Vice-Chair of the Chehalis River Basin Flood Authority (Flood Authority).

As leaders in the Chehalis Basin communities we serve we are tasked with seeking balanced solutions for people, fish, and aquatic species. The key to doing this is working with factual and objective information. On this point, we'd like to compliment the Corps for the very comprehensive and thorough analysis taken on the Chehalis Basin Flood Control Zone District's (District) proposed Chehalis River Basin Flood Damage Reduction Project. Not only did the Corps take an objective and straightforward look at resources and impacts, but it also found the time and capacity to analyze 61 potential alternatives. As an organization that has worked tirelessly to find solutions to flooding for well over a decade, we must say the Corps found many potential solutions we hadn't yet considered. That's impressive!

Our Flood Authority was formed because our communities have been devastated by catastrophic flooding for decades. Families lose everything. Small businesses are destroyed. Careers and jobs are lost. Children's futures are harmed. Schools flood. Churches and nursing homes flood. Lives are lost along with livestock. I-5 is covered for days as are State Highways 6 and 12. This threat has hung over the Chehalis Basin forever. As a result, after years of study by many local, state, and federal agencies and stakeholders, we have identified a solution that will reduce the peak of these catastrophic floods for the benefit of all basin communities from Pe Ell to Cosmopolis. That solution is emergency, temporary water storage above Pe Ell.

The Draft NEPA EIS analysis spells out many benefits at a basin-wide scale, including protection for more than 1,300 homes which are disproportionately inhabited by social justice populations. The best science shows that if we take this step along with other local flood measures across the basin we can aggressively enhance aquatic species habitat, protect people, property and livelihoods, and achieve a win-win for the twin problems of fish decline and flood damage.

On the subject of impacts identified through the Corps' analysis of Alternatives 1 and 2, we'd like to specifically comment on the subject of impacts to fish. We believe the analysis to be credible, i.e., that there will be impacts to fish from both Alternatives. Our primary comment here is that those impacts should be considered in the same scale and context as the many benefits to be gained through advancing the project. More specifically:

1. **Appropriate Scale of Fish Impacts** – The Draft NEPA EIS identifies, at a basin-wide scale, that impacts on salmonid abundance from construction and operation of the District's proposal to be "low". This is because at a basin-wide scale the number of salmonids above Rainbow Falls in relation to the entire basin is very small. From WDFW's annual fishery census we see that the Department has found an annual average of 7 Spring-run Chinook spawners identified at and above the facility site and 1,122 at a basin-wide scale. See Attachment A. We know the District is committed to avoiding, minimizing, and mitigating impacts to this fishery. We appreciate the analysis on pages 118, 126, 132, and 137 of the DEIS (here). It helps us all to understand and scale impacts to be mitigated. We are confident that mitigation measures can be taken to minimize fishery impacts to the system as a whole.

2. **Benefits to be gained** – We believe there is more is to be gained than lost by Alternatives 1 and 2. We also believe the Corps analysis shows, at a basin-wide scale, that the beneficial gains for people and fish from Alternatives 1 and 2 substantially outweigh further impacts from doing nothing (No Action). The District's proposed project will deliver significant reductions in catastrophic levels of flooding for basin communities from Pe Ell to Montesano and further downstream and provide substantial reductions in impact and flood inundation for thousands of valuable structures critical for post-disaster recovery, e.g., essential public infrastructure (wastewater treatment plants, water treatment plants, drinking water supplies, roads, bridges, I-5, etc.), homes, schools, churches, small businesses, business parks, industrial facilities, port districts, hospitals and more. The District's proposed project holds back and manages 65,000 acre/feet of water that would otherwise descend with catastrophic consequence on our communities.

We fully support mitigating any and all impacts to fish caused by the District's proposed project. From the analysis we have been given by the mitigation teams we believe fish impacts can and should be mitigated.

In closing, we'd like to add that in 2008 and 2009, almost all jurisdictions on the Flood Authority adopted resolutions in favor of a basin-wide flood plan that included support for a science-based evaluation of a water retention facility above Pe Ell. In 2016, the Flood

Authority as a whole, and many of its member jurisdictions individually, adopted resolutions and statements of support favoring a basin-wide solution to flooding that included: flood retention structure; floodproofing structures; improvements to land use management; local projects; flood warning system; and aquatic species habitat restoration. Flood Authority members updated and passed new resolutions in 2020 restating and again affirming their support for a basin-wide solution[i]. See Flood Authority's Local Resolutions Library here.

Thank you for your consideration of our perspectives as citizens and leaders in the Chehalis Basin. We need solutions that provide the most beneficial combination of flood protection and aquatic species enhancement in the Chehalis Basin with the least amount of adverse impact. Alternatives 1 and 2 are essential to doing this. Please feel free to contact either of us if you have any questions. You may also contact Scott Boettcher (Flood Authority staff) at 360/480-6600, scottb@sbgh-partners.com.

Sincerely,

Vickie Raines, Chair
Chehalis River Basin Flood Authority
Grays Harbor County Commissioner
360/590-4100
VRaines@co.grays-harbor.wa.us

Edna Fund, Vice-Chair
Chehalis River Basin Flood Authority
Lewis County Commissioner
360/269-7515
Edna.Fund@lewiscountywa.gov

CC: Andrea McNamara Doyle, WA State Office of Chehalis Basin
Chehalis River Basin Flood Authority members
Chehalis Basin Board members

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i. Chehalis River Basin Flood Authority is comprised of representatives from Lewis County, Grays Harbor County, Thurston County and the following cities and towns: Centralia, Chehalis, Napavine, Pe Ell, Aberdeen, Cosmopolis, Hoquiam, Montesano, Oakville and Bucoda. Thurston County's position of support for the Flood Retention Facility portion of the project is at this time contingent upon finding sufficient, technically feasible mitigation.

Attachment A

WDFW Annual Fishery Census

Chehalis River Basin Flood Authority
NEPA DEIS Comment Letter
Proposed Chehalis River Basin Flood Damage Reduction Project
11/13/2020

Chehalis Basin spawning information 2010-2019
Compiled 5/6/2020
DRAFT

Spring Chinook

Spawn Year	Basin-wide		Above Dam Site		% above
	Spawners	Redds	Spawners	Redds	
2010	3,495	1,398	NA	NA	
2011	2,563	1,025	NA	NA	
2012	878	351	NA	NA	
2013	2,459	984	34	14	1%
2014	1,583	633	65	26	4%
2015	1,822	729	3	1	0%
2016	926	370	6	2	1%
2017	1,384	554	8	3	1%
2018	495	198	3	1	1%
2019	983	393	15	6	2%
AVG	**1,122**	**AVG**	**7**		

Fall Chinook

Basin-wide	Above Dam Site	% above
Spawners	Spawners	
11,158	NA	
16,292	NA	
9,778	NA	
10,158	297	3%
8,590	302	4%
13,227	314	2%
7,117	338	5%
9,594	239	2%
12,876	575	4%
11,118	178	2%

Coho

Basin-wide	Above Dam Site	% above
Spawners	Spawners	
87,959	NA	
58,083	NA	
63,523	NA	
52,133	174	0%
92,000	1,460	2%
19,386	910	5%
31,730	256	1%
22,691	1,240	5%
62,342	2,126	3%
30,012	NA	4%

Winter Steelhead

Basin-wide	Above Dam Site	% above
Spawners	Spawners	
6,090	NA	
7,592	NA	
9,776	NA	
6,946	922	13%
10,567	1,492	14%
8,824	1,232	14%
4,618	992	21%
6,840	860	13%
6,130	944	15%

Notes:
All Species: Basin-wide escapement estimates are preliminary and are subject to change. If change occurs, those are expected to be minor.
Steelhead: 2019 fish have not spawned yet
Coho: Intensive surveys above proposed dam site were last conducted in 2018. The 4% above is the percent of enumerated redds counted from index surveys from above the dam

STATE OF WASHINGTON April 2020

Spawner Abundance and Distribution of Salmon and Steelhead in the Upper Chehalis River, 2019 and Synthesis of 2013-2019

by Lea Ronne,
Nick VanBuskirk and Marisa Litz

Washington Department of
FISH AND WILDLIFE
Fish Program

FPT 20-066

Spawner Abundance and Distribution of Salmon and Steelhead in the Upper Chehalis River, 2019 and Synthesis of 2013-2019

Washington Department of Fish and Wildlife

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April 2020

Acknowledgements

We would like to thank Mike Scharpf, Amy Edwards, Curt Holt, James Losee, and Mara Zimmerman for their assistance and helpful comments on this work, and our surveyors for collecting data and samples during the 2018/2019 field season: Brian Barry, Oliver Crew, Kim Figlar-Barnes, Chad Gabreski, Jesse Guindon, Craig Loften, Danielle Williams, Ben Stillman, and Bill Youmans. Thanks to Kim Figlar-Barnes who reconciled and input data. Scale ages were provided by WDFW Fish Ageing and Otolith Laboratory staff. We would also like to thank Panesko Tree Farm, Green Diamond Resource Company, and the Weyerhaeuser Corporation for allowing access to survey on their property.

This work was funded by the Washington State Legislature with funding designated for study, analysis, and implementation of flood control projects in the Chehalis River Basin. Projects completed under this funding were selected to fill key information gaps identified in the Aquatic Species Enhancement Plan Data Gaps Report published in August 2014. Project funding was administered by the Washington State Recreation Conservation Office.

Recommended citation: Ronne L., N. VanBuskirk, M. Litz. 2020. Spawner Abundance and Distribution of Salmon and Steelhead in the Upper Chehalis River, 2019 and Synthesis of 2013-2019, FPT 20-06 Washington Department of Fish and Wildlife, Olympia, Washington.

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Executive Summary

Flood control alternatives being considered as part of the Chehalis Basin Strategy include a Flood Retention Expandable (FRE) facility that would be located in the main stem Chehalis River at river mile 108.2 upstream of the town of Pe Ell. Monitoring efforts in the Chehalis River Basin have not historically focused on delineating population trends above vs. below the location of the proposed facility. However, information on spawner abundance and distribution data in this area of the river was identified as a data gap by the Aquatic Species Enhancement Plan Technical Committee of the Chehalis Basin Strategy (Aquatic Species Enhancement Plan Technical Committee, 2014). This study was undertaken to understand the numbers and species of salmonids that would be affected above, within, and below the area backwatered (referred throughout the document as the inundation footprint) by the proposed FRE facility and its associated temporary reservoir. The   This work also informs fish passage needs should an FRE facility be chosen as a structural solution to control flooding within the Chehalis Basin.

Two different frequencies of survey were used to evaluate salmonid spawners above the proposed FRE site – index surveys were conducted at approximately seven-day intervals throughout the spawning period and supplemental surveys were conducted once during peak spawning. Together, index and supplemental surveys covered the entirety of known spawning habitat for each species. Surveys started the third week of September based on prior knowledge of when fish (spring Chinook) begin spawning and continued on a weekly basis through the spawning seasons for spring and fall Chinook salmon, Coho salmon, and winter Steelhead. Surveys concluded in mid-June when no new redds were observed for two consecutive weeks at the end of the project spawning period. An additional survey of the main stem Chehalis River from river mile 108.2 (proposed FRE facility) downstream to the Newaukum River confluence (RM 75.4) was surveyed four times annually, once during the peak spawn timing for each species and run type. The purpose of these additional surveys was to document the spatial distribution of spawning in the main stem river.

Surveys were conducted either on foot, in pontoon-style boats, or by helicopter. Crews identified and recorded all spawning activity by species per reach segment. Individual redd locations were georeferenced. Live and dead fish counts included the species and sex. Carcass sampling included fin mark sampling (adipose fin clip vs. adipose intact), fish length, coded wire tag (CWT) status, and scale collection for aging Chinook and Steelhead. Tissue samples were taken from Coho for genetic analysis.

Results from the 2018-2019 survey season were collected in a similar manner to the previous five survey seasons (2013-2018) to document the spawning distribution of spring and fall Chinook, Coho, and winter Steelhead in the reaches upstream, within, and below the proposed FRE facility footprint and associated temporary reservoir. Major findings from the 2018/2019 survey season include:

- The majority of spawners observed for all species in this area of the watershed were natural-origin; hatchery fish were rare to absent.
- Abundance of spring and fall Chinook salmon within the study area was estimated to be 3 (spring) and 578 (fall) adult spawners. Chinook spawning activity was observed between September and December. Both spring and fall Chinook spawned primarily in the main stem river, 100% (1/1) and 90% (207/230) of redds, respectively. The percentage of spring Chinook redds found within the FRE facility inundation footprint was 100% (1/1) and fall Chinook 96% (221/230).
- Abundance of Coho salmon within the study area was estimated to be 2,128 adult spawners. Coho spawning activity was observed between late October and February with 25% (270/1062) of redds in the inundation footprint.

- Abundance of winter Steelhead within the study area was estimated to be 956 adult spawners. Steelhead spawning activity was observed between the months of February and June. Percentage of Steelhead redds in the inundation footprint was 33% (194/589).
- On the main stem river from the proposed FRE facility site downstream to Newaukum River, we observed minimal Coho and Steelhead spawning but significant spring and fall Chinook spawning activity. The highest density of fall Chinook occurred between the proposed FRE facility site (RM 108.2) and Elk Creek (RM 100.2). In contrast, spring Chinook spawning distribution was more evenly distributed between the proposed FRE facility site and the Newaukum River.

After six years of intensive monitoring in the Upper Chehalis sub-basin above the proposed FRE facility we found that spawning occurred almost continuously from September through June. The majority of spawning for spring and fall Chinook occurred within the mainstem and inundation footprint. Coho and Steelhead utilize the mainstem habitat in the inundation footprint but a greater proportion of their spawning occurred upstream and in tributaries. There is also a higher density of spawning by spring and fall Chinook in the mainstem below the proposed FRE facility near Pe Ell when compared to other mainstem locations.

During the first four field seasons (2013-2018), Steelhead were the most abundant species utilizing the spawning habitat above the proposed facility. Coho had the next highest abundance followed by fall Chinook and spring Chinook. However, in the last two years of the study (2017-2019) a shift has occurred, and Coho are now exhibiting higher spawner abundances than Steelhead, which have been declining in abundance since 2015. In addition, Coho are exhibiting a brood cycle decrease in abundance every three years that can be traced back to the 2007 flood. Overall, spring Chinook exhibited a ten-fold decline after the first two years of the study. This could be partially attributed to refinement of the method for field identification of spring Chinook to a weight of evidence approach that was formerly implemented during the 2015/2016 survey season. However, there was also a noticeable decline of total spawner abundance in the last week of September and first week of October which indicates that this decline was likely not just due to a refinement of methodology. A way to validate field calls or alternative ways to differentiate spring from fall Chinook spawners needs to be developed. Recent studies on genetics and otoliths holds promise for new and more accurate methods for determining run-type, but there is still work needed to make that information available for field biologists.

The Upper Chehalis sub-basin does not have a large component of hatchery strays for any species but data on the hatchery-origin contribution to the Steelhead run has been uncertain. While snorkel surveys have not confirmed hatchery presence, results from spawning ground surveys revealed two carcasses with adipose fin clips. It is apparent from our data that the convention of using March 15th as a cutoff date for hatchery- to natural-origin Steelhead when estimating escapement is not be appropriate for the Upper Chehalis sub-basin and likely not appropriate for other areas in the Chehalis basin. Compared to other species, Steelhead make up the greatest contribution (15.43%) to the entire Chehalis basin spawner abundance. Other species (spring Chinook, fall Chinook, and Coho) contribute less to the Chehalis basin totals at 1.25%, 3.37% and 2.72%, respectively. Though these proportions may seem small relative to the entire Chehalis Basin, genetic data supports that the Upper Chehalis Coho contribute a sizable abundance to a population that is genetically diverse from the rest of the Chehalis basin. Steelhead in the Chehalis basin also have a population structure that is genetically diverse and is comprised of three distinct groups: Willapa Hills, Cascades, and Olympics. Chinook salmon also show genetic diversity between the upper basin and lower basin populations. Genetic diversity as well as habitat heterogeneity is important to the continuation of these species in the face of climate change and anthropogenic impacts. We do not fully understand the extent to which these genetically distinct populations in the Upper Chehalis sub-basin contribute to the Chehalis population. However, all six years of the study demonstrate that spring and fall Chinook, Coho, and Steelhead actively spawn at varying levels of intensity in the area likely to be impacted by the proposed FRE facility.

Introduction

Understanding the numbers and diversity of native salmonids originating from the Upper Chehalis River sub-basin is an important part of the Chehalis Basin Strategy, a multi-tiered plan to reduce flooding in the Chehalis Basin and restore habitat to support native aquatic species. In 2014, spawning distribution of salmonids in the Chehalis River and tributaries was identified as a data gap (Aquatic Species Enhancement Plan Technical Committee 2014), including the area where a Flood Retention Expandable (FRE) facility site was being proposed upstream of the city of Pe Ell, Washington (Figure 1). The Chehalis River and its tributaries upstream of river mile (RM) 108.2 near Pe Ell are described as the 'Upper Chehalis River sub-basin' in this report. Spring and fall Chinook salmon (*Oncorhynchus tshawytscha*), Coho salmon (*O. kisutch*), and winter-run Steelhead (*O. mykiss*) (hereafter referred to as Steelhead) were previously known to spawn in this area of the river. Other salmonids are either not currently found in the upper sub-basin (Chum *O. keta*, Pink *O. gorbuscha*, and Sockeye *O. nerka*) or were not a species of focus (Cutthroat *O. clarkii* and resident rainbow trout). Construction and operation of a dam would alter the existing habitat and has the potential to interrupt migration patterns in the river. Diverse habitats are important to the life history diversity of salmonids and their resilience in an increasingly warming climate (Timpane-Padgham et al. 2017, Milner et al. 2013, Sturrock et al. 2019). Therefore, there is a need to understand the current migration timing, numbers, and distribution of adult salmon and Steelhead that would be affected within and above the proposed FRE footprint to help inform fish passage needs associated with the proposed structure.

