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Spawner Abundance and Distribution of Salmon and Steelhead in the Upper Chehalis River, 2013-2017

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Cover photos: Chinook spawning redd and upper Chehalis crew member Justin Zapata. Photos by Nick Vanbuskirk.

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Executive Summary

Flood control alternatives being analyzed as part of the Chehalis Basin Strategy include a dam that would be located in the main stem Chehalis River at river mile 108.2 upstream of the town of Pe Ell. Stock assessments in the Chehalis River basin have not historically focused on delineating population trends above or below the location of the proposed dam. 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 within and above the footprint of the proposed dam and its associated reservoir. This work also informs fish passage needs should a dam be chosen as a structural solution to flooding within the Chehalis Basin.

Two types of surveys methods were used – index surveys were conducted at approximately 7 to 14 day intervals throughout the spawning period and supplemental surveys were conducted once or twice during peak spawning. Together, index and supplemental surveys covered the entirety of known spawning habitat for each species. Surveys started the first 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 late May or early June when no new redds were observed for two consecutive weeks at the end of the project spawning period.

Surveys were conducted either on foot or by pontoon-style boats. 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. Dead fish or carcass sampling included fin mark sampling, fish length, scale collection for aging Chinook and Steelhead, tissue (genetic analysis) and otoliths (life history, Chinook only). Additional data taken for Chinook and Steelhead included scales (aging), tissue (genetic analysis) and otoliths (life history, Chinook only). Other data collected included water clarity, stream flow, riffle and pool visibility, direction being surveyed, and weather.

Results from four survey seasons document the importance of the reaches upstream of the proposed dam and reservoir as a spawning area for spring and fall Chinook, Coho, and winter Steelhead:

- The majority of spawners observed for all species in this area of the watershed were wild; hatchery fish were rare to absent.
- Chinook spawning activity was observed between September and November. The total number of spawners ranged between 3 and 65 spring Chinook and 297 and 424 fall Chinook. Both spring and fall Chinook spawned primarily in the main stem river, with the majority of redds (72% to 100%) found within the dam inundation footprint. Chinook spawning distribution was variable among years and responsive to river flows. For example, low flows in fall 2015 resulted in only 7% of Chinook (spring and fall) spawning outside of the main stem river whereas high flows in fall 2016 resulted in 45% of Chinook (spring and fall) spawning outside of the main stem river.
- Coho spawning activity was observed between October and February. The total number of Coho ranged between 174 and 1,590 spawners. An average of 41% of Coho spawning above the proposed dam site occurred within the inundation footprint over the four years of study.
- Steelhead spawning activity was observed between the months of December and June. The total number of steelhead ranged between 1,048 and 1,850 spawners with 7% to 16% of the redds observed prior to March 15th. An average of 35% of Steelhead spawning above the proposed dam site occurred within the dam inundation footprint over the four years of study.

Introduction

Understanding the numbers and diversity of wild salmon and steelhead in the upper Chehalis River is an important part of the Chehalis Flood and Aquatic Species Project and contributes to the Chehalis Basin Flood Hazard Project and Aquatic Species Enhancement Plan (The Aquatic Species Enhancement Plan Technical Committee 2014). Adult monitoring for spring and fall Chinook salmon (*Oncorhynchus tshawytscha*), Coho salmon (*O. kisutch*), and winter-run Steelhead (*O. mykiss*) (hereafter referred to as Steelhead) was identified as an information gap for the area of the Chehalis River where a proposed dam site may be located 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. There are two dam alternatives being evaluated at this location: a flood retention only (FRO) and a flood-reduction-flow-augmentation (FRFA). Construction of a dam would alter the existing habitat used by salmon and steelhead and interrupt their migration patterns in the river. Therefore, there is a need to understand the current migration timing, numbers, and distribution of salmon and steelhead that would be affected within and above the proposed dam footprint and determine fish passage needs of the dam structure.

Spawning ground surveys (redd counts and live counts) along with carcass surveys 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 the spawn time 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. The goal of this study was to provide a time series that reflected inter-annual variation in the abundance, spawn timing, spatial distribution, and diversity of salmon and steelhead that spawn in the upper Chehalis River sub-basin. This report summarizes the results of surveys conducted between September 2013 and June 2017.

Objectives

The overall goal of this study was to describe the abundance, spawn timing, spatial distribution, and diversity of spring and fall Chinook, Coho, and Steelhead in the upper Chehalis River sub-basin. In order to accomplish this goal, our objectives were to:

- Establish a survey frame for each species,
- Set-up index survey reaches needed to be completed weekly within the survey frame and supplemental survey reaches to be completed during peak spawning upstream of established index survey reaches to determine upper limit of spawning,
- Conduct weekly surveys by foot or pontoon boat (as conditions allow) and collect information on live fish, carcasses, and redds,
- Calculate the abundance of each species and summarize results related to timing, spatial distribution and diversity of spawners, and
- Interpret results with respect to potential impacts of the proposed dam footprint near Pe Ell, WA.

Methods

Study Area

The majority of the land in the upper Chehalis River sub-basin is owned by Weyerhaeuser Corporation, a privately owned tree farm, with smaller holdings by Panesko Tree Farm, and Green Diamond Resource Company. This area is regenerated Douglas fir managed for production, and the forest ranges in age from freshly harvested to harvest age (40 to 55 years old). Newly harvested sections of the landscape are clear cut, creating open areas with low brush and stumps. Logging roads created to generate access for timber harvest are also used to access streams for surveying.

Prior to 2013, index reaches surveyed for stock assessment purposes 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 dam site. At the start of this project, spatially continuous survey reaches were added to the project area to create a more inclusive picture of the salmonid use above river mile (RM) 108.2. The original extent of these reaches included in the survey frame was selected using the WDFW stream catalog as a guide for potential spawning distribution of each species (Phinney and Bucknell 1975). This survey frame was further refined over four seasons based on observed spawning distributions (Figure 1; exact survey reaches are provided in the Appendix Tables 1-4).

There were two primary types of surveys used for this project: index and supplemental. Index surveys covered most of the available anadromous areas and occurred every 7-14 days, with the goal of 7 days between surveys. If heavy rain events were forecasted index surveys were conducted less than 7 days apart, or if high water prevented surveying they were conducted more than 14 days apart. Supplemental surveys were performed once or twice during peak spawning or high water events that enabled fish to pass up a tributary otherwise unlikely to be accessed for spawning. In all years, the index surveys covered 14 sections of the upper Chehalis including the main stem Chehalis River, Crim Creek, Big Creek, Roger Creek, Alder Creek, Thrash Creek, Mack Creek, East Fork (EF) Chehalis River and its tributaries 1211 and 1213, Cinnabar Creek, George Creek, West Fork (WF) Chehalis River, and Sage Creek (Figure 1). In 2016/17, index surveys were added in Lester and tributary 1179C. These 14 (16 in 2016/17) sections were further divided up into 36 (38 in 2016/17) index reaches for the purpose of surveying. The additional division used distinct breaks in the river environment such as a bridge crossing or at the mouth of a tributary joining the reach, that were accessible by the road system. If no distinct break was observed, flags were added to indicate start and stop breaks between reaches. The reach breaks were created to allow for multiple surveyors in one area, instead of one surveyor conducting the survey for the entire stream. The breaks also defined the spatial distribution of redds among survey reaches.

Supplemental surveys were conducted at the upper extent of the index reaches and in smaller tributaries that do not typically have enough water for fish to move into. For example, Lester, Hull, and Browns creeks were surveyed during peak spawning times. Lester Creek is a tributary of Crim Creek and has an impassable dam at RM 0.7, upstream from the mouth. Hull Creek and Browns Creek both have cascades near the mouth of their streams making it difficult for fish to move up into them unless a high water event occurs. Spot surveys were conducted to determine fish access and potential spawning in small tributaries during peak spawning or high water events. Spot surveys were less than 0.05 RM and were conducted at the discretion of the surveyor while surveying an index or supplemental reach.

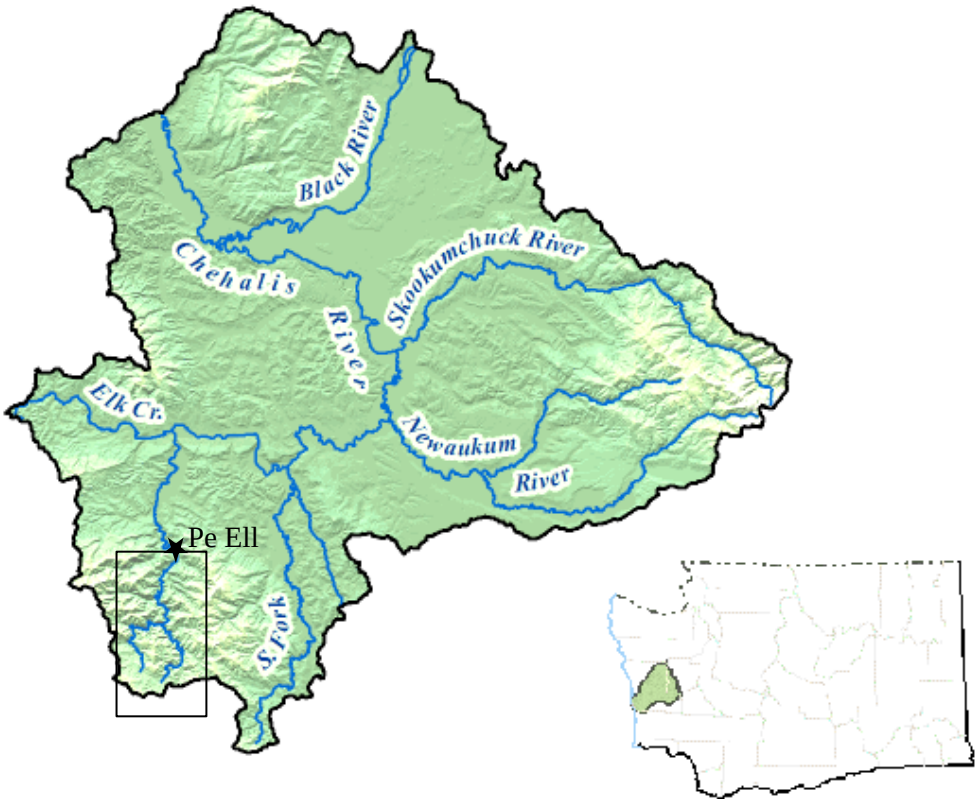


Figure 1. Map of WRIA unit 23 containing the upper Chehalis basin. Black star denotes the location of the proposed water retention facility at river mile 108.2. Black box denotes the project area.