Spawning ground surveys (redd counts and live counts), along with carcass sampling, are commonly used to assess abundance and biological characteristics of adult salmonid spawners (Johnson et al. 2007). In the Upper Chehalis River sub-basin, surveys were conducted throughout the known distribution and spawn timing of each species with additional effort to obtain the upper limits of each species' spawning distribution. These surveys provided intensive and fine-scale information on salmonid use and expanded the spatial coverage of long-term index reaches surveyed by the Washington Department of Fish and Wildlife (WDFW) for stock assessment purposes in the entire Chehalis basin. This report summarizes the most recent results of surveys conducted between September 2018 and June 2019 and provides a synthesis of all years (2013-2019), with recommendations for future monitoring.

Objectives

The overall goal of this study was to describe the abundance, spawn timing, spatial distribution, and diversity of adult spring and fall Chinook, Coho, and Steelhead in the Upper Chehalis River sub-basin and to document the spatial distribution of spawning in the main stem river downstream of the proposed FRE site. In order to accomplish this goal, our objectives were to:

- Conduct weekly surveys by foot or pontoon boat (as conditions allowed) and collect information on redds, live fish, and carcasses,
- Calculate the abundance of each species and summarize results related to timing, spatial distribution and diversity of spawners,
- Conduct a peak survey on the main stem river below the proposed FRE site for each target species to collect information on spatial distribution of spawning, and
- Interpret results with respect to potential impacts of the proposed FRE facility near Pe Ell, WA.

Methods

Study Area

Prior to 2013, index reaches surveyed for salmon and Steelhead were designed as part of a Chehalis basin-wide stock assessment effort and had limited spatial coverage within the Upper Chehalis River sub-basin. The current project intensified the spatial and temporal coverage of surveys above the proposed FRE site. At the start of this project, spatially continuous survey reaches were added to the project area to create a more inclusive picture of salmonid use above river mile (RM) 108.2 (Ashcraft et al. 2017). This spatial distribution has been further refined over six seasons based on observed spawning (details on survey reaches provided in Appendix A).

There were two primary types of surveys used for this project: index and supplemental. Index surveys were designed to cover all or most of the available anadromous spawning areas and occurred approximately every seven days. These surveys were conducted throughout the spawn timing for all salmon and Steelhead in the project area. Supplemental surveys were performed during peak spawning to cover any potential spawning habitat that was unable to be covered on a weekly basis. The observational relationships between index and supplemental surveys above the proposed FRE site were used to expand supplemental survey observations.

Supplemental surveys were conducted for Coho and Steelhead at the upper extent of the index reaches and in smaller tributaries where it was logistically unfeasible to survey weekly. Spring and fall Chinook did not require any upper supplemental surveys since all the spawning occurred within the index surveys. To determine the lower extent of spawning in the mainstem above the Newaukum River, a supplemental survey below the FRE site was implemented for each species during peak spawning.

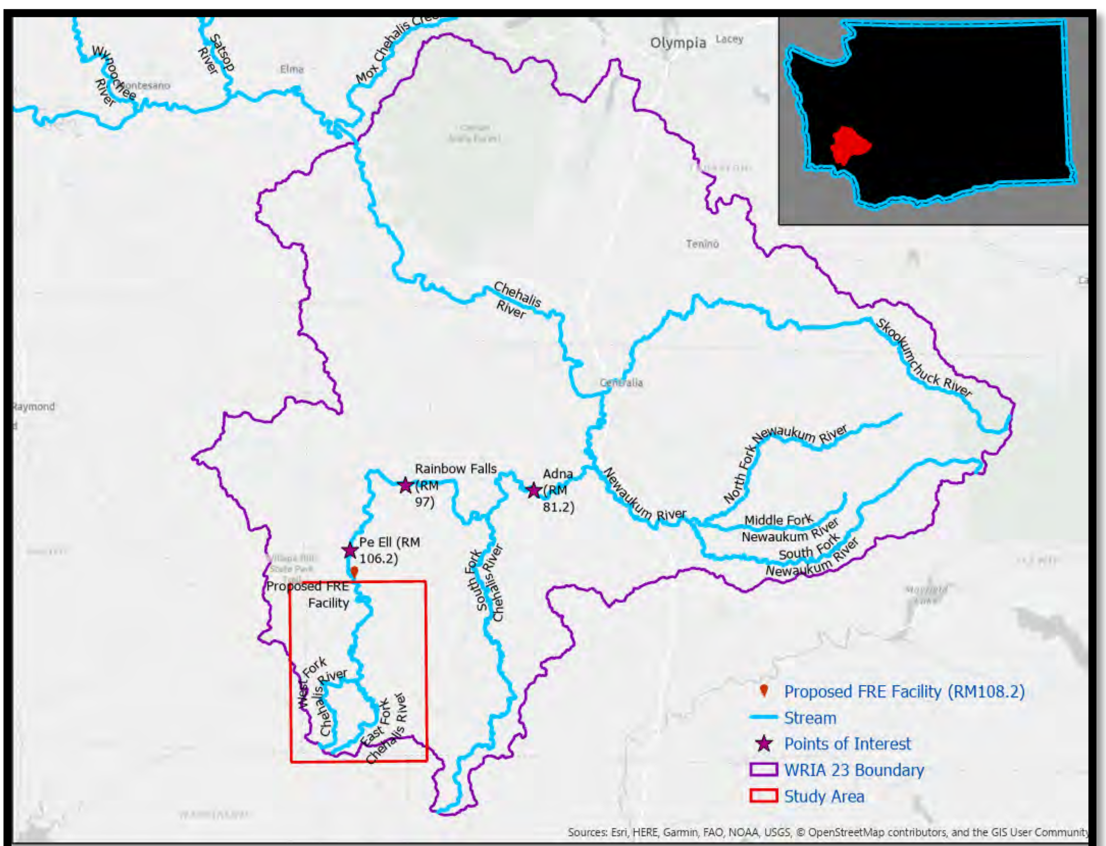

Figure 1. Map of Water Resource Inventory Area (WRIA) 23 containing the Upper Chehalis River sub-basin.

The upper extent of Chinook spawning within their potential spawning distribution was determined by maintaining surveys upstream of the location where the last occurrence of Chinook (lives, deads or redds) was observed. If Chinook were observed within a kilometer of the top of a reach, the next reach upstream was added as an index. Coho and Steelhead had similar total river miles surveyed among years for both index and supplemental reaches (Table 1).

Table 1. Total river miles targeted for weekly (Index=IND) surveys and for supplemental surveys (SUP; preformed once during peak) , in the Upper Chehalis River sub-basin for each species and year.

	Spring Chinook[a]		Fall Chinook[a]		Coho		Steelhead	
Survey Season	IND	SUP	IND	SUP	IND	SUP	IND	SUP
2013-2014	29.2	---	30.0	---	33.2	10.8	34.6	7.1
2014-2015	27.7	---	31.7	---	35.5	9.9	34.8	15.5
2015-2016	21.5	---	31.7	---	35.5	12.7	34.8	17.2
2016-2017	31.0	---	31.5	7.3	36.8	14.2	36.8	14.8
2017-2018	31.0	---	31.5	---	37.1	15.4	37.7	15.1
2018-2019	31.0	---	35.3	---	35.7	17.0	36.8	16.8

[a] No supplemental surveys were conducted for spring or fall Chinook in 2018 season because their entire spawning distribution was included in the index surveys.

Data Collection

Spawning ground surveys were conducted for spring and fall Chinook from September through mid-December, Coho from October through February, and Steelhead from December through June. Survey timing in statistical weeks (SWs) used for fish management ranged from SW 38 in year one through SW 21 in year two. Index reaches were surveyed weekly when possible unless weather conditions, stream flows, clarity, or safety concerns became apparent. Surveys of index reaches started before spawning began in the study area (based on prior knowledge of the basin) and continued until no new redds were observed for two consecutive weeks during the end of the projected spawning period. Supplemental reaches were surveyed once for each species as close to peak spawn timing to maximize the numbers of redds visible for enumeration.

During each survey, information was recorded on a data sheet (Appendix C). In order to standardize observer efficiency as much as possible, all surveyors wore polarized sunglasses and a brimmed hat while conducting surveys. Surveys were conducted on foot or by pontoon boat and all spawning activity was recorded by species and reach. Surveys included monitoring new and old redds, counting live and dead fish, and opportunistically sampling carcasses for both adipose mark status and biological collections.

Redds

A redd is defined as an excavation made in the stream bed by a female salmonid that contains a partial or full complement of her eggs. Each redd was identified to species, flagged, numbered, and georeferenced. In the field, new redds were flagged and marked and distance from the flag to the leading edge of the pit noted in order to track future redd visibility, identify upstream expansion of the dig, and interpret superimposition by other female salmonids. Since spatial and temporal overlap in spawning activity occurs between fall Chinook and Coho, and between Coho and Steelhead, surveyors were trained to recognize the redd differences between each species based on habitat use and redd structures (Burner 1951; Gallagher et al. 2007). In addition, surveyors continually explored potential spawning areas through supplemental and exploratory surveys.

We followed the WDFW Region 6 District 17 protocol to assign run type (spring or fall) of a Chinook salmon redd based on timing, redd condition, and phenotypic characteristics, behavior, and condition of any associated live fish observed with the redd. These assignments also used information on observations of fall Chinook activity, flow levels, and other spawning activity within the basin. Redds constructed after October 15th were all assumed to be fall Chinook, but redds constructed on or prior to

October 15th were assigned either spring or fall Chinook based on the condition of live fish associated with the redd (Appendix D). If a surveyor was unable to make an informed decision on run type of a redd constructed on or prior to October 15th, the redd was assumed to be spring Chinook.

Live fish

Surveyors counted live fish while surveying and recorded species, sex, and mark status (adipose fin present or absent) if possible. Surveyors were trained to recognize species differences among live fish using morphology, coloration, behavior and movement.

Carcasses

Carcasses were opportunistically recovered during redd surveys and sampled for species, sex, mark status (adipose-clipped), coded-wire-tag (CWT) presence, and biological data. Mark status and CWTs can be used to determine hatchery-origin. Sex and fork length were collected to assist with diversity metrics. Three or more scales were collected from each Chinook carcass and six or more scales from each Steelhead carcass for ageing. Coho scales were not sampled due to the consistency in age structure of returning adults (e.g. three years old). Tissue samples were collected from Coho for a companion genetics study that was published separately from this report (Seamons et al. 2020). Run type of Chinook carcasses in the field was assigned as spring or fall based on recovery timing, coloration, and fungus condition (see Appendix D).

Snorkel Surveys

Because of the low numbers of carcasses found during Steelhead redd surveys, snorkel surveys were conducted approximately every two weeks from late February through late April to determine proportions of natural-origin (unclipped) versus hatchery-origin (adipose fin clipped) Steelhead in the study area. The snorkel survey schedule was designed to encompass the period before and after the March 15th cutoff date used to differentiate hatchery-origin fish from natural-origin fish (hatchery fish are assumed to arrive earlier than natural-origin fish). Snorkel surveys in the Upper Chehalis sub-basin occurred from the falls (RM 4.2) on West Fork Chehalis to the mouth, East Fork Chehalis from George Creek (RM 124.2) to the confluence with West Fork, and the mainstem from the East and West Fork Chehalis confluence (RM 120.1) to the proposed FRE site (RM 108.2). Teams of two to three divers covered two to four miles of river in a downstream direction, recording observations of Steelhead (unclipped, adipose fin clipped, unknown clip) throughout each reach.

Analysis

Abundance

Estimates of abundance were based on enumerated redds in index reaches, enumerated and expanded redds in supplemental reaches, and a species-specific expansion factor. Redds observed in supplemental reaches were expanded by the ratio of visible-to-cumulative redds observed in the nearest applicable index reach. The visible-to-cumulative ratio was the number of redds visible in the nearest index reach on the day of, or within one day of, the supplemental survey divided by the cumulative redds observed in the nearest index reach for entire spawning season. The timing of supplemental surveys was selected to coincide with when the highest proportion of the total redds for the season were visible. The visible-to-cumulative expansion was applied if the visible to cumulative ratio was ≥ 0.20 at the time the supplemental survey occurred. If the visible to cumulative ratio was <0.20, the number of observed redds in the supplemental reach was included in the abundance estimate, but no expansion was made. The result of this calculation was the estimate of the total number of redds in the supplemental survey reach for the season.

Species-specific expansion for Chinook assumes 1.0 female per redd and 1.5 males per female, which is the standard expansion used for WDFW stock assessment in western Washington. For Coho, the expansion from redd estimate to adult spawners assumes 1.0 female per redd and 1.0 male per female, which is also the standard expansion used for WDFW stock assessment in western Washington. For Steelhead, the expansion from redd estimate to adult spawners assumes 0.81 females per redd and 1.0 male per female and is based on previous trap studies conducted in Snow Creek, Washington (USFWS and WDG 1980; Freymond 1982). The Steelhead expansion factor reflects a combination of observer efficiency (not observing every redd), multiple redds built by a single female Steelhead, and an assumed one-to-one ratio for male and female Steelhead. These expansion factors were not independently validated (e.g., using abundance from a weir or mark-recapture study). The redd based estimation methodology is based on multiple assumptions, including:

Assumption 1: redds are correctly identified to species,
Assumption 2: survey reaches provide representation of spatial and temporal distribution of redds,
Assumption 3: true redds are accurately distinguished from natural scour and test digs in the field,
Assumption 4: ratio of fish per redd is constant among years and is accurately represented by the species-specific expansion factor, and
Assumption 5: no difference in spawn timing distribution between supplemental reaches and index reaches used in the visual-to-cumulative ratio expansions (proportional visibility of redds between related index reaches and supplemental reaches)

The Steelhead redd counts were partitioned as early or late to align with WDFW methodology, where early Steelhead redds (on or before March 15th) are assumed to be hatchery origin and late Steelhead redds (after March 15th) are assumed to be wild origin. Early redds were assumed to be of hatchery origin because many hatchery Steelhead programs in western Washington have an early run and spawn timing. However, most hatchery Steelhead programs in the Chehalis River have a similar run and spawn timing to wild Steelhead due to the integration of wild origin fish into the hatchery production. Ongoing field observations gathered and reported as part of this study suggest that there are minimal hatchery Steelhead returning to the Upper Chehalis River sub-basin. Therefore, an estimate for the entire run (pre- and post-March 15th) was also created for this year and for all previous years of the study for this report.

Timing

Spawn timing for each species was summarized as the number of new redds observed each statistical week and presented in graphical format.

Spatial Distribution

Redd locations were plotted using ArcGIS Pro for each species. These locations were visualized in map form overlaying the areas surveyed as index and supplemental reaches. The maps also include the potential inundation footprint for the proposed FRE facility. The inundation footprint is the expected extent of the temporary reservoir created when the facility is closed to reduce flooding. Spatial distribution of spawning activity was also summarized for each species as the proportions of redds within versus outside the FRE footprint and the proportions in main stem versus tributary habitat. These calculations were based on the total redds and included those estimated from visible to cumulative expansions in supplemental reaches.

Diversity

Life history diversity was assessed based on age structure (years in freshwater and the ocean) and summarized based on results from scales sampled from Chinook and Steelhead carcasses. Age data were not collected for Coho, but rather Coho were all assumed to be age 3.

The ratio of hatchery- to natural-origin spawners was calculated based on mark status of sampled carcasses. Chinook, Coho, and Steelhead hatchery- to natural-origin ratio was determined from the adipose fin and CWT status of recovered carcasses. Steelhead origin was further validated by scale growth patterns as determined by the WDFW Otolith and Ageing Lab.

Results

Survey Effort

The 2018-2019 survey season began September 15th and concluded June 16th (Figure 2). The most frequently surveyed areas were the main stem Chehalis, East Fork (EF) Chehalis, and the West Fork (WF) Chehalis as these three areas encompassed spawning habitat for Chinook, Coho, and Steelhead. The main stem Chehalis and EF Chehalis were the areas most affected by weather, high flows, or turbidity. Total miles of stream surveyed for spring and fall Chinook were 31 and 35.3, respectively. In comparison, Coho and Steelhead required 52.7 and 53.6 miles, respectively, of stream surveyed to cover the complete distribution.