The survey frame for each species was modified slightly among years if stream flows altered the ability of fish to access certain areas. For example, there were variations on the total RM surveyed between survey seasons and between the spring and fall Chinook (Table 1). In the 2016 season, there were eight supplemental survey reaches added for fall Chinook after surveyors observed fall Chinook in the upper reaches of Crim and Big creeks as well as the East Fork Chehalis River. In the 2015 season, spring Chinook RM surveyed decreased from previous years because water flow was low and fish preferred spawning in the main stem instead of moving into the tributaries where there was less water. The absence of Chinook within their potential spawning distribution was determined two ways: by an intensive survey week at the beginning of the survey season to determine presence and absence of live fish, and by the height of water in the survey reach which was determined for each reach. For example, a complete survey would be done for each of the three survey reaches in Crim Creek, and if no fish or redds were seen above the bottom survey reach and the water level was low, then only the bottom two reaches were surveyed until either fish or redd presence was recorded or the water level rose. Another factor that contributed to variation in survey lengths between survey seasons was the ability to complete the survey due to weather conditions and logging activity. Coho and Steelhead had similar total river miles surveyed among years for both index survey reaches and supplemental survey reaches. Variation in survey lengths among seasons was due to temporary impediments, such as poor weather conditions, or logging activity, and instream passage barriers, such as log jams or substrates that change from year to year. The logging activity is unique to specific survey reaches and years and limited surveyor access to a particular survey reach due to activity near the water (creating safety concerns, or closure of roads needed to reach survey area).

Table 1. Total river miles in the upper Chehalis River sub-basin surveyed for each species for each survey year. (IND: Index survey, and SUP: Supplemental survey)

	Spring Chinook[a]		Fall Chinook		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

[a] No supplemental surveys were conducted for spring Chinook in 2013/14, 2014/15, 2015/16 seasons 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 and for Coho from October through February. Spawning ground surveys for Steelhead were conducted from December through June. Index reaches were surveyed weekly when possible unless weather conditions, stream flows/clarity, or logging activity made the survey impossible due to limited access, safety concerns, or lack of water clarity. Surveys 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.

During each survey, we collected information on water clarity, stream flow, riffle and pool visibility, direction being surveyed, and weather (Appendix 5). Water clarity was measured as depth (ft.) the surveyor could see in the water column. Stream flow was measured on a 1 to 5 scale, where 1 indicates low flow/height and 5 indicates high flow/height for the reach. Riffle visibility was measured as how well the substrate could be observed in riffle habitat on a qualitative 1-5 scale, where 1 is excellent visibility and 5 is poor visibility. Pool visibility was measured as how well fish could be observed in pool habitat on a qualitative 1-5 scale, where 1 is excellent visibility and 5 is poor visibility. The direction being surveyed was either upstream or downstream. The weather was recorded as sunny/clear, cloudy/overcast, rain, or snow. All surveyors wore polarized sunglasses and a brimmed hat while conducting surveys.

Surveys were conducted on foot or by pontoon boat to identify and record all spawning activity by species and by reach. Surveys included monitoring new and old redds, counting live and dead fish, and sampling carcasses for both fin mark sampling and biological collections. A redd was defined as an excavation made in the stream bed by a female salmonid that contains a partial or full complement of her eggs; an excavation that does not contain eggs is referred to as a test dig. For salmon a redd was recorded when the nest had a defined tail spill and a mound within a deep pocket. Salmon, in general, do not construct many test digs and the females guard their nests after laying eggs, so a redd could have an associated live fish over multiple weeks. The guideline for Steelhead is to call excavations over six feet in length 'redds', and excavations under six feet 'test digs'. However, in small streams a surveyor could call an excavation under six feet a redd if they observed evidence of excavation, deposition, and reburial of eggs.

Redds

Each redd was identified to species, flagged and numbered for future identification. The number consisted of three pieces of information: species, statistical week, and a unique redd number for that survey reach and statistical week. Redds were flagged and marked with a distance from the flag to the head of the pocket for future redd visibility estimations used to determine redd life, identify upstream expansion of the dig, and interpret superimposition by other female salmonids. Previous redds were tracked during subsequent surveys and recorded based on their condition during each survey (new, 25%, 50%, 75%, or 100% deteriorated) until determined to be absent (Table 2). Redd visibility is variable over survey weeks due to stream flow, scouring, algal growth, location of redd in the river channel, size of redd, superimposition by another redd, and sedimentation. The surveyor's classification of redd condition may vary due to stream flow, depth, weather (i.e., glare from the sun, rain hitting the water) and turbidity (i.e., water clarity which is effected by runoff). Redd visibility was used to calculate the visible redd to cumulative redd ratio. This ratio evaluated the best time to conduct supplemental surveys, which were used to estimate abundance within these reaches.

Table 2. Redd condition categories and their description.

Redd condition	Description
New (N)	Substrate contrasting from surrounding gravel, well defined pit, and mounding
25% deteriorated	Colored up (by algae) at borders of redd, some hydrologic damage
50% deteriorated	Algae ~50%, hydrologic damage - flatter in tail
75% deteriorated	Algae 50-100% but structure good, can distinguish from test dig or scouring
100% deteriorated	Algae 100%, pocket and tail flattened by hydrologic damage but still distinguishable from test dig or scouring
Absent (A)	Absent – either not visible or there is very poor structure not distinguishable between hydrologic damage, or test digging

Surveyors obtained latitude and longitude locations for each new redd. Three different technologies were used to record location information during this project. An Open Data Kit (ODK) survey form app on a Samsung S3 smartphone was used from September 2013 to December 2014. The Orux app on a Samsung S3 smartphone was used from December 2014 to December 2015. Garmin GPSMAP 78sc handheld units were used from January 2016 to June 2017

Since spatial and temporal overlap occurs between fall Chinook and Coho, and between Coho and Steelhead in their respective spawning, surveyors were trained to recognize the differences between each species for identifying redds based on habitat use and redd structures. Although there are exceptions, Chinook generally prefer to spawn in medium to large rivers with large gravel, and the redds are typically long and wide with a well-defined pocket and large wavy mounding through the tailspill. Coho prefer to spawn in small streams with smaller gravel and moderate gradient, typically near the edges of the streams or in braids and side channels. Coho redds are well-defined like Chinook redds but narrower and on a smaller scale, and will often contain more irregularities in shape due to site selection. Chinook will spawn

in deeper water and larger gravel than Coho. Steelhead spawn in faster flowing water than Coho, and their redds can be found throughout the wetted width of the river channel (from margins to mid-channel). Steelhead redds have shallower pockets compared to Coho redds that have deeper pockets. Steelhead build their redds straight and parallel with the current whereas Coho redds are constructed in slower water out of the main current and could be angled away from the current.