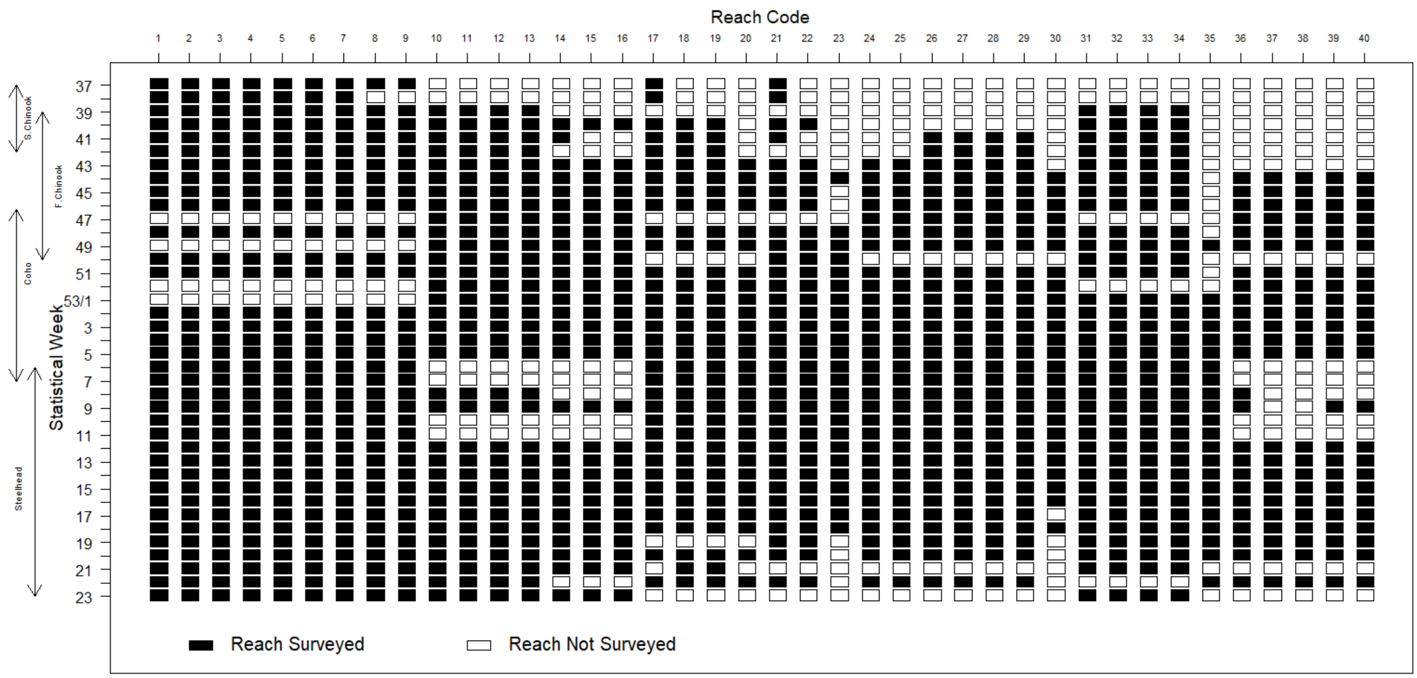

Figure 2. Survey status of index reaches by statistical week for the 2018-2019 survey season. Description of reach codes and statistical weeks provided in Appendix A and Appendix B.

Abundance

During the 2018-2019 survey season, the estimated abundance of spring Chinook was 3 adults, fall Chinook was 578 adults, Coho was 2,128 adults, and early and late Steelhead were 88 and 862, respectively (Table 3, Figure 3). A combined estimate of early and late Steelhead was 956 adults. Coho in 2018 had the biggest change in abundance from previous years (2013-2018) at 2.5 times the average. Fall

Chinook also had a higher abundance in 2018 at 1.8 times the previous year's average. Both Steelhead and spring Chinook were below the 2013-2018 average with 74% and 13%, respectively.

Table 2. Number of total redds and estimated abundance of adult salmon and Steelhead spawners in the Chehalis River sub-basin above the proposed Flood Retention Expandable (FRE) site. Redds include those observed in index reaches and estimated from supplemental reaches.

	Spring Chinook		Fall Chinook		Coho		Early Steelhead		Late Steelhead		Combined Steelhead	
Year	Redds	Adults	Redds	Adults	Redds	Adults	Redds	Adults	Redds	Adults	Redds	Adults
2018-2019	1	3	230	578	961	2128	51	88	532	862	589	956
2013-2018 Avg	--	23	--	320	--	858	--	141	--	1142		1295

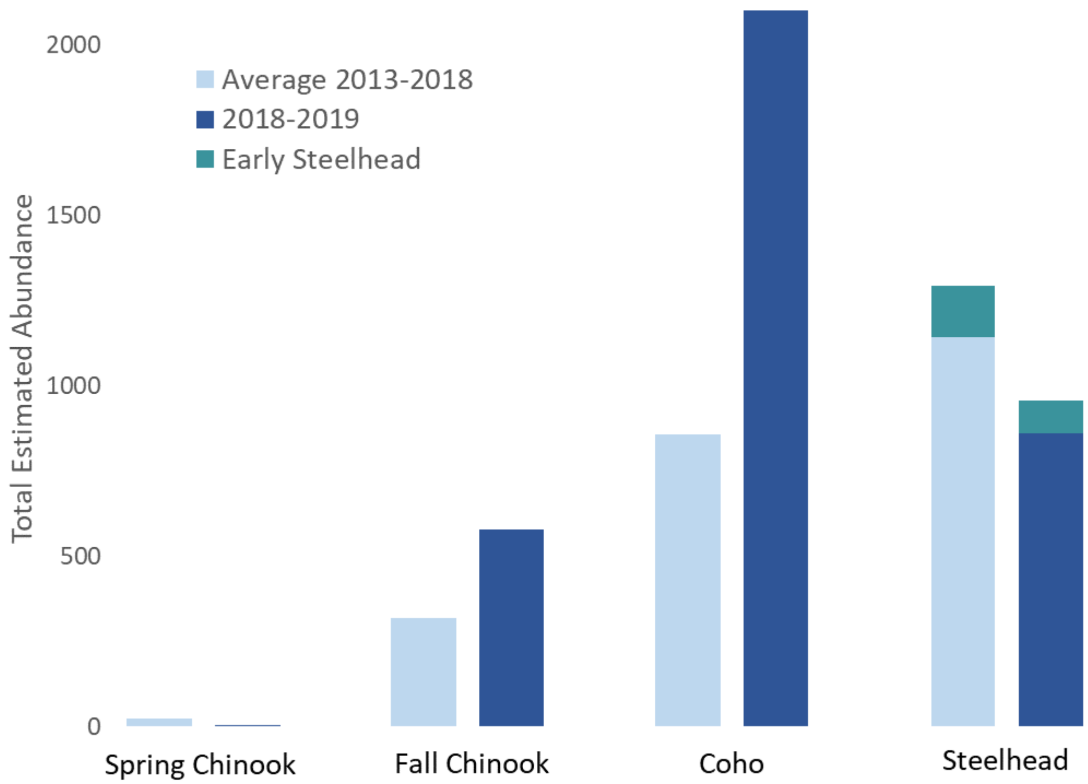

Figure 3. Total estimated spawner abundance of spring Chinook, fall Chinook, Coho, early Steelhead (on or before March 15th), late Steelhead (after March 15th) and combined Steelhead in 2018-2019 season and the previous 5-year average.

Coho displayed a distinct brood cycle decline every three years coinciding with the brood line associated with the 2007 flood (Figure 4). By contrast, the aparent decline of Steelhead after 2015 in the Upper Chehalis appears to align with a similar decline in natural stocks occuring throughout the Pacific Northwest. The percent contribution of each species observed in the Upper Chehalis sub-basin relative to the entire Chehalis Basin and Grays Harbor Basin (including the Humptulips and South Harbor rivers) was determined for each species (Table 4). Steelhead spawning in the Upper Chehalis Basin contributed the most to the entire Chehalis Basin at 15.43% and spring Chinook contributed the least at only 1.24%.

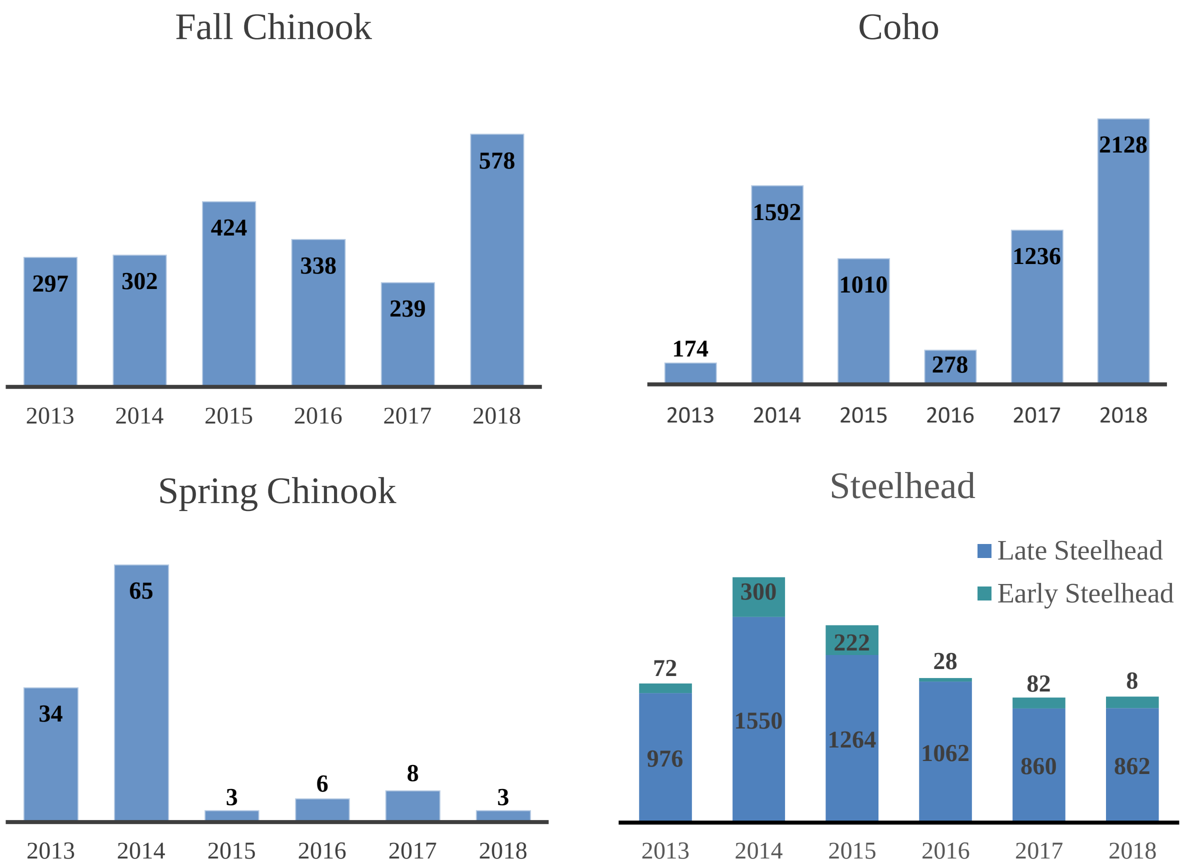

Figure 4. Annual estimates of spawner abundance from 2013-2019 for spring Chinook, fall Chinook, Coho and Steelhead.

Table 3. The contribution of Upper Chehalis, above the proposed Flood Retention Expandable (FRE) site, escapement to the Chehalis Basin (Chehalis River and all tributaries) and Grays Harbor (Chehalis Basin plus Humptulips and the South Harbor rivers) escapement totals.

Species	Chehalis Basin	Grays Harbor
Spring Chinook	1.24%	N/A*
Fall Chinook	3.37%	2.40%
Coho	2.72%	2.37%
Steelhead	15.43%	12.55%

*No additional contributions for spring Chinook from Humptulips or south harbor rivers

Timing

Spawn timing for spring Chinook in the Upper Chehalis sub-basin in 2018 occurred in mid-September, equivalent to Statistical Week (SW) 38 (Figure 5). Fall Chinook spawn timing (Figure 5) began in early October (SW 40) and ended in late November (SW 48), with peak spawning occurring in mid-October (SW 43). Coho spawn timing began in mid-October 2018 (SW 44), with peak spawning occurring in early December (SW 50) and terminating at the end of January (SW 5, Figure 6). Spawn timing for Steelhead (Figure 7) began in mid-January of the following calendar year (SW 5) and ended in mid-June (SW 21) with peak spawning occurring in mid-April (SW 16) which was consistent with previous years.

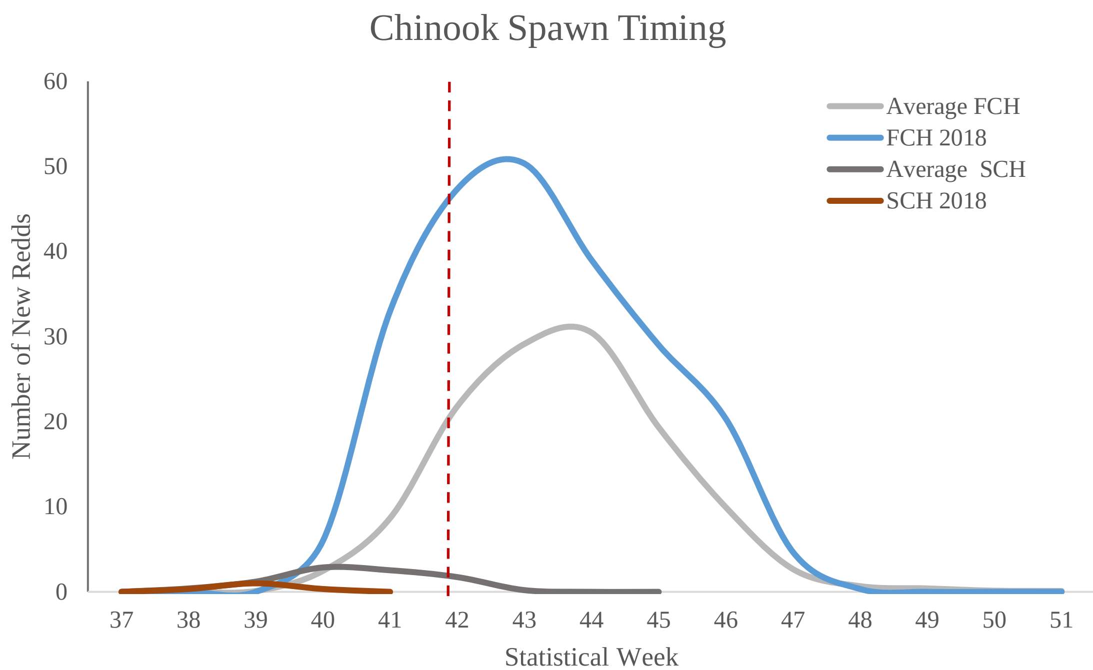

Figure 5. Smoothed three-week average of spawn timing for spring Chinook (SCH) and fall Chinook (FCH) in the Upper Chehalis sub-basin for 2018. The average of SCH and FCH were from survey years 2013-2017. The number of new redds indicates new redds observed each statistical week. Description of statistical weeks provided in Appendix B. The vertical red line indicates the WDFW October 15th threshold date for run identification (spring/fall).

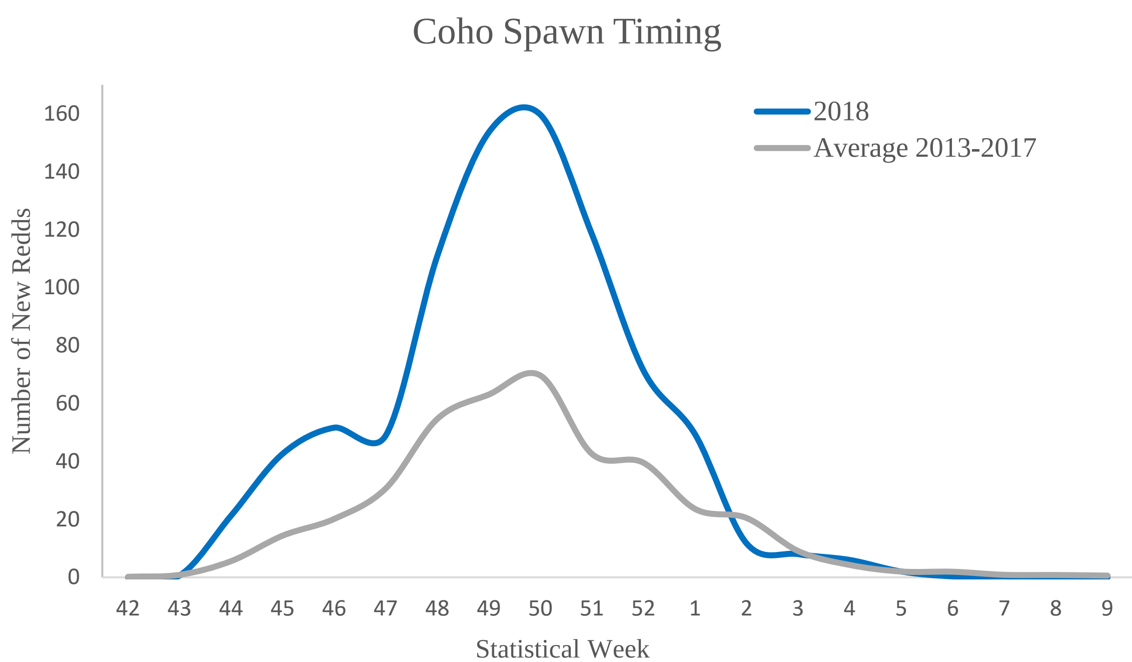

Figure 6. Smoothed three-week average of spawn timing for Coho in Upper Chehalis sub-basin for 2018. The average spawn timing is from survey years 2013-2017. The number of new redds indicates new redds observed each statistical week for index reaches only. Description of Statistical weeks provided in Appendix B.