Due to overlap in spawn timing of spring and fall Chinook, the WDFW Region 6 District 17 protocol is to determine run type (spring or fall) of a redd based on timing, redd condition, and phenotypic characteristics, behavior, and condition of associated live fish observed with the redd, as well as prior 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 redd and fish associated with the redd (Appendix 6). If a surveyor was unable to make an informed decision on run type of a redd, redds constructed on or prior to October 15th were assumed to be spring Chinook and those constructed after October 15th were assumed to be fall Chinook.

Live fish

Surveyors counted live fish while surveying and recorded species, sex, and mark status (adipose fin present or absent) if possible. All live Steelhead were counted but not assigned as male/female, due to less morphological differentiation between males and females than other salmonids.

Surveyors were also trained to recognize species differences among live fish. Mature adult Chinook are generally larger than Coho and Steelhead, are olive green-brown (may also be a darker purple-red color), with large, conjoined spots on back and upper/lower tail lobes, and have black gums. Mature adult Coho are generally smaller than Chinook, with a more forked tail, and a red body with spots on back and upper lobe of tail. Mature male adult Coho also have a very pronounced kype. Mature adult Steelhead have a large square tail, many small spots on body and tail, and olive green brown body coloration with a stripe of red or pink color along the length of the body, with a reddish coloring on the operculum. Both Chinook and Coho die after spawning with the female guarding her nest until death after laying eggs. Steelhead, unlike Chinook and Coho, are iteroparous, meaning that they do not die after spawning and can spawn in more than one year.

Carcasses

Carcasses were sampled for all species. Few Steelhead carcasses were recovered due to their iteroparous behavior; however, additional biological data was collected for unmarked Steelhead based on live captures via hook-and-line sampling for a companion genetic analysis. For carcass sampling surveyors recorded the species, sex (and if female, determined spawning success), and mark status (i.e., adipose-clipped, coded-wire tag (CWT) presence). Run type of Chinook carcasses in the field was assigned as spring or fall based on coloration, fungus condition, and caudal peduncle characteristics (Appendix 6). The caudal fin was removed from the carcass to identify the fish as previously sampled if seen in later surveys. If the species could not be determined the surveyor did not sample the carcass. Sex was recorded as male, female or sex not determined (SND). Jacks were determined by fork length for each species: 60 cm or less for Chinook, and 50 cm or less for Coho. Steelhead were determined to be adults if the fork length measured 50 cm or longer, with fish less than 50 cm recorded as Rainbow "resident" trout. Spawning success of females was determined as yes or no by splitting the belly of the female after lengths were taken. If there was less than 25% eggs still in the carcass, spawning was determined successful. The pre-spawn mortality condition is more often observed in cases where there was low, warm water, specifically for spring and fall Chinook.

Mark status is an important data record as it provides information about the origin of the fish, whether hatchery or wild. Mark status has two records based on the presence or absence of adipose fins and CWTs. Fish with adipose clips were assigned as hatchery origin. Fish with adipose fins intact and no

CWT were assigned as wild origin. Fish with adipose fins intact and CWT present were assigned to origin (wild, hatchery) after the CWT code was identified to its source. In the field, adipose fin status was recorded as unmarked (adipose fin present), marked (adipose fin clipped), or unknown (area of the adipose fin was missing from the carcass due to predation or decomposition). CWT status was recorded as beep (CWT presence), no beep (CWT absence), or no head (CWT information missing due to predation or decomposition). The 'beep' refers to results from electronically scanning each carcass for CWT using a hand-held CWT scanner. If the surveyor detected a CWT, the snout of the fish was removed and labeled for later identification by the WDFW CWT Lab.

Fork lengths and scales were collected from Chinook and Steelhead. Fork length was recorded as length (cm) from the tip of the snout to fork of the tail. If a portion of the carcass was missing that would affect the length measurement, then no fork length was recorded. Three scales were collected from each Chinook carcass and six scales from each Steelhead carcass for aging. Coho scales were not sampled due to the consistency of returning adults being three years old. Scales were collected from the area posterior to the dorsal fin, anterior to the anal fin and above the lateral line. Scales were mounted on adhesive scale cards with a unique identifier for each fish (Appendix 7). Ages of each fish were determined by the WDFW Ageing and Otolith Lab.

Additional genetic and otolith samples were collected for companion studies that were published separately from this report (Brown et al. 2017, Campbell et al. 2017, Seamons et al. 2017). Tissue samples for genetic analysis were collected for spring and fall Chinook (2013, 2014, 2015, 2016), and Steelhead (2014/15, 2015/16). To ensure quality of tissue for genetic analysis, samples were collected from carcasses with red/pink gills only, using a hole punch through the operculum. Genetic samples for Steelhead were also collected from live individuals captured by hook-and-line methods to increase the number of samples available for analysis. Coho tissue samples were collected during the 2014/15 survey season. Tissue samples were stored in ethanol in individually labeled vials that could be associated with biological data and were archived with the WDFW Molecular Genetics Lab. During the 2015 and 2016 seasons, otoliths were collected for spring and fall Chinook, stored in ethanol, and delivered to the WDFW Otolith and Scale Ageing Lab for analysis.