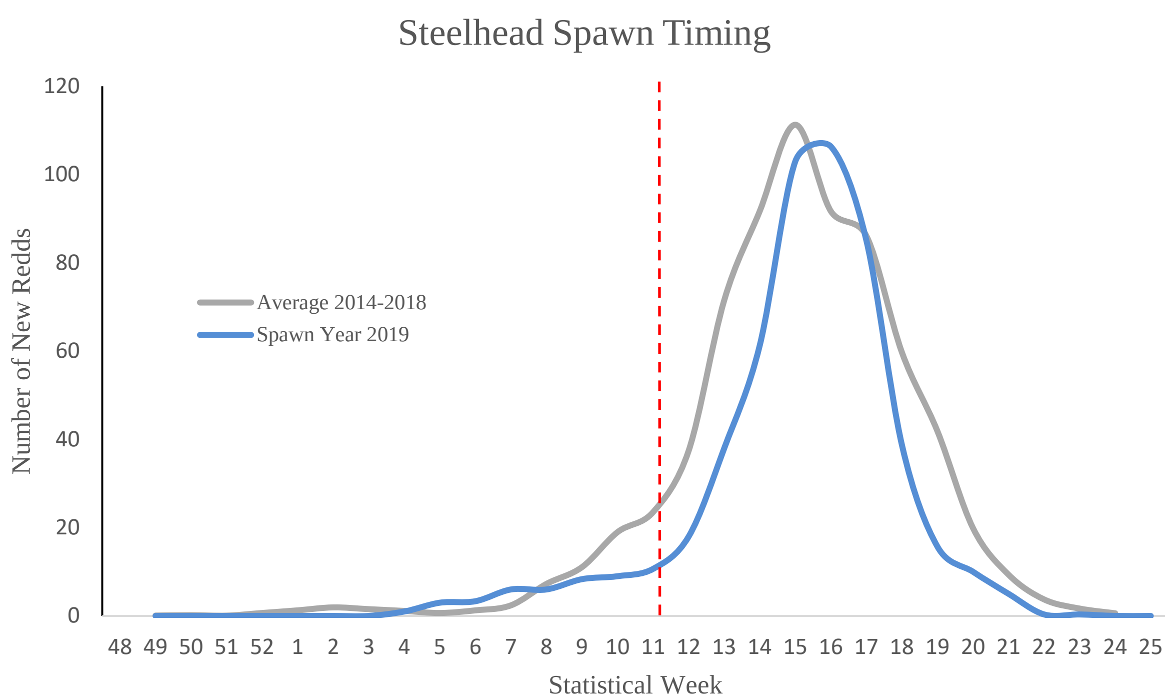

Figure 7. Spawn timing for 2019 Steelhead in the Upper Chehalis sub-basin. The number of new redds indicates redds newly observed each statistical week for index reaches only. The vertical line in the Steelhead spawn timing

graph indicates the WDFW March 15th threshold date for origin identification (hatchery:natural origin). Description of statistical weeks provided in Appendix B.

Spatial Distribution

In 2018, spring Chinook spawned exclusively in the Chehalis River main stem (Figure 8), and 100% of all spring Chinook redds (n = 1) were located within the FRE inundation footprint (Table 5). Fall Chinook spawning occurred in both main stem and tributary habitats. Ninety percent (90%, 207/230) of fall Chinook redds occurred in the main stem (Figure 9) and 96% (221/230) of all fall Chinook redds occurred within the FRE inundation footprint (Table 5). Coho spawning in 2018 also occurred in both main stem and tributary habitats. Estimated redds in supplemental reaches represented 19% of total redds. Twenty-five percent (25%, 270/1062) of Coho redds occurred within the FRE inundation footprint (Table 5). Steelhead spawning distribution in 2019 occurred 39% in the East and West Fork Chehalis, 25% in the tributaries and 36% in the main stem (Figure 11). Supplemental surveys contributed 10% to the total redd count estimate. Thirty-three percent (33%, 194/589) of all Steelhead redds were located within the FRE inundation footprint (Table 5). Nine percent of the total Steelhead redds would be considered “hatchery” or “early” utilizing the March 15th cutoff date.

Table 4. Number of redds estimated in the Upper Chehalis River sub-basin upstream of river mile 108.2 from 2013-2019. Numbers are shown within and outside the area expected to be inundated by water behind the facility when in use during high flow events (inundation footprint). Includes information from both index and supplemental survey reaches.

	Spring Chinook		Fall Chinook		Coho		Steelhead	
Survey Season	Within	Outside	Within	Outside	Within	Outside	Within	Outside
2013-2014	13	0	86	31	55	32	197	449
2014-2015	24	1	89	34	190	606	359	781
2015-2016	1	0	169	0	269	236	330	585
2016-2017	2	0	99	34	45	94	161	507
2017-2018*	1	2	89	5	203	417	150	428
2018-2019*	1	0	221	9	270	794	194	389

*Calculated for the Flood Retention Expandable (FRE) inundation footprint only.

Spring Chinook Redds 2018

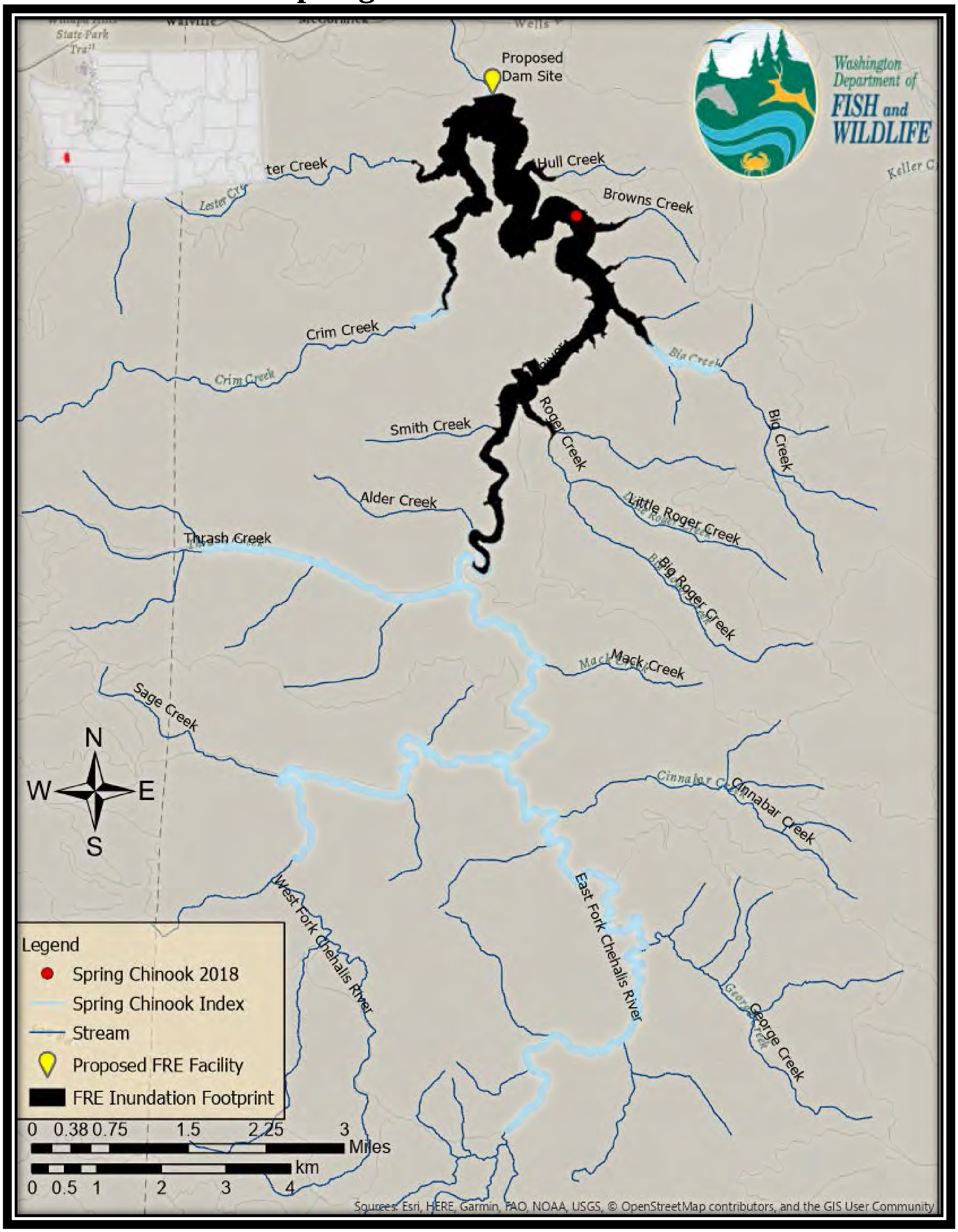

Figure 8. Map of the spatial distribution of redds for spring Chinook on the Chehalis River upstream of river mile 108.2. Map show the predicted inundation footprint of Flood Retention Expandable (FRE) facility.

Fall Chinook Redds 2018

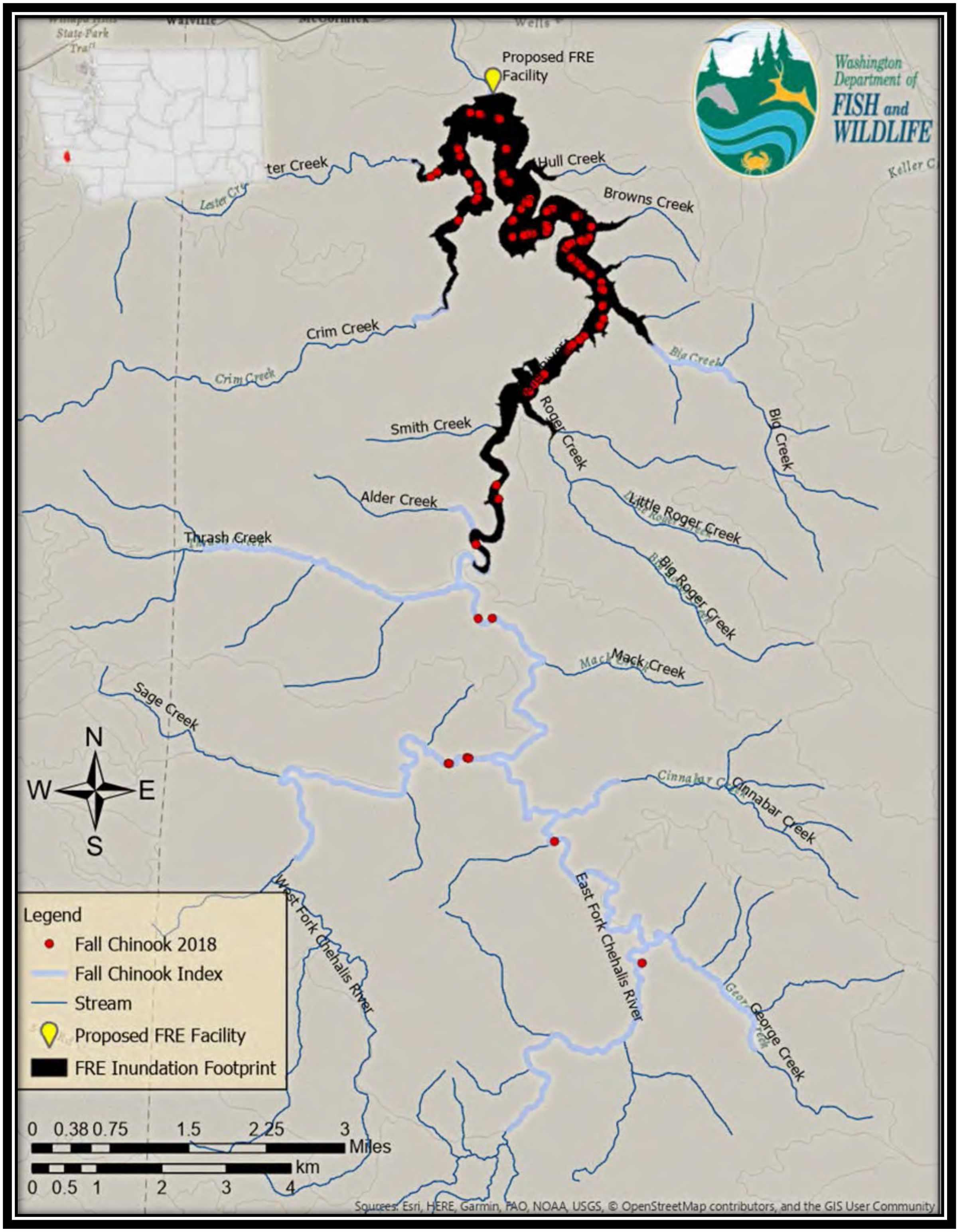

Figure 9. Map of the spatial distribution of redds for fall Chinook on the Chehalis River upstream of river mile 108.2. Map show the predicted inundation footprint of Flood Retention Expandable (FRE) facility.

Coho Redds 2018

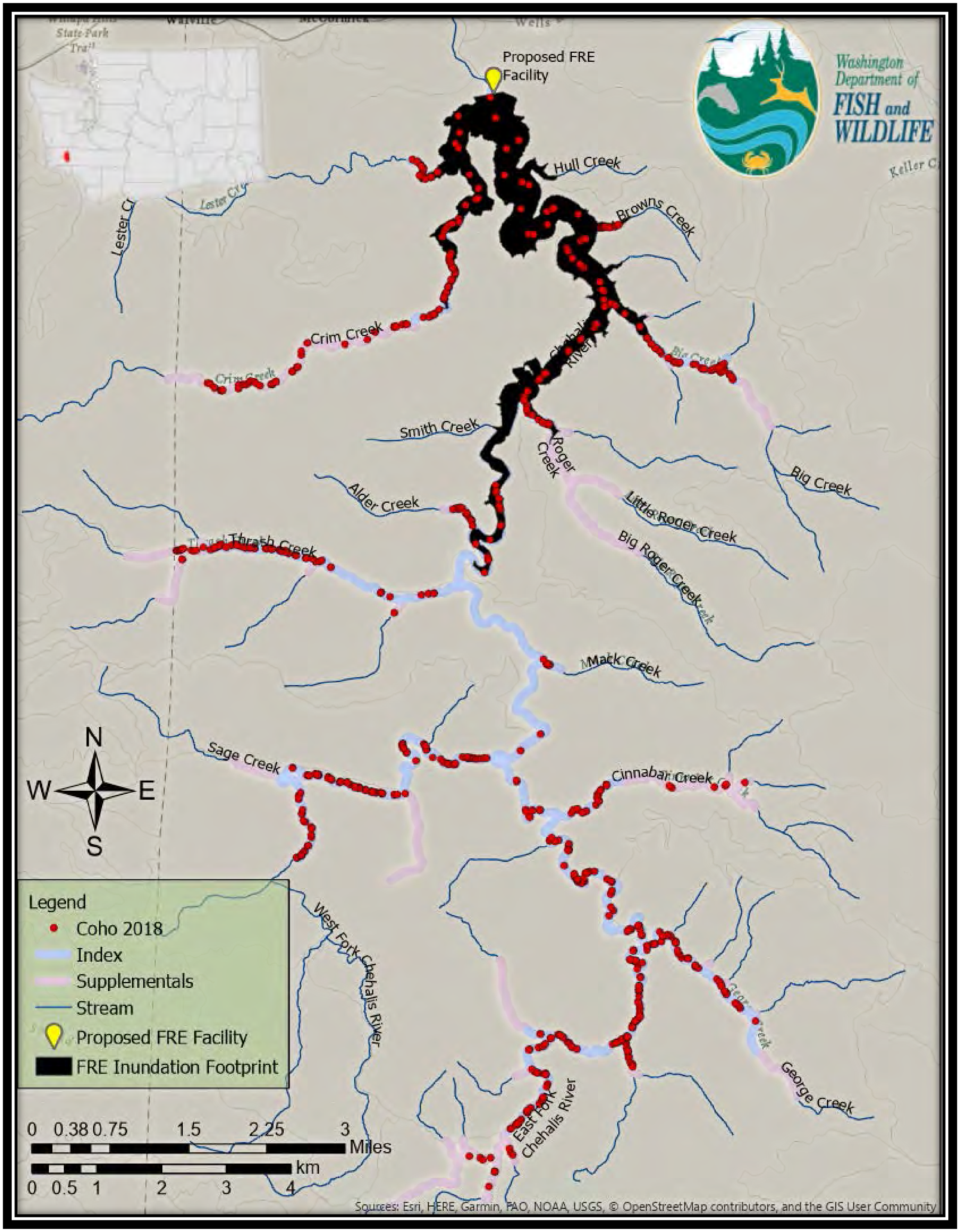

Figure 10. Map of the spatial distribution of redds for Coho on the Chehalis River upstream of river mile 108.2. Map show the predicted inundation footprint of Flood Retention Expandable (FRE) facility.

Steelhead Redds 2019

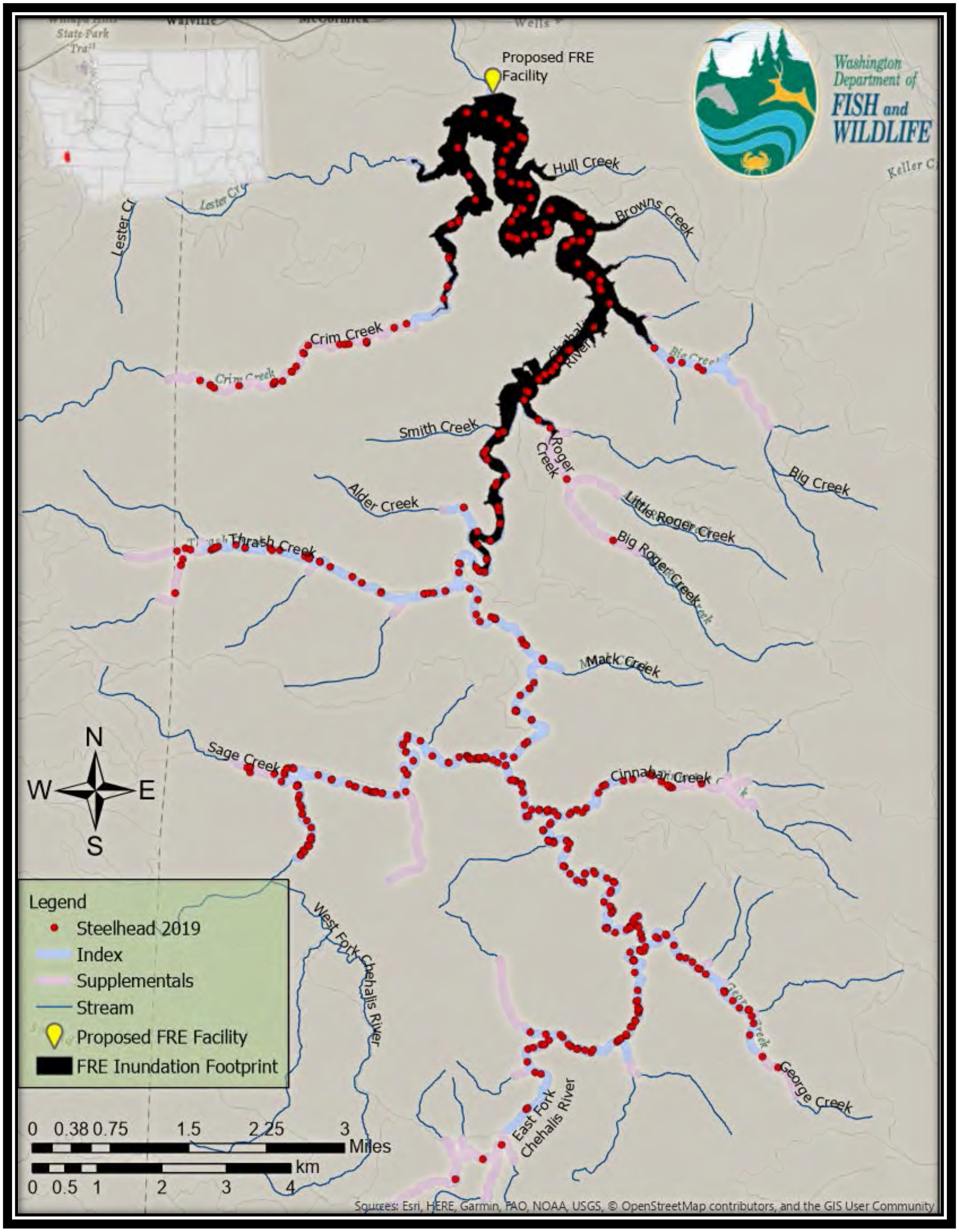

Figure 11. Map of the spatial distribution of redds for Steelhead on the Chehalis River upstream of river mile 108.2. Map show the predicted inundation footprint of Flood Retention Expandable (FRE) facility.

Diversity

During the 2018-2019 survey season, a total of 45 fall Chinook carcasses were recovered, zero of which had a clipped adipose fin. Only six Steelhead carcasses were recovered; one had a clipped adipose fin and one could not be aged. A total of 83 Coho carcasses were recovered and sampled. The female to male ratio for Coho was 1:1 with a single jack recovered. Jack Coho are sexually mature 2-year olds and were identified by size (<XX cm fork length). There were no Coho carcasses with a clipped adipose fin or CWT. All adult Coho were assumed to be ocean age 3. In 2018, no spring Chinook were recovered.

Of the 45 fall Chinook carcasses sampled in 2018, 45% were female and 55% were male with no jacks (<48 cm fork length). Of the sampled carcasses, 19 provided age and length information, six carcasses had length but no age information (due to regenerated scales), and seven carcasses had age but no length information. All sampled fall Chinook with readable scales had emigrated to saltwater as sub-yearlings (migrated to the ocean during the first spring and indicated by the .1 in the age notation). Scale analysis of fall Chinook carcasses estimated that 2% were age 3.1, 81% were age 4.1, and 16% were age 5.1. The average fork length and standard deviation were calculated for each age and sex group (Figure 12).

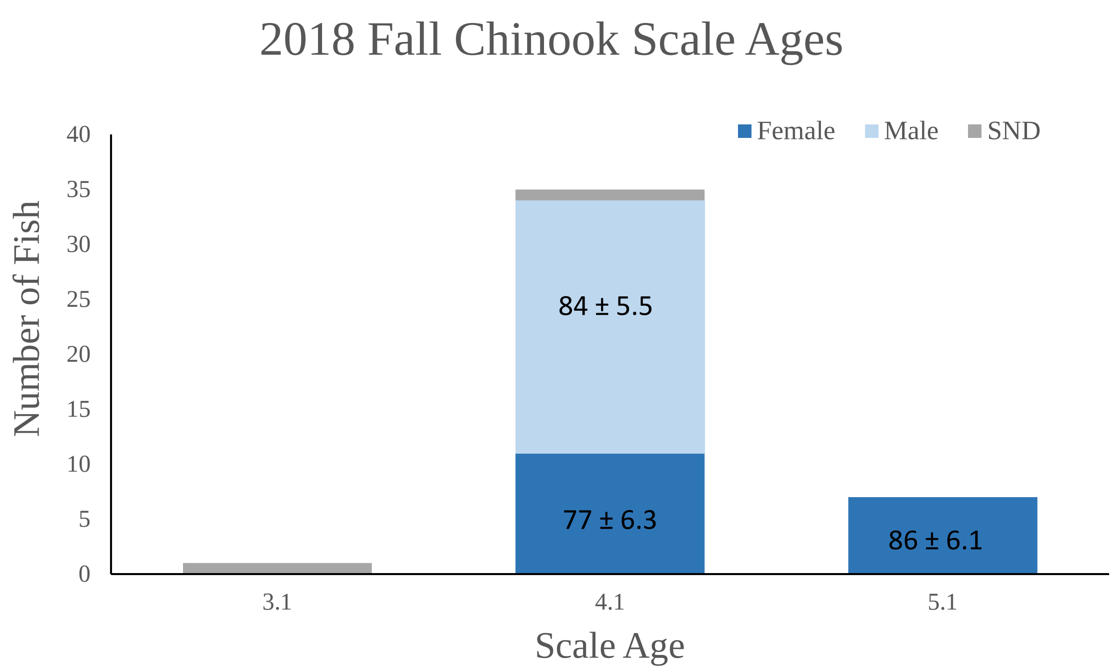

Figure 12. Age structure and average length (cm ± SD) of 2018 fall Chinook by sex for Upper Chehalis sub-basin above the proposed FRE site. Age is total number of years (all readable scales indicated that the fish had migrated to the ocean in their first year of life as a sub-yearling). The one 3.1 age sample did not have a fork length and was sex not determined (SND).

Six Steelhead carcasses were recovered in 2019 but only four natural-origin fish were aged (Figure 13) and none had lengths recorded due to degradation. However, those four fish displayed three life history types: W1.1+, 2.1+, and 2.2+ (Appendix F). One carcass was determined to be of hatchery-origin; it spent one year in freshwater and one year in saltwater before returning to spawn. An accurate determination of sex ratio was not obtained for either natural-origin or hatchery-origin due to the small sample size.

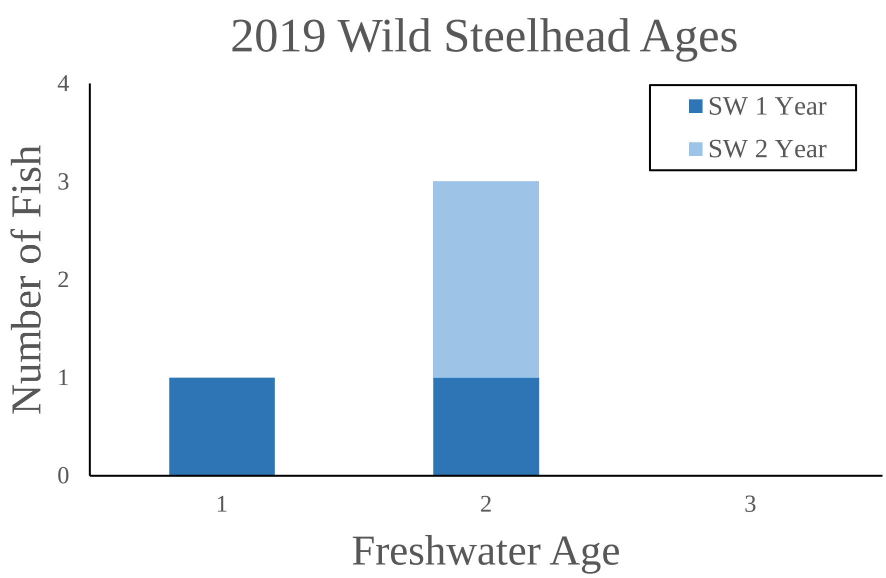

Figure 13. Freshwater and saltwater (SW) age structure of wild winter-run Steelhead returning to the Upper Chehalis sub-basin, 2019 spawn year.

Four snorkel surveys were conducted from February 28, 2019 to April 22, 2019 (Table 6). A total of 207 steelhead were observed with no confirmed adipose-clipped Steelhead recorded during any of those surveys.

Table 5. Number of Steelhead observed during snorkel surveys in the Upper Chehalis River sub-basin upstream of river mile 108.2.

Snorkel Dates	Adipose Intact (UM)	Adipose Clipped (AD)	Unknown	Total
2/28/2019*	3	0	0	**3**
3/15/2019	47	0	9	**56**
3/29/2019	85	0	17	**102**
4/22/2019	33	0	13	**46**
Total	**168**	**0**	**39**	**207**

*Surveyed length was reduced during this sampling event due to water temperatures.

All Years Trends in Diversity

Fall Chinook ages were predominantly 4.1 for all six years of the study with an average of 66% from 2013-2018. Only one jack (age 2.1) was encountered in 2016 and one age 6.1 encountered in 2017 (Figure 14). The proportion of female to male for 2013-2018 fluctuated interannually ranging from a 1:1 ratio to a 1:2 ratio of females to males (Figure 15). Fork lengths for fall Chinook showed females were on average 4 cm longer than males at age three but by age four the males surpassed the females in length by an average of 8 cm (Figure 16).

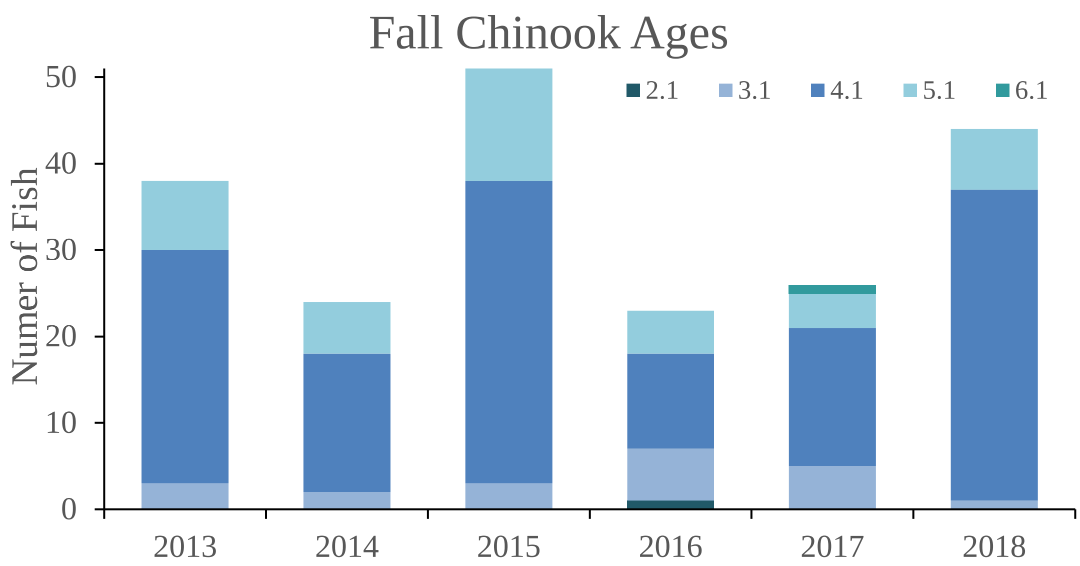

Figure 14. Fall Chinook age structure for 2013-2018 in the upper Chehalis River sub-basin above the proposed Flood Retention Expandable (FRE) facility. Age is total number of years (all readable scales indicated that the fish had migrated to the ocean in their first year of life as a sub-yearling, represented by the .1 in the age notation)

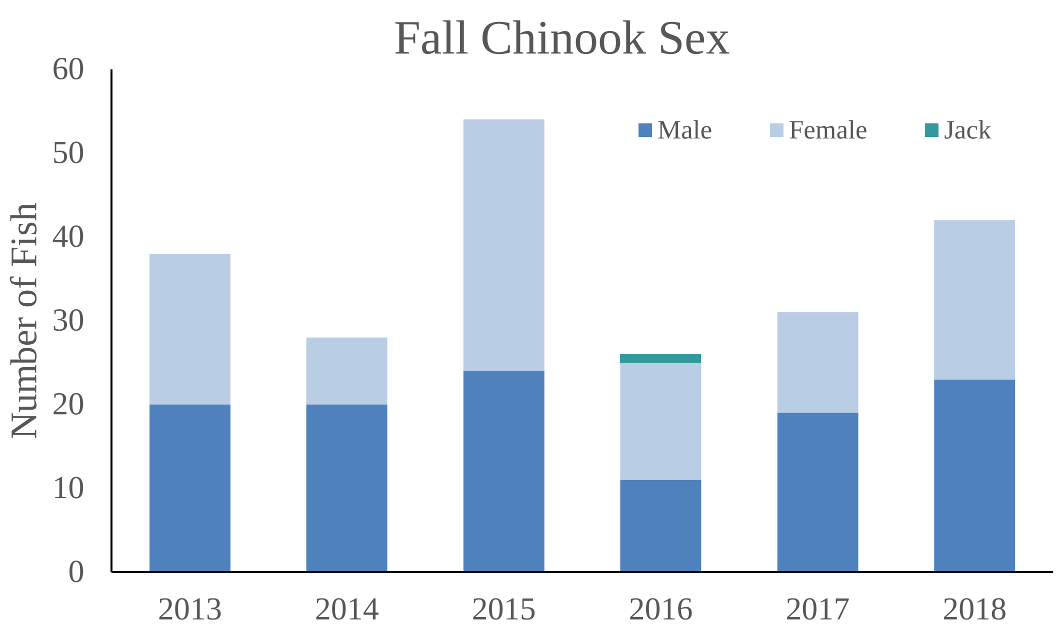

Figure 15. Fall Chinook sex proportion for 2013-2018 survey seasons from carcass recoveries.

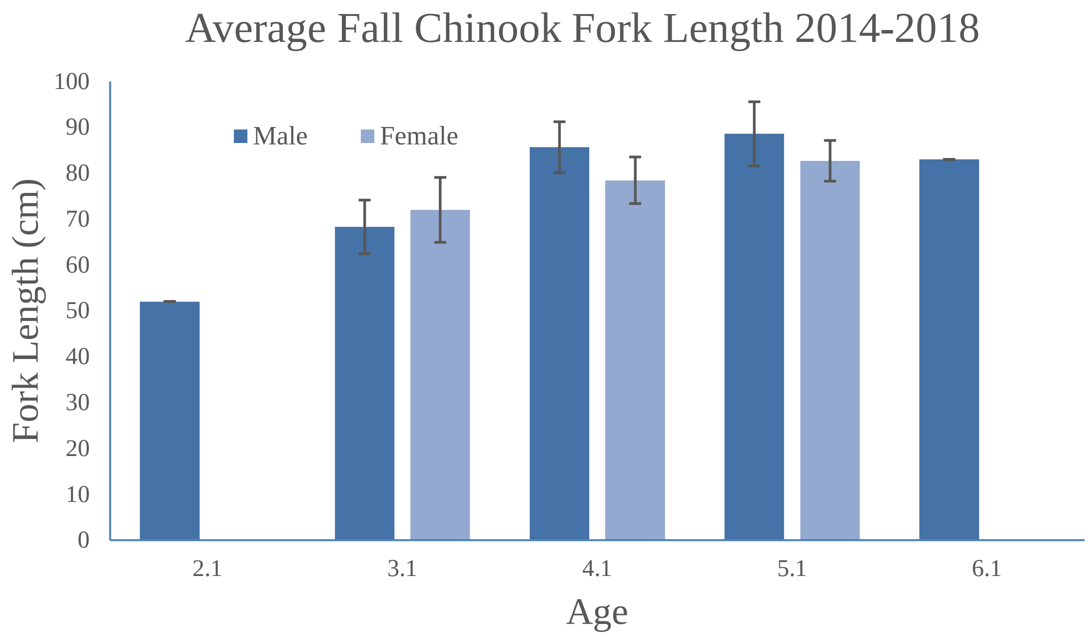

Figure 16. Average fork length (cm) for fall Chinook by age and sex for study years 2014-2018. No ages were taken in the first year of the study (2013). Vertical lines are standard error.

Combining all six years of data demonstrates the diverse life history strategies of natural-origin Steelhead originating from the Upper Chehalis sub-basin. Most Steelhead spent two years in freshwater prior to ocean migration, where they typically spent one to two years before returning to spawn (Figure 17). Male Steelhead carcasses were recovered at a rate of more than six times that of female Steelhead in spawning ground surveys. However, during hook and line surveys done to collect genetics for a different study in the same area, males were recovered at only 2.5 times the rate of females. One-third of all observed fish were unable to have their sex determined, primarily because of carcass degradation and were designated sex not determined (SND), indicating a high rate of uncertainty in the proportions (Figure 18).