Data Management

Field data cards were collected and summarized by a survey crew member on a regular basis throughout the season. Cards and georeferenced locations were examined for any errors or missing information that was not recorded and the field data and summarized cards were stapled together. The field data card, summarized survey card, and georeferenced locations were reconciled again before the summarized card was entered into the WDFW Spawning Ground Survey database in Microsoft Access 2010. Once all information was entered into the database, the original and summarized data cards were collected for the entire survey year and stored in a file box in the WDFW Region 6 office. Carcass survey data were entered into the District 17 Biological Sampling database in Access 2010. Once entered, scale cards were copied and the originals were delivered to the WDFW Otolith and Scale Ageing Lab to be aged. The final ages were added to the database. The genetic sample and otolith sample identification numbers were checked against the scale cards to verify that they matched the corresponding biological data.

Analysis

Abundance

Estimates of abundance were based on enumerated redds in index reaches, enumerated and estimated redds in supplemental reaches, and a species-specific expansion factor. Redds observed during supplemental surveys were expanded by a visible-to-cumulative ratio of redds observed in the nearest index reach. The visible-to-cumulative ratio was the number of redds visible during the supplemental survey divided by the cumulative redds observed for entire spawning season in the nearest index reach.

Species-specific expansion factors were 2.5 fish per redd for Chinook (spring, fall), 2 fish per redd for Coho, and 1.62 fish per redd for Steelhead and were consistent with stock assessment methods for these species used in WDFW Region 6 District 17. These expansion factors were not independently validated with annual estimates of fish per redd (e.g., abundance from a weir or mark-recapture study). This estimation methodology is based on several assumptions regarding redd counts:

Assumption 1: redds are correctly identified to species,
Assumption 2: survey reaches cover all areas where redds are constructed,
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)

There are some factors that may prevent surveyors from identifying a redd properly: overlapping redds counted as a single redd, counting natural scouring as a redd, weather condition or stream flows that reduce visibility of redds, and not surveying all possible spawning areas within a survey. A strong effort was made to reduce this error by using well-trained and experienced surveyors and consistent survey gear (i.e., polarized glasses and brimmed hats). In addition, surveyors continually explored potential spawning areas through supplemental and spot surveys, and optimize survey times to maximize visibility associated with corresponding weather events (e.g., when a rain event is anticipated, we survey main stem prior to small rain events and then survey tributaries that are less affected by rain events and still have good water clarity during rain events).

Abundance for spring Chinook (all years) and fall Chinook (2013-2015) was based on index reach surveys only because the entire spawning distribution was surveyed. Abundance for fall Chinook (2016 only), Coho and Steelhead required both index and supplemental surveys in order to cover the entire spawning distribution. The 2016 fall Chinook required supplemental surveys because spawning distribution increased into the upper reaches of the tributaries following high flows during the months of September and October. Coho and Steelhead required supplemental surveys in all years due to the wider spawning distribution typical of these species. Supplemental surveys were conducted during peak spawning to sample upper limits of the spawning habitat. Since supplemental reaches are surveyed just once or twice during the spawning season the redd counts in these reaches must be expanded to the entire season. The goal of supplemental sampling was to select a survey time when the highest proportion of the total redds for the season were visible. The visible-to-cumulative expansion was applied to the enumerated redds in the supplemental reach if the supplemental survey was conducted during a period when visible:cumulative ratio was greater than or equal to 0.20. If the visible:cumulative ratio was less than 0.20, the number of observed redds in the supplemental reach was included in the abundance estimate, but no expansion was made to account for redds that are no longer visible or not yet constructed. The result of this calculation was the estimate of the total number of redds in the supplemental survey reach for the season.

Redd-based estimates for Chinook salmon were the sum of all observed redds was multiplied by a factor of 2.5 (assumes 1 female per redd and 1.5 males per female to estimate the total number of spawners). Redd-based estimates for Coho and Steelhead was the sum of redds in index reaches and redds estimated for supplemental reaches that were expanded to total abundance using species-specific standards of fish per redd. For Coho, the expansion from redd estimate to adult spawners is two times the number of redds (assumes one female per redd and one male per female) which is the standard expansion used for WDFW stock assessment in western Washington. For Steelhead, the expansion from redd estimate to adult spawners used a fish per redd ratio of 1.62 (assumes 0.81 females per redd and one male

per female) and was used for Steelhead based on historical surveys conducted in Snow Creek, WA (US FWS & WDG, 1980; Freymond, 1982). This expansion factor reflects a combination of observer efficiency (not observing every redd), multiple nests built by a single female steelhead, and an assumed one to one ratio for male and female steelhead.

The Steelhead spawner estimate was further partitioned into early Steelhead redds observed on or before March 15th and late Steelhead redds observed after March 15th. Per WDFW Region 6 District 17 methodology, 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. If the supplemental survey was conducted on or before March 15th, the abundance estimate included the observed number of redds and those estimated using the visible:cumulative ratio, all of which are assumed to be hatchery origin. If the supplemental survey was conducted after March 15th, the abundance estimate included the observed number of redds and those estimated using the visible:cumulative ratio, but to produce a hatchery and wild estimate the observed redds in the supplemental survey were split based on the ratio of redds before/after March 15th visible in the nearest index. This extra step provided a separate estimate of hatchery and wild redds when the supplemental survey was only done once, and was surveyed after March 15th. During supplemental surveys conducted after March 15th, few to no early Steelhead redds (that might confound the counts) were still visible in index reaches. 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 but true proportions of wild fish spawning before March 15th and hatchery fish spawning after March 15th is unknown.

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 v. 10 for each species and spawning season. Survey reaches were also plotted to depict the areas surveyed as index reaches and areas surveyed as supplemental reaches. Maps showing survey reaches and redd locations were developed for each species and each survey year. The maps also included the potential dam inundation footprint for the FRFA alternative, which has the most extensive inundation footprint of the two dam options being considered. The proportions of redds within versus outside the dam footprint were calculated for each species and survey season.