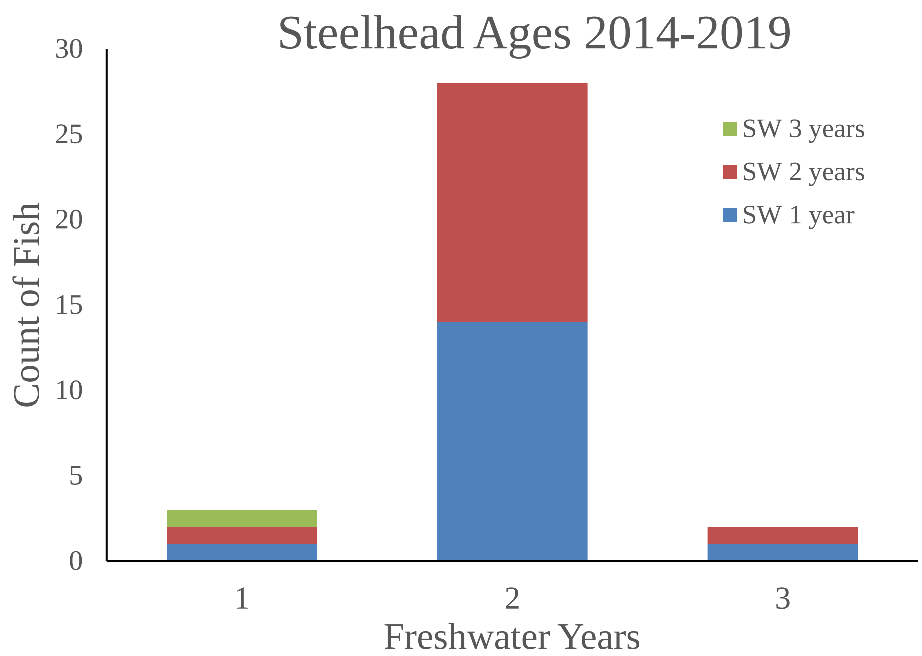

Figure 17. Freshwater and saltwater (SW) age structure of wild winter-run Steelhead returning to the Upper Chehalis sub-basin, combined 2014-2019 spawn years.

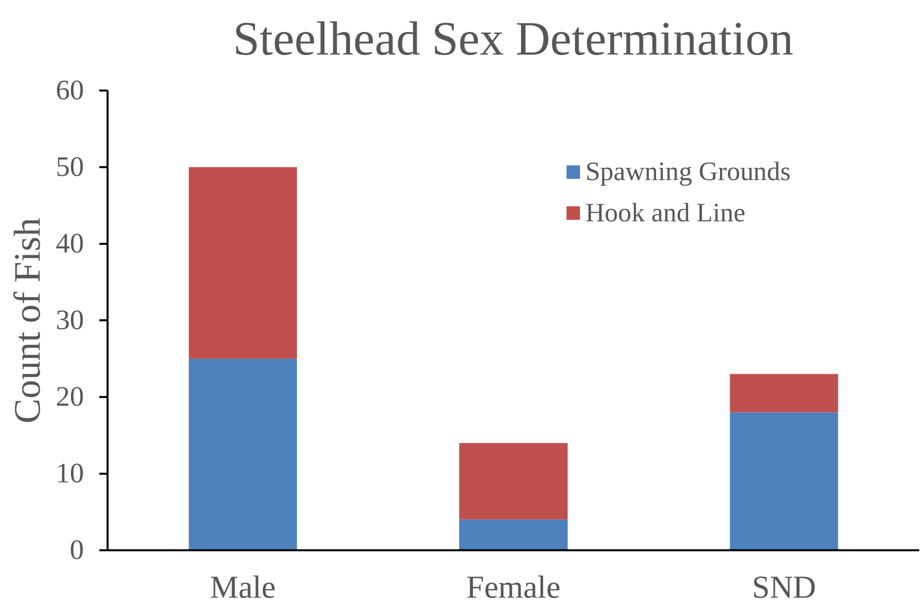

Figure 18. The number of Steelhead by sampling method and by sex where SND is sex not determined from survey seasons 2014-2019.

Main Stem Spawning Below Proposed FRE Site

A peak supplemental survey for spring Chinook was conducted on October 2, 2018 and a total of 39 redds were observed in this single week between the proposed FRE site and the Newaukum River (Figure 19). This compares with zero redds observed above the proposed FRE site during the same survey week. Redds were evenly distributed from the proposed FRE site downstream to RM 78.5 below the town of Adna. No redds were observed between RM 78.5 and the confluence with the Newaukum River.

Peak supplemental surveys for fall Chinook were conducted between October 21-23, 2018. A total of 480 redds were observed in this survey between the proposed FRE site and the Newaukum River (Figure 20). This compares with 139 fall Chinook redds above the FRE site during the same survey week. Redds had the highest density in the upper portion of the survey reach near the town of Pe Ell and were observed downstream to RM 76.2. No redds were observed between RM 76.2 and Newaukum River

A Peak supplemental survey for Coho was conducted on December 14, 2018 and very few redds (n=5) were observed between the proposed FRE site and Rainbow Falls State Park (Figure 21). This compares with 533 Coho redds above the proposed FRE site during the same survey week. The last Coho redd was observed 2.7 miles above Elk Creek.

Peak supplemental surveys for Steelhead were conducted on April 17th and 18th, 2019 and 53 redds were observed during this single event survey between the Pe Ell bridge and the Newaukum River (Figure 22). This compares with 399 Steelhead redds above the proposed FRE site during the same survey week. Unfortunately, the section between the proposed FRE site and Pe Ell, where historically there are a higher proportion of redds than below Pe Ell, was not surveyed during the peak in 2019. This suggests that there were Steelhead redds unaccounted for during this time period.

Spring Chinook Below Proposed FRE Site

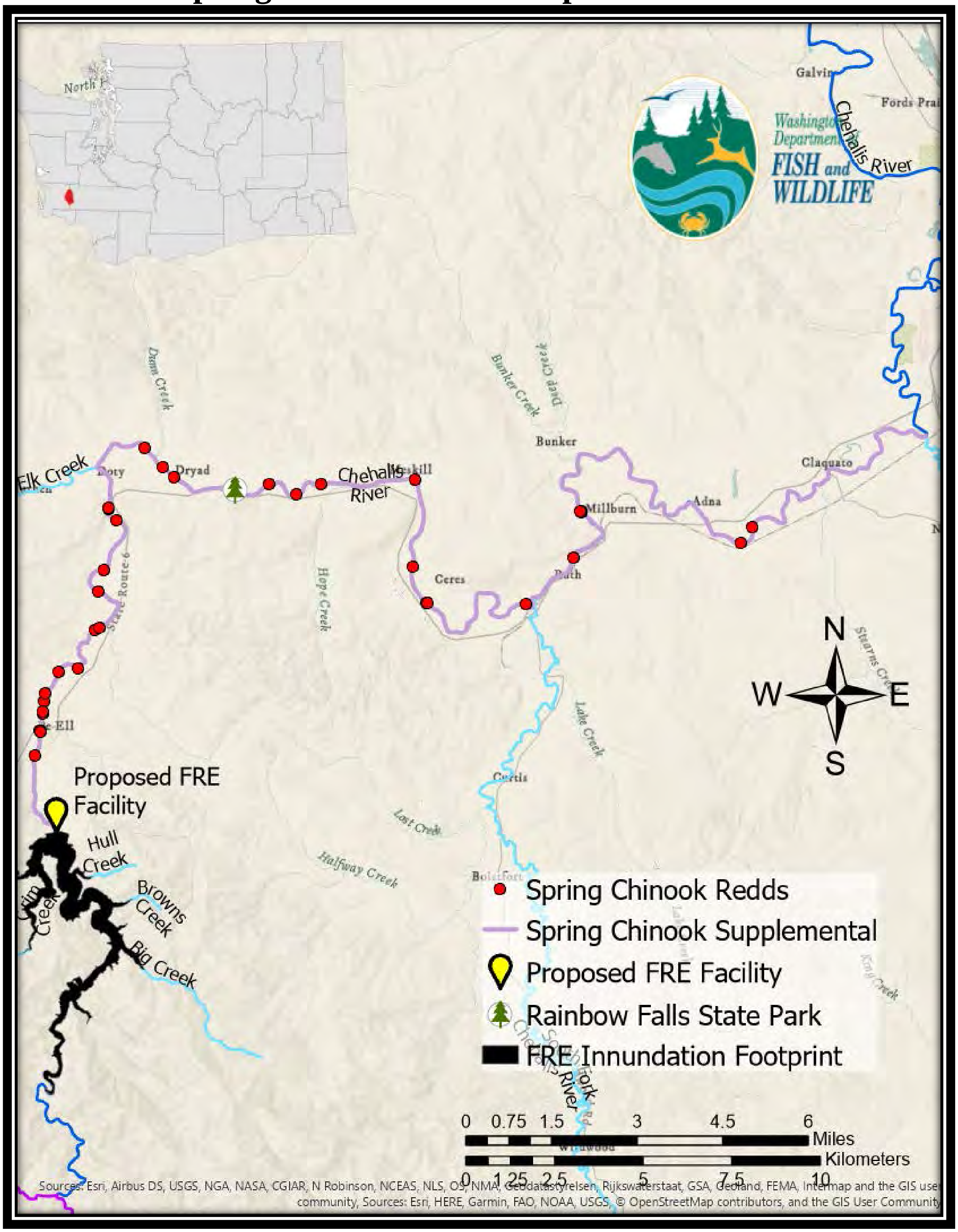

Figure 19. Spring Chinook salmon distribution of redds below the proposed Flood Retention Expandable (FRE) site during peak spawn timing (October 2, 2018) in the Chehalis River, Washington State.

Fall Chinook Below Proposed FRE Site

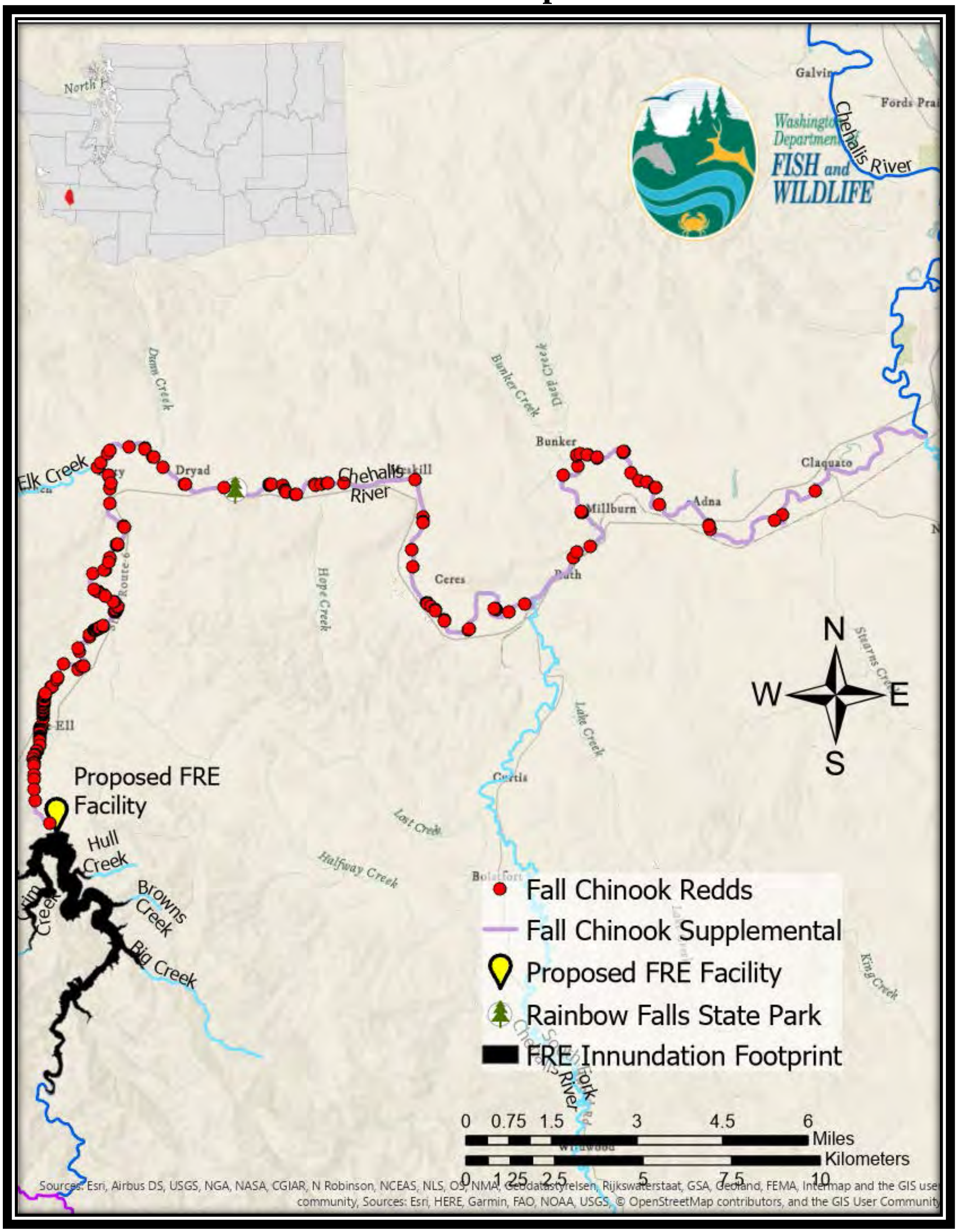

Figure 20. Fall Chinook distribution of redds below the proposed Flood Retention Expandable (FRE) site during peak spawn timing (November 22, 2017).

Coho Redds Below Proposed FRE Site

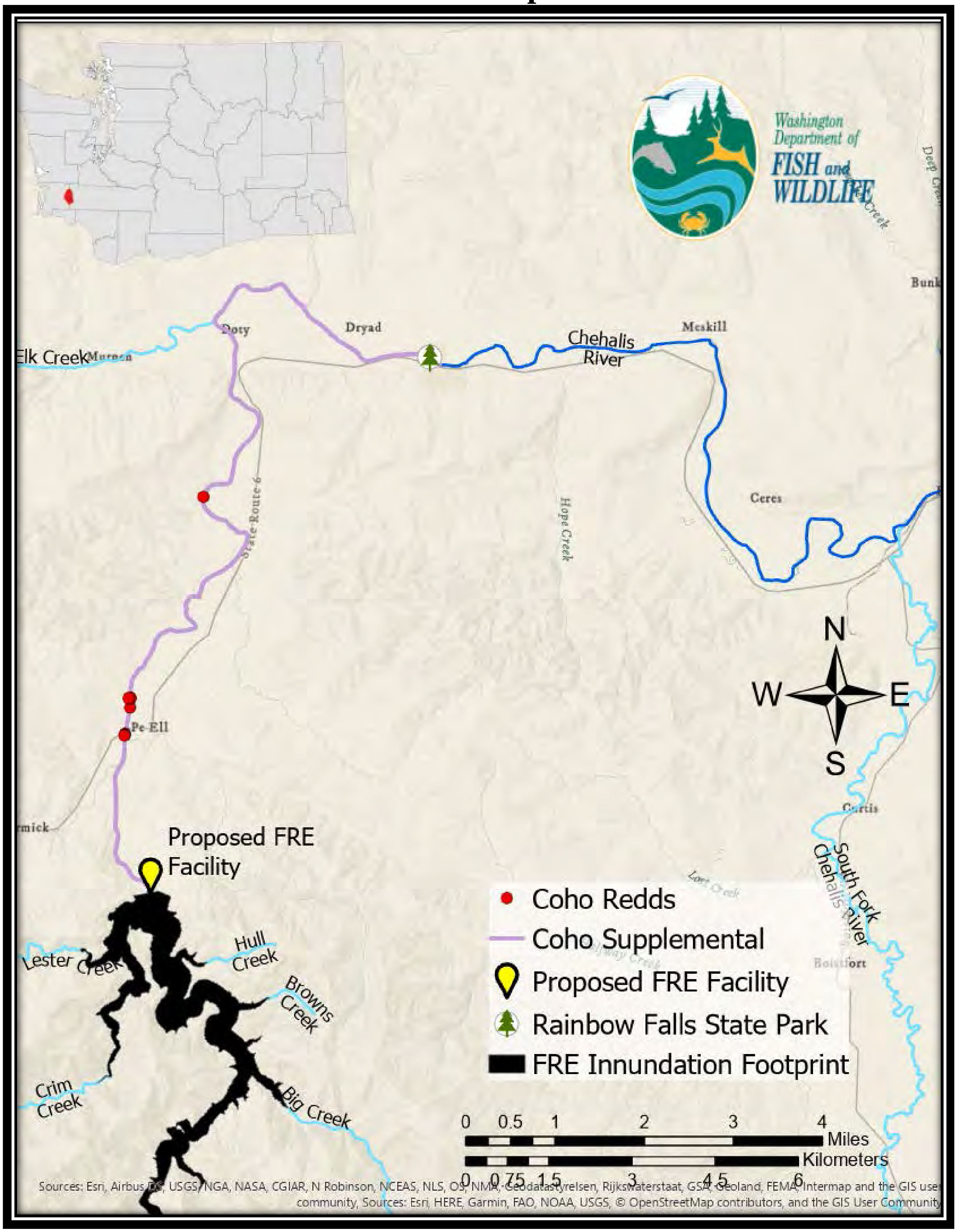

Figure 21. Coho distribution of redds below the proposed Flood Retention Expandable (FRE) site during peak spawn timing (December 14, 2018).

Steelhead Redds Below Proposed FRE Site

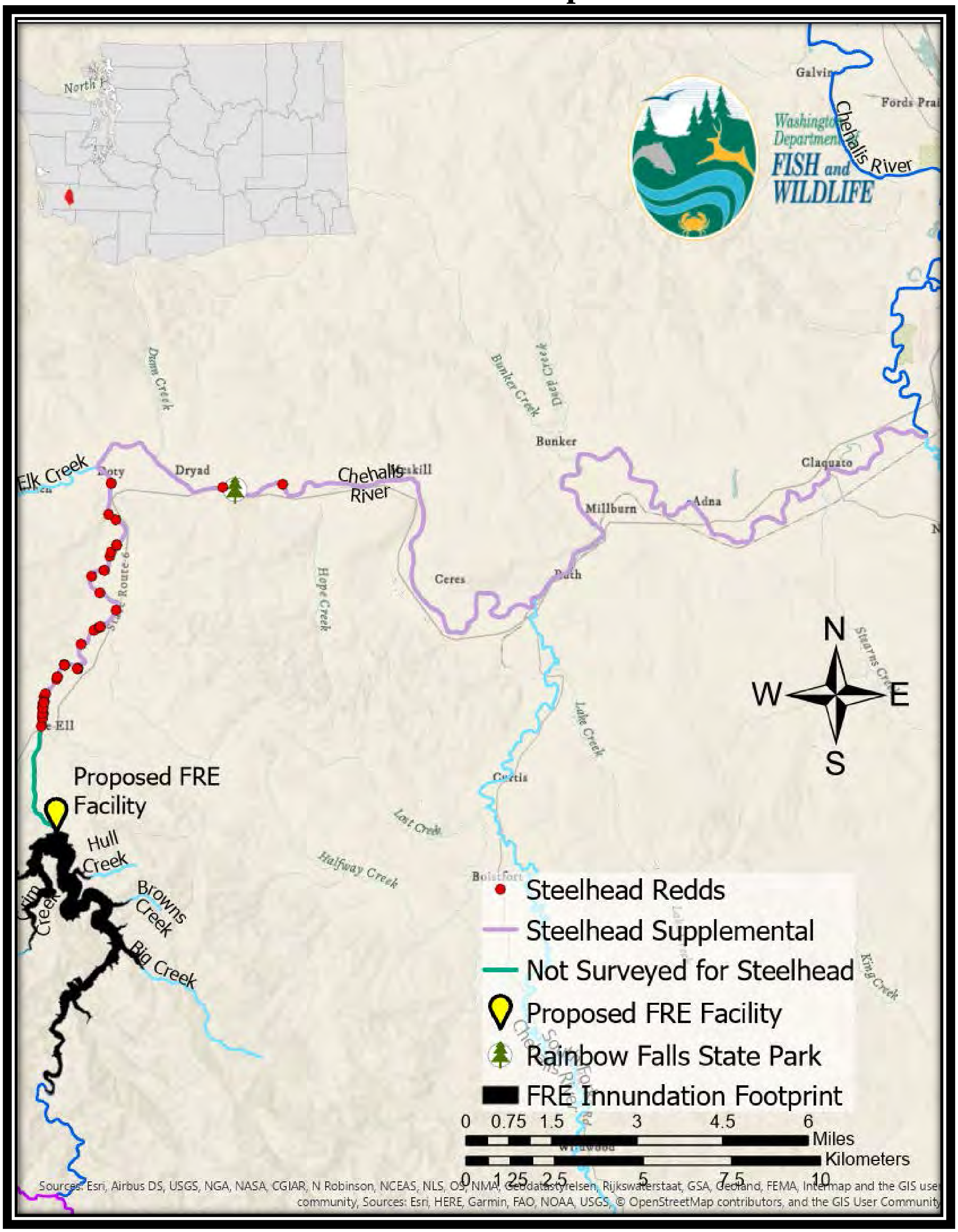

Figure 22. Steelhead distribution of redds below the proposed Flood Retention Expandable (FRE) site during peak spawn timing (May 5, 2019).

Discussion

This report summarizes 6 years of research and monitoring of Chinook (spring and fall run salmon), Coho, and Steelhead upstream of the proposed FRE site and two years in the main stem river downstream of the study site. Results to date indicate that for salmon and Steelhead, spawning occurs in the Upper Chehalis River sub-basin continuously between the months of September and June. More importantly, spawning in the upper Chehalis basin contributes over 15% of the total Steelhead spawning in an area that represents only 4% of the available habitat in the entire Chehalis River. This area also contributes important genetic diversity for all salmon and Steelhead representing populations from the Chehalis River watershed.

Across all years of the study, spawner abundances of Coho and Steelhead were higher than spring or fall Chinook in the Upper Chehalis River sub-basin. In the first four years of this study, Steelhead were the most abundant species, averaging roughly three times higher abundance than Coho, and four times higher than Chinook. However, in the 2017-2018 and 2018-2019 seasons, Coho were the most numerous among all the species. The 2018 Coho spawner abundance was twice that of the 2019 Steelhead spawner abundance and almost four times the 2018 fall Chinook spawner abundance. These differences reflect stronger returns of Coho to the Upper Chehalis River sub-basin beginning in 2017 and weaker returns of Steelhead over the last two years. Though fall Chinook had a relatively strong return for the Upper Chehalis River sub-basin in the 2018 return year (relative to the previous five-year time series), they contribute less fish to the sub-basin. Coho returns in 2018 were 2.5 times higher than the five-year average and fall Chinook were 1.8 times higher. Current 2019 Steelhead returns were 74% of the five-year average and 2018 spring Chinook were only 13% of the five-year average.

Over the six years of the study, fish originating from hatcheries were rare to absent (< 1% of carcasses) in the study area. There are no releases of hatchery salmon or Steelhead above the proposed FRE site at RM 108.2 and no hatchery releases of spring Chinook anywhere in the Chehalis River basin. The closest release location for hatchery fall Chinook is in the Satsop River sub-basin located near RM 20. The closest release of hatchery Coho and Steelhead is Elk Creek (Chehalis RM 100.2). A potential error associated with using mark status to estimate hatchery- and natural-origin composition of Coho comes from plants of unmarked Coho through Remote Site Incubation (RSI). However, the nearest RSI location is 32 RM downstream of the study site, indicating that the increase of Coho abundance in the Upper Chehalis sub-basin was due to natural, not hatchery production, and straying to the surveyed areas of the watershed was likely minimal. In the 2019 Steelhead snorkel surveys, no adipose marked Steelhead were observed, but one out of six carcasses encountered was of hatchery origin. The contribution of hatchery Steelhead to the Upper Chehalis sub-basin could not be determined with accuracy because of low carcass sample size. However, the convention of using March 15th as a cutoff date for hatchery origin Steelhead appears to be invalid for this area. Therefore, if an accurate estimate of the origin (hatchery vs. natural) of Steelhead spawning in the wild is desired, WDFW's current methodology in the Chehalis Basin and elsewhere should be revised.

Collectively, these data indicate an FRE facility would have a negative impact on natural-origin fish. In addition to an FRE facility, the Chehalis Basin Strategy also proposes an historic restoration effort (Aquatic Species Restoration Plan) to restore and improve habitat for aquatic species and make the region more resilient in the face of climate change. A review of literature by Timpane-Padgham et al. (2017) of ecological attributes that confer resilience to climate change in environmental restoration concluded that maintaining connectivity across healthy habitat types was the most successful strategy for increasing resilience of aquatic biota by helping regulate processes such as stream flow, temperature, water quality, and the maintenance of food webs. This suggests that a facility controlling these naturally occurring flood events and thereby reducing the heterogeneity of the habitat would be expected to adversely affect adult and juvenile salmonids utilizing the Upper Chehalis River sub-basin.

Species Summaries

Chinook

Spring Chinook are the earliest arrivals to the study area and spawn in September and October, followed by fall Chinook, which spawn October to November. In fall 2018, only three adult spring Chinook were estimated to be above the FRE site. The numbers for spring Chinook in 2013 and 2014 were more than 10 times higher than from 2015-2018. Along with a decrease in spring Chinook abundance, lower spring Chinook estimates could partially be attributed to how field calls were determined. Prior to 2015, field calls for spring Chinook were primarily separated by date (October 15th), with all redds classified as spring Chinook prior to October 15th, and all redds classified as fall Chinook afterwards. In 2015, the methodology was modified to use a weight of evidence approach (Appendix D). Redds constructed after October 15th were all assumed to be fall Chinook, but redds constructed on or prior to October 15th were assigned either spring- or fall-run type based on the condition of the redd and phenotypic characteristics, behavior, and condition of associated live fish observed in the vicinity of the redd. Other considerations included prior observations of either spring or fall Chinook activity during the survey period, current and previous flow levels, and spawning activity within the basin.

In 2018, fall Chinook spawning peaked around mid-October, similar to spring Chinook, but fall fish had a more protracted spawning period that lasted over an eight-week period. The 2018 fall Chinook spawner abundance in the Upper Chehalis sub-basin was higher than in the previous five years, which is consistent with returns throughout the basin that year. Throughout all years of the study, both spring and fall Chinook spawned in the inundation footprint of the proposed FRE facility. Spring Chinook spawning in the Upper Chehalis, spawned within the inundation footprint an average of 93% of the time and fall Chinook averaged 87% of the time. However, there were years when 100% of spring Chinook that spawned in the Upper Chehalis, spawned within the inundation footprint. Also, both spring and fall Chinook had a high rate of spawning below the proposed FRE site. Any modifications or disruption to flow or habitat in those areas would be expected to have an impact on spawning and egg-to-fry survival.

In the Chehalis basin, spring and fall Chinook salmon overlap spatially and temporally, making determination of run type difficult in the field. New studies based on genetics (Thompson et al. 2019) and otoliths (Campbell et al. 2017) suggest that run type may be distinguished using biological markers. In those studies, researchers used carcasses sampled opportunistically throughout the basin from 2001-2016 to determine the accuracy of carcass field calls with the biological run-type markers. Both studies concluded that field carcass calls were overestimated for spring Chinook and underestimated for fall Chinook. However, the opportunistic sampling of carcasses has led to questions about how representative the results are to Chinook salmon across the Chehalis Basin at the population level. Importantly, redds, not carcasses, are used to determine run size, therefore designations of spring- and fall Chinook run-type based on redds, and the accuracy of carcass field calls remain unknown. Additionally, in the Thompson et al. (2019) study, both genetic and genomic data were analyzed. The genomic data indicated that spring and fall Chinook in the Chehalis basin were randomly mating, adding to the increased uncertainty in how genetically distinct spring Chinook are from fall Chinook. Additional work needs to be done to determine the identification and diversity of Chinook run-types and accuracy of survey run-type calls.

Coho

Coho had a more protracted spawning period (14 weeks) than Chinook with spawning activity observed between mid-November and February. Coho spawning in the Upper Chehalis sub-basin have typically exhibited two distinct peaks during this period (Ashcraft et al. 2017), one in late November/early December and the second in late December/early January. Redds associated with the first peak are consistently more numerous than those associated with the second peak. The bimodality of Coho spawn timing is consistent, but less pronounced, compared to elsewhere in the Chehalis River basin. In 2017 and 2018, the overall duration of Coho spawning was similar to past years, but the bimodal pattern was not as evident as the previous four years. The lack of a bimodal pattern may have resulted from overall higher abundances resulting in overlap between the ‘modes’ or may reflect inter-annual variation in spawn timing associated with stream flow. For example, the lower spawner abundance observed in 2013 and 2016 can be directly tied to the 2007 flood. Coho have a static life history, primarily returning at age three, so a single event that reduces survival of a cohort in a particular run year can have lasting cyclical effects that are measurable every three years.

Chehalis basin Coho are genetically distinct from Puget Sound Coho and have greater genetic diversity within the Chehalis Basin than all Coho inhabiting Puget Sound (Seamons et al. 2019). This diversity is dependent on location, spawning habitat, run timing, and rearing habitat. The difference in spawning locations and run timing have led to adaptation at the tributary scale due to homing behavior. This becomes particularly important when noting that the Upper Chehalis sub-basin is a main contributor to that genetic diversity. This broad plasticity of phenotypic traits across the basin may help Coho utilize a spectrum of available habitat which increases population resilience (Schindler et al. 2010), especially in the face of climate change and anthropogenic changes to habitat.

Steelhead

Steelhead had the most protracted spawning period (19 weeks) compared to Chinook and Coho. Steelhead spawning occurred from December through June, three times as long as the duration of fall Chinook spawning. Since 2015, Steelhead abundance in the study area has been declining. It is possible this trend is due to normal cyclical nature, overfishing, or habitat degradation as this decline is consistent with trends in abundance across the basin and much of Washington State. Another possibility suggested by an ongoing Weyerhaeuser study (Jason Walter, WeyCo pers. comm.) is that the 2007 flood altered habitat to make it more productive for Steelhead relative to Coho, leading to increased Steelhead abundance in years following the flood event. More recently, as the Upper Chehalis sub- basin reverts to pre-flood conditions, less favorable habitat for Steelhead is expected and more habitat favorable for Coho. The decreasing Steelhead abundance in recent years is especially important when considering that Upper Chehalis and South Fork (SF) Chehalis Steelhead may be a distinct population from the rest of the Chehalis basin based on genetics (Seamons et al. 2017). The FRE facility is likely to disrupt sediment retention, water temperatures, and refugia within the inundation footprint and below the facility. Additional disruption to spawning and rearing habitat by a proposed FRE facility could further decrease the abundance and diversity in this genetically distinct population. In addition to maintaining these habitats, an effort on the part of WDFW to reduce impacts from fishing could help improve escapement and start to address this concern of declining stocks and diversity in the basin.

The current method for determining hatchery-origin Steelhead on spawning grounds using the March 15th cut off has been standard practice throughout many basins in Washington State. There is evidence that the Steelhead in the Upper Chehalis sub-basin do not conform to this assumption (Ashcraft et al. 2017; Ronne et al. 2018). Total Steelhead abundance for all years is likely to be more accurate of the actual abundance for natural-origin Steelhead than the convention of assigning all Steelhead observed prior to March 15th as being of hatchery-origin. It is suggested that WDFW re-evaluate using this method in the Chehalis basin and elsewhere, particularly in areas where Chambers Creek (early-timed) stock has not been used for hatchery Steelhead production for more than a decade (Mike Scharpf WDFW, per. comm.). Last decade hatcheries switched to an integrated program using natural-origin Steelhead as brood. An exception is Humptulips hatchery which still uses a mix of Chambers Creek and Quinault (Randy Aho WDFW, per. comm.) in their program and has an earlier spawn timing than natural-origin. However, the Humptulips is located at the mouth of Chehalis River in Grays Harbor, therefore likely does not influence the Upper Chehalis sub-basin spawn timing to a measurable degree. In addition, the closest area for any hatchery Steelhead plants are Elk Creek which is approximately eight miles downstream of the study area, further reducing the likelihood of significant impacts from hatchery stocks.

Temperature monitoring at >100 locations has resulted in spatially continuous summer stream temperature maps (“Thermalscapes”) of the entire Chehalis River watershed (Winkowski and

Zimmerman 2019). Using these Thermalscapes to project future temperatures into the mid- and late-century (2040 and 2080) reveals that the Upper Chehalis sub-basin is one of the few areas in the watershed that is predicted to maintain thermally suitable rearing habitat for juvenile salmonids. This is the area that is most likely to be impacted by the proposed FRE facility and would be expected to threaten the thermal refugia for salmon, and especially Steelhead, by reducing shade coverage and large woody material inputs.

Conclusions

The 2018-2019 season provided information on spawning activity within and above the FRE inundation footprint as well as the main stem river downstream of the proposed FRE site. Spawning habitats above and downstream of the proposed FRE site are likely to be impacted by FRE operations. For example, the main stem and tributaries above the proposed FRE site will be influenced by clearing of riparian areas and periodic inundation during high flow events whereas the main stem river downstream of the proposed FRE site will be influenced by changes in bed-load movement, scouring, reduced input of large wood, and substrate size caused by regulated flows (Department of Ecology 2020). Spring and fall Chinook are primarily main stem spawners indicating their spawning will be influenced by alteration of main stem spawning habitat upstream and downstream of the proposed FRE facility. Based on all six years of this study (2013/14-2018/19), a much larger proportion of Chinook spawning occurs in the main stem river downstream rather than above the proposed FRE site. Genetic research indicates fall Chinook in the Chehalis basin may be comprised of two genetically distinct population; an upstream group and downstream group (Brown et al. 2017). This suggests that any disruption of main stem habitat downstream of the structure are particularly important to the spawning success of both spring and fall Chinook salmon.

Spring Chinook numbers in the Upper Chehalis sub-basin have decreased ten-fold since the 2015 field season and are thought to be a fraction of historic levels (Hiss and Knudsen 1993). Though there are currently no ESA listed species in the Chehalis River basin, there are petitions to list two coastal spring Chinook populations (Klamath-Trinity River ESU and Oregon Coast ESU) as threatened or endangered. If coastal spring Chinook are a candidate for listing, we need to have a better resolution of spring and fall Chinook abundance in the Chehalis River basin for conservation and management of the resource.

Coho and Steelhead have a much more extensive spatial distribution of spawning habitat than Chinook and use both main stem and smaller tributaries for spawning in the Upper Chehalis River sub-basin. During the full study period, approximately one third of Coho and Steelhead redds above the proposed FRE site were located within the FRE inundation footprint. In contrast to Chinook, very little spawning activity for Coho and Steelhead was observed in the main stem river downstream of the proposed FRE site. This suggests that any changes to main stem and tributary habitat upstream of the structure is particularly important to the spawning success of Coho and Steelhead. Both Coho and Steelhead from the upper basin comprise a large portion of genetically diverse stocks. It has been shown that genetic diversity as well as habitat heterogeneity are important to the survival of these species in the face of climate change and anthropogenic impacts. Installation of a structure that disrupts these natural processes will likely have a negative impact on wild populations of Chinook, Coho and Steelhead.