Diversity

Age structure was summarized based on results from scales retrieved from Chinook and Steelhead carcasses and from live Steelhead captured using hook-and-line methods.

Coho and Chinook hatchery:wild composition were determined from the adipose fin and CWT status of recovered carcasses. Steelhead hatchery:wild composition was determined from redd timing and the visual appearance of live fish and recovered carcasses. Visual characteristics used to assign hatchery versus wild included the presence (wild) or absence (hatchery) of the adipose fin, dorsal fin height and disfiguration (stubby or disfigured in hatchery fish), and scale growth patterns as determined by the WDFW Otolith and Ageing Lab. Hatchery Steelhead in the Chehalis basin do not receive a CWT, though all Steelhead are scanned in case of straying from other basins outside the Chehalis River. Steelhead surveys conducted in the upper Chehalis sub-basin encompass the timing of both the hatchery and wild populations. The current state-wide standard assumes that Steelhead fish and redds observed on/before March 15th are hatchery fish and fish and redds observed after March 15th are wild fish. This assumption was used to partition the redd estimate in this report. However, the contribution of hatchery fish to early and late spawning steelhead in the upper Chehalis River sub-basin is uncertain. There are no hatchery

releases above RM 108.2. The closest hatchery plants are located in Elk Creek (Chehalis River at RM 100.2) and Gheer Creek (South Fork Newaukum River at RM ~19.7). The source of hatchery plants in these tributaries is the Skookumchuck winter-run Steelhead program which has a similar (not early) run timing to wild winter Steelhead. Early spawning hatchery steelhead may originate from hatcheries producing summer steelhead or 'early' (Chambers) winter steelhead. The closest hatchery programs for summer steelhead are Lake Aberdeen (entrance via Elliott Slough at RM 1.4 on the Chehalis) and Humptulips hatchery (Grays Harbor). The closest hatchery program that produces 'early' winter steelhead is the Humptulips hatchery in Grays Harbor. In 2015, a snorkel survey conducted in the upper Chehalis River sub-basin in early March revealed numerous wild Steelhead and minimal to no hatchery Steelhead. The snorkel survey was conducted between the East Fork/West Fork confluence (RM 120.1) and RM 108.2 on March 10th, 2015 (E. Walther, WDFW, personal communication) and over 300 wild Steelhead (unmarked) and no hatchery Steelhead (adipose-clipped) were observed. Snorkel surveys were attempted in 2016 and 2017 during statistical weeks 9, 11, and 13 (late February to late March), but as a result of high flows and unsafe conditions only one out of three surveys was completed in 2016 and no surveys were completed in 2017. If wild Steelhead are indeed spawning earlier than March 15th, the current estimate of wild Steelhead is underestimated and the estimate of hatchery Steelhead is overestimate for this portion of the Chehalis River basin.

Results

Survey Effort

The 2013-2014 survey season began September 2nd and concluded June 29th (Figure 2A, Appendix 1A). The most frequently surveyed areas were the main stem Chehalis, the EF Chehalis, and the WF Chehalis as these three areas encompassed spawning habitat for all three salmon species and steelhead. The main stem Chehalis and EF Chehalis were the areas most affected by weather, high flows, or turbidity. There was only one instance during the season when logging activity restricted surveying (EF RM 126.4-127.7, statistical week (SW) 44). Missed surveys, defined as no time to survey or no fish activity to survey were more common later in the survey season, after the peak of the Steelhead run. The areas surveyed for Coho only were Big Creek Tributary A and EF Tributary 1213. The areas surveyed for Steelhead only were Mack Creek, WF RM 3.2-4.2, and Sage Creek.