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Appendices

Appendix A. Survey reaches for the 2018-2019 survey season in the Upper Chehalis River sub-basin. Reach Codes correspond to Survey Effort (Figure 2), RM: River Mile, S.CH: spring Chinook, F.CH: fall Chinook, CO: Coho, STHD: Steelhead

Reach Codes	River/RM	RM Surveyed	Type of Survey	Species Surveyed
1	Chehalis River 108.2-108.7	0.5	Index	S.CH,F.CH,CO,STHD
2	Chehalis River 108.7-110.2	1.5	Index	S.CH,F.CH,CO,STHD
3	Chehalis River 110.2-111.5	1.3	Index	S.CH,F.CH,CO,STHD
4	Chehalis River 111.5-112.6	1.1	Index	S.CH,F.CH,CO,STHD
5	Chehalis River 112.6-113.7	1.1	Index	S.CH,F.CH,CO,STHD
6	Chehalis River 113.7-116.7	3.0	Index	S.CH,F.CH,CO,STHD
7	Chehalis River 116.7-117.5	0.8	Index	S.CH,F.CH,CO,STHD
8	Chehalis River 117.5-118.1	0.6	Index	S.CH,F.CH,CO,STHD
9	Chehalis River 118.1-120.1	2.0	Index	S.CH,F.CH,CO,STHD
10	East Fork Chehalis 120.1-121.3	1.2	Index	S.CH,F.CH,CO,STHD
11	East Fork Chehalis 121.3-122.5	1.2	Index	S.CH,F.CH,CO,STHD
12	East Fork Chehalis 122.5-123.3	0.8	Index	S.CH,F.CH,CO,STHD
13	East Fork Chehalis 123.3-124.3	1.0	Index	S.CH,F.CH,CO,STHD
14	East Fork Chehalis 124.3-125.4	1.1	Index	S.CH,F.CH,CO,STHD
15	East Fork Chehalis 125.4-126.4	1.0	Index	S.CH,F.CH,CO,STHD
16	East Fork Chehalis 126.4-127.7	1.3	Index	S.CH,F.CH,CO,STHD
17	Crim Creek 0.0-0.8	0.8	Index	S.CH,F.CH,CO,STHD
18	Crim Creek 0.8-1.9	1.1	Index	S.CH,F.CH,CO,STHD
19	Crim Creek 1.9-2.9	1.0	Index	S.CH,F.CH,CO,STHD
20	Lester Creek 0.0-0.7	0.7	Index	F.CH,CO,STHD
21	Big Creek 0.0-0.9	0.9	Index	S.CH,F.CH,CO,STHD
22	Big Creek 0.9-1.7	1.7	Index	S.CH,F.CH,CO,STHD
23	Big Trib C 0.0-0.3	0.3	Index	CO,STHD
24	Roger Creek 0.0-0.5	0.5	Index	F.CH,CO,STHD
25	Alder Creek 0.0-0.4	0.4	Index	F.CH,CO,STHD
26	Thrash Creek 0.0-0.6	0.6	Index	S.CH,F.CH,CO,STHD
27	Thrash Creek 0.6-1.2	0.6	Index	S.CH,F.CH,CO,STHD
28	Thrash Creek 1.2-1.6	0.4	Index	S.CH,F.CH,CO,STHD
29	Thrash Creek 1.6-2.7	1.1	Index	S.CH,F.CH,CO,STHD
30	Mack Creek 0.0-0.3	0.3	Index	CO,STHD
31	West Fork Chehalis 0.0-1.2	1.2	Index	S.CH,F.CH,CO,STHD
32	West Fork Chehalis 1.2-2.3	1.1	Index	S.CH,F.CH,CO,STHD
33	West Fork Chehalis 2.3-3.2	0.9	Index	S.CH,F.CH,CO,STHD
34	West Fork Chehalis 3.2-4.2	1.0	Index	S.CH,F.CH,CO,STHD
35	Sage Creek 0.0-0.6	0.6	Index	STHD
36	Cinnabar Creek 0.0-0.7	0.7	Index	CO,STHD
37	George Creek 0.0-1.0	1.0	Index	CO,STHD
38	George Creek 1.0-2.0	1.0	Index	CO,STHD
39	23.1211 0.0-0.2	0.2	Index	CO,STHD
40	23.1213 0.0-0.2	0.2	Index	CO,STHD
	East Fork Chehalis River 128.6-129.7	1.1	Supplemental	CO,STHD
	Crim Creek 2.9-5.8	2.9	Supplemental	CO,STHD
	Unnamed Triburaty 1175 0.0-0.1	0.1	Supplemental	CO
	Browns Creek 0-0.3	0.3	Supplemental	CO,STHD

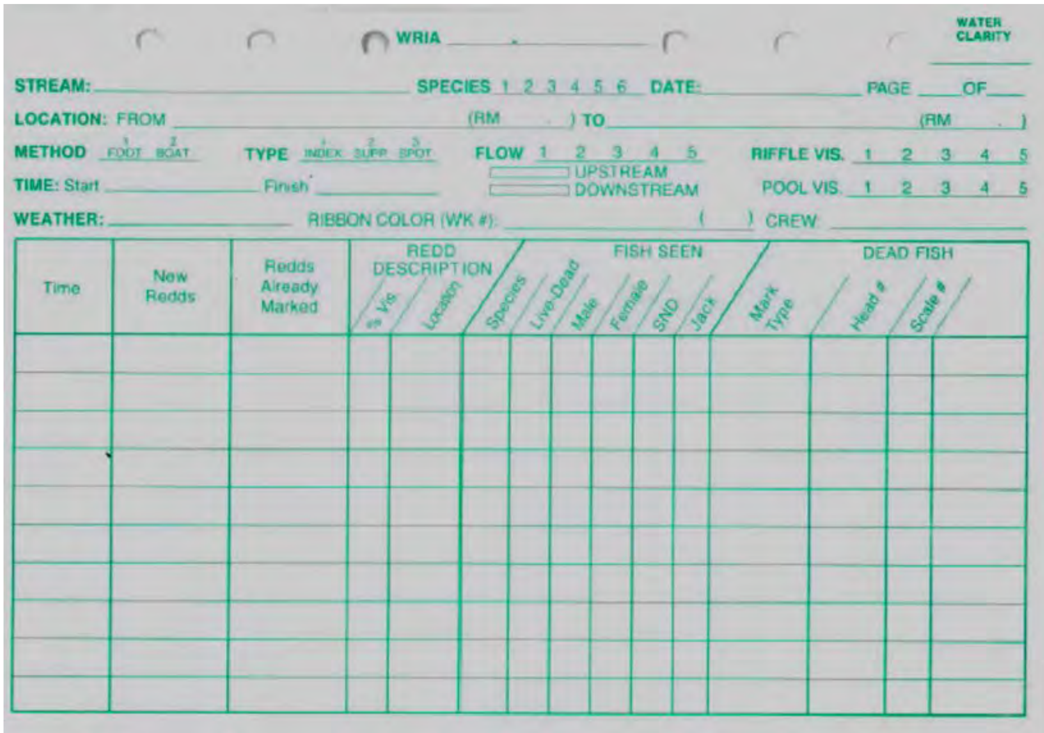
Appendix A. *cont.*

Reach Codes	River/RM	RM Surveyed	Type of Survey	Species Surveyed
	Unnamed Tributary 1178 0-0.2	0.2	Supplemental	CO,STHD
	Big Creek 1.7-2.7	1.0	Supplemental	CO,STHD
	Big Trib A 0-0.2	0.2	Supplemental	CO,STHD
	Big Trib D 0-0.1	0.1	Supplemental	CO
	Big Trib E 0-0.04	0.04	Supplemental	CO
	Roger Creek 0.5-1.2	0.7	Supplemental	CO,STHD
	Roger Creek 1.2-2.2	1.0	Supplemental	CO,STHD
	Roger Trib 1182 0-0.2	0.2	Supplemental	CO,STHD
	Little Roger Creek 0-0.5	0.5	Supplemental	CO,STHD
	Alder Creek 0.4-0.5	0.1	Supplemental	CO,STHD
	Thrash Creek 2.7-3.5	0.8	Supplemental	CO,STHD
	Thrash Trib 1187 0-0.2	0.2	Supplemental	CO,STHD
	Thrash Trib 1188 0-0.1	0.1	Supplemental	CO,STHD
	Thrash Trib 1189 0-0.1	0.1	Supplemental	CO,STHD
	Thrash Trib 1190 0-0.7	0.7	Supplemental	CO,STHD
	West Fork Trib 1194 0-0.3	0.3	Supplemental	CO,STHD
	Sage Creek 0.0-0.6	0.6	Supplemental	CO
	Sage Creek 0.6-0.9	0.3	Supplemental	STHD
	Cinnabar Creek 0.7-2.1	1.4	Supplemental	CO,STHD
	Cinnabar Trib 1204 0-0.1	0.1	Supplemental	CO,STHD
	Cinnabar Trib 1205 0-0.2	0.2	Supplemental	CO,STHD
	George Creek 2.0-2.4	0.4	Supplemental	CO,STHD
	George Creek 2.4-3.0	0.6	Supplemental	STHD
	George Trib 1208A 0-0.1	0.1	Supplemental	CO,STHD
	George Trib 1208B 0-0.1	0.1	Supplemental	CO
	George Trib 1209 0-0.1	0.1	Supplemental	CO,STHD
	George Trib 1210 0-0.1	0.1	Supplemental	CO,STHD
	Unnamed Trib 1211 0.2-0.4	0.2	Supplemental	CO,STHD
	Unnamed Trib 1212 0-0.2	0.2	Supplemental	CO,STHD
	Unnamed Trib 1213 0.2-1.0	0.8	Supplemental	CO,STHD
	East Fork Trib A 0-0.2	0.2	Supplemental	CO,STHD
	East Fork Trib B 0-0.5	0.5	Supplemental	CO,STHD
	East Fork Trib C 0-0.2	0.2	Supplemental	CO,STHD
	East Fork Trib D 0-0.2	0.2	Supplemental	CO,STHD
	East Fork Trib E 0-0.2	0.2	Supplemental	CO,STHD
	East Fork Trib K 0.0-0.1	0.1	Supplemental	CO

Appendix B. Statistical weeks by date for survey season 2018-2019.

Statistical Week	Start Date	End Date
37	9/9/2018	9/15/2018
38	9/16/2018	9/22/2018
39	9/23/2018	9/29/2018
40	9/30/2018	10/6/2018
41	10/7/2018	10/13/2018
42	10/14/2018	10/20/2018
43	10/21/2018	10/27/2018
44	10/28/2018	11/3/2018
45	11/4/2018	11/10/2018
46	11/11/2018	11/17/2018
47	11/18/2018	11/24/2018
48	11/25/2018	12/1/2018
49	12/2/2018	12/8/2018
50	12/9/2018	12/15/2018
51	12/16/2018	12/22/2018
52	12/23/2018	12/29/2018
53/1	12/30/2018	1/5/2019
2	1/6/2019	1/12/2019
3	1/13/2019	1/19/2019
4	1/20/2019	1/26/2019
5	1/27/2019	2/2/2019
6	2/3/2019	2/9/2019
7	2/10/2019	2/16/2019
8	2/17/2019	2/23/2019
9	2/24/2019	3/2/2019
10	3/3/2019	3/9/2019
11	3/10/2019	3/16/2019
12	3/17/2019	3/23/2019
13	3/24/2019	3/30/2019
14	3/31/2019	4/6/2019
15	4/7/2019	4/13/2019
16	4/14/2019	4/20/2019
17	4/21/2019	4/27/2019
18	4/28/2019	5/4/2019
19	5/5/2019	5/11/2019
20	5/12/2019	5/18/2019
21	5/19/2019	5/25/2019
22	5/26/2019	6/1/2019
23	6/2/2019	6/8/2019

Appendix C. Field data card used by the surveyor to record information in field.



WRIA ___ . ___

WATER CLARITY

STREAM: ___ SPECIES 1 2 3 4 5 6 DATE: ___ PAGE ___ OF ___

LOCATION: FROM ___ (RM ___ . ___) TO ___ (RM ___ . ___)

METHOD 1 FOOT 2 BOAT TYPE 1 INDEX 2 SUPP 3 SPOT FLOW 1 2 3 4 5 RIFFLE VIS. 1 2 3 4 5

TIME: Start ___ Finish ___ UPSTREAM DOWNSTREAM POOL VIS. 1 2 3 4 5

WEATHER: ___ RIBBON COLOR (WK #): ___ ( ) CREW: ___

Time	New Redds	Redds Already Marked	REDD DESCRIPTION: % Vis.	REDD DESCRIPTION: Location	FISH SEEN: Species	FISH SEEN: Live-Dead	FISH SEEN: Male	FISH SEEN: Female	FISH SEEN: SND	FISH SEEN: Jack	DEAD FISH: Mark Type	DEAD FISH: Head #	DEAD FISH: Scale #	

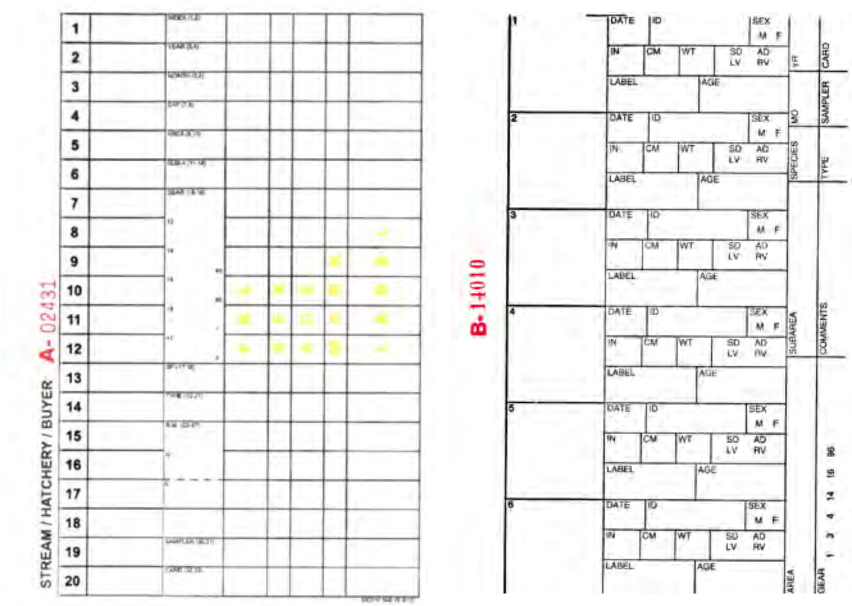
Appendix D. Description of spring-run Chinook vs. fall-run Chinook characteristics used to distinguish between run-type during their overlapping spawning period around October 15th.

		Spring Chinook	Fall Chinook
Overlap			
	Fish[a]	Grey, olive, or black/dark in color;	Red, green, or purple in color;
		Dull and/or dusky appearance, not bright and shiny colors;	Bright, shiny colors, vivid
		Low energy level, lethargic, exhibiting an unwillingness to be spooked off of redds (for females) or into quick currents; [b]	High energy level, spooking easily and powering through riffles and low water areas, exhibiting a frantic behavior when spooked or scared
		Fungus present on fish and edges of snout, and fins showing wear;	No or minimal amounts of fungus and/or wear
		Have a soft caudal peduncle	Have a firm caudal peduncle
	Redds	Presence of a spring Chinook female;	Presence of a fall Chinook female;
		If no female presence: Before/on October 15th the redd was recorded as spring-run type unless other fish presence indicates fall Chinook After October 15th the condition of the redd determines run type If redd was built on/prior to Oct. 15th it was recorded as spring-run type If redd was built after Oct. 15th it was recorded as fall-run type	
Post-overlap		After Oct. 15th live fish and redds are fall-run type unless the observation is different from the rest of the observations in the survey	

[a]: For live fish – justify decision with 3 of the 4 characteristics; for carcasses – justify decision with 2 of the 3 characteristics

[b]: Energy level and behavior of fish on a redd was used to clarify run type on live fish and associated redds only

Appendix E. Scale cards used by the surveyor to mount scales and record information in the field. The card on the left is used for spring and fall Chinook (3 scales/carcass), and the card on the right is used for Steelhead (6 scales/carcass). Notice the Steelhead scale card has more space for mounting scales.



Appendix F. Steelhead age notation guide.

Steelhead Age Guide

FW.SW+

FW (Fresh Water).SW(Salt Water)+

HATCHERY = 1.+

"+" = indicates number of times it has spawned
S = Repeat spawn events

AGE / SCALE DESIGNATION	*TOTAL AGE*	*SALT AGE*
1.1+	3	2
1.2+	4	3
1.3+	5	4
1.+S+	3	2
1.+S+S+	4	3
1.+S+S+S+	5	4
1.1+S+	4	3
1.1+S+S+	5	4
1.1+S+S+S+	6	5
1.2+S+	5	4
1.2+S+S+	6	5
1.2+S+S+S+	7	6
1.3+S+	6	5
1.3+S+S+	7	6

WILD = 2.+

AGE / SCALE DESIGNATION	*TOTAL AGE*	*SALT AGE*
W1.1+	3	2
W1.2+	4	3
2.1+	4	2
W1.3+	5	4
2.2+	5	3
3.1+	5	2
2.3+	6	4
3.2+	6	3
4.1+	6	2
3.3+	7	4
4.2+	7	3
4.3+	8	4

If it has a "w" in front of the hatchery age, it looks like a hatchery fish but it's actually Wild.

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