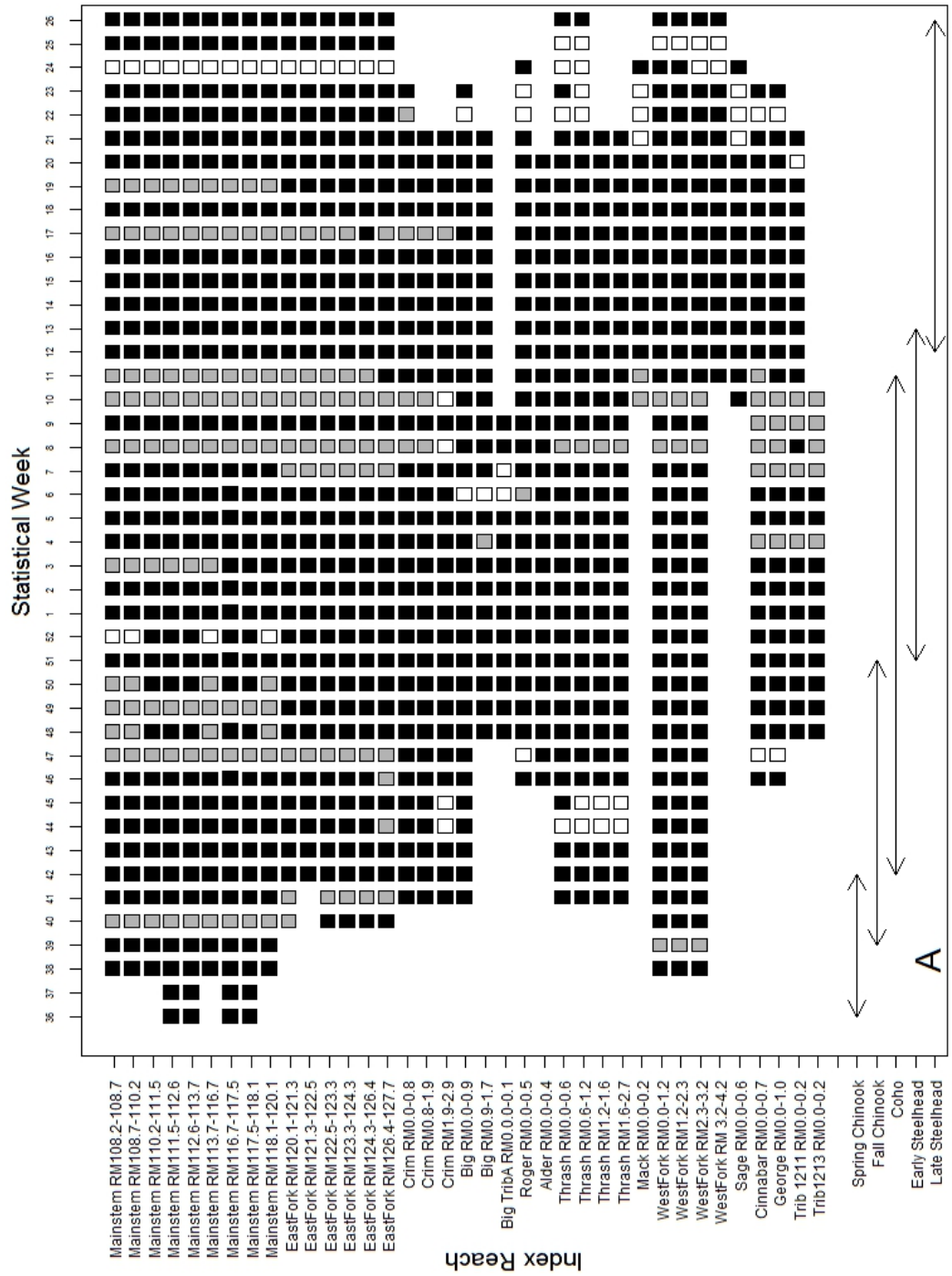
The 2014-2015 survey season started September 15th and ended June 21st (Figure 2B, Appendix 2). The most frequently surveyed areas were the main stem Chehalis, the EF Chehalis, and the WF Chehalis. The main stem Chehalis and EF Chehalis were again the most affected areas to not be surveyed due to weather, high flows, or turbidity. There were no instances during the season when logging activity restricted surveying. Missed surveys were more common later in the survey season, once Steelhead started spawning.

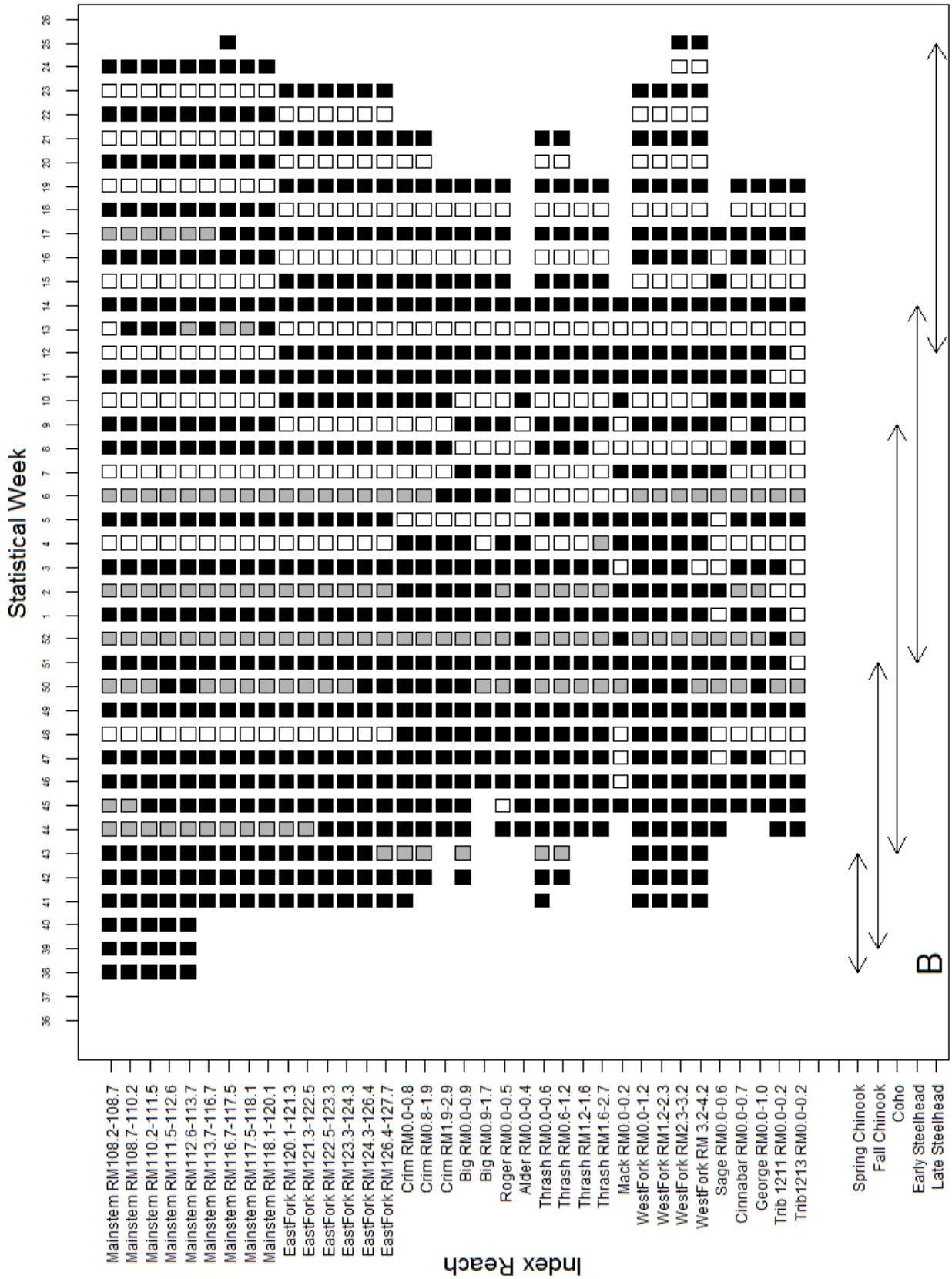
The 2015-2016 survey season started September 14th and ended June 26th (Figure 2C, Appendix 3). The most surveyed area was the main stem Chehalis. The EF Chehalis and WF Chehalis were not surveyed for spring Chinook due to low stream flow at the beginning of September. Spot surveys in these areas were conducted to confirm absence of fish. There was logging activity in the main stem, EF Chehalis and Cinnabar Creek that restricted surveying (main stem RM118.1-120.1, SW 3-4; EF RM 121.3–122.5, SW 46-1and RM 122.5-123.3, SW 46-47; Cinnabar, SW 44-50). Snow limited access to the EF Chehalis preventing surveys on SW 1 (RM 122.5-123.3, and RM 123.3-124.3). High flows occurred often between mid-November to late December (SW 47-52). Missed surveys were most common during late January to February (SW 4-8).

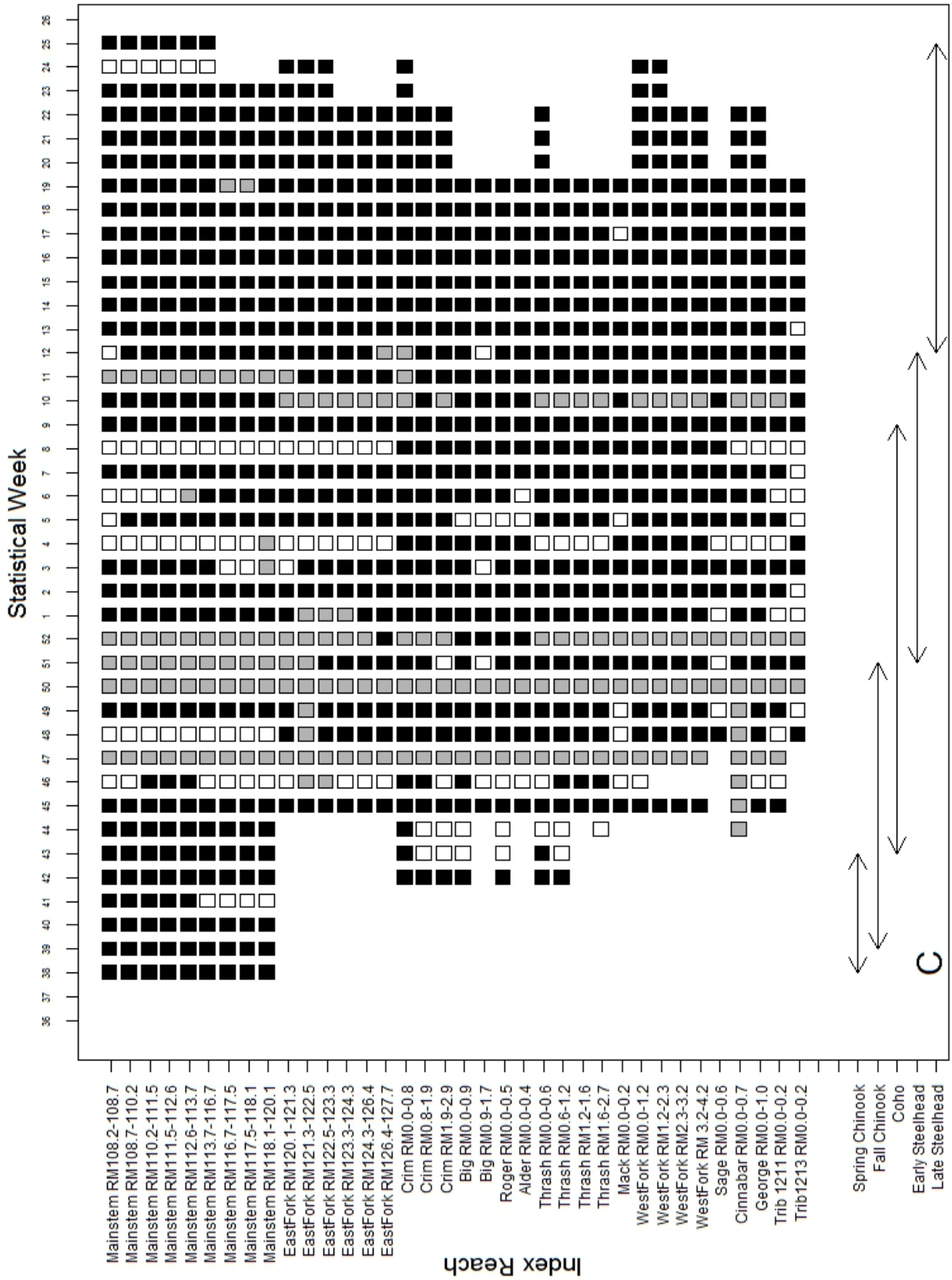
The 2016-2017 survey season began September 12th and ended June 25th (Figure 2D, Appendix 4). The most surveyed areas were the main stem Chehalis, EF Chehalis, WF Chehalis, Crim Creek, and Thrash Creek. The main stem Chehalis was the area most affected by weather, high flows, or turbidity. Due to snow, there was no access to the EF Chehalis and its tributaries (SW 51, 6, 10) and due to heavy snowfall while surveying the EF tributaries (Cinnabar, George, 1211 and 1213) were not surveyed for SW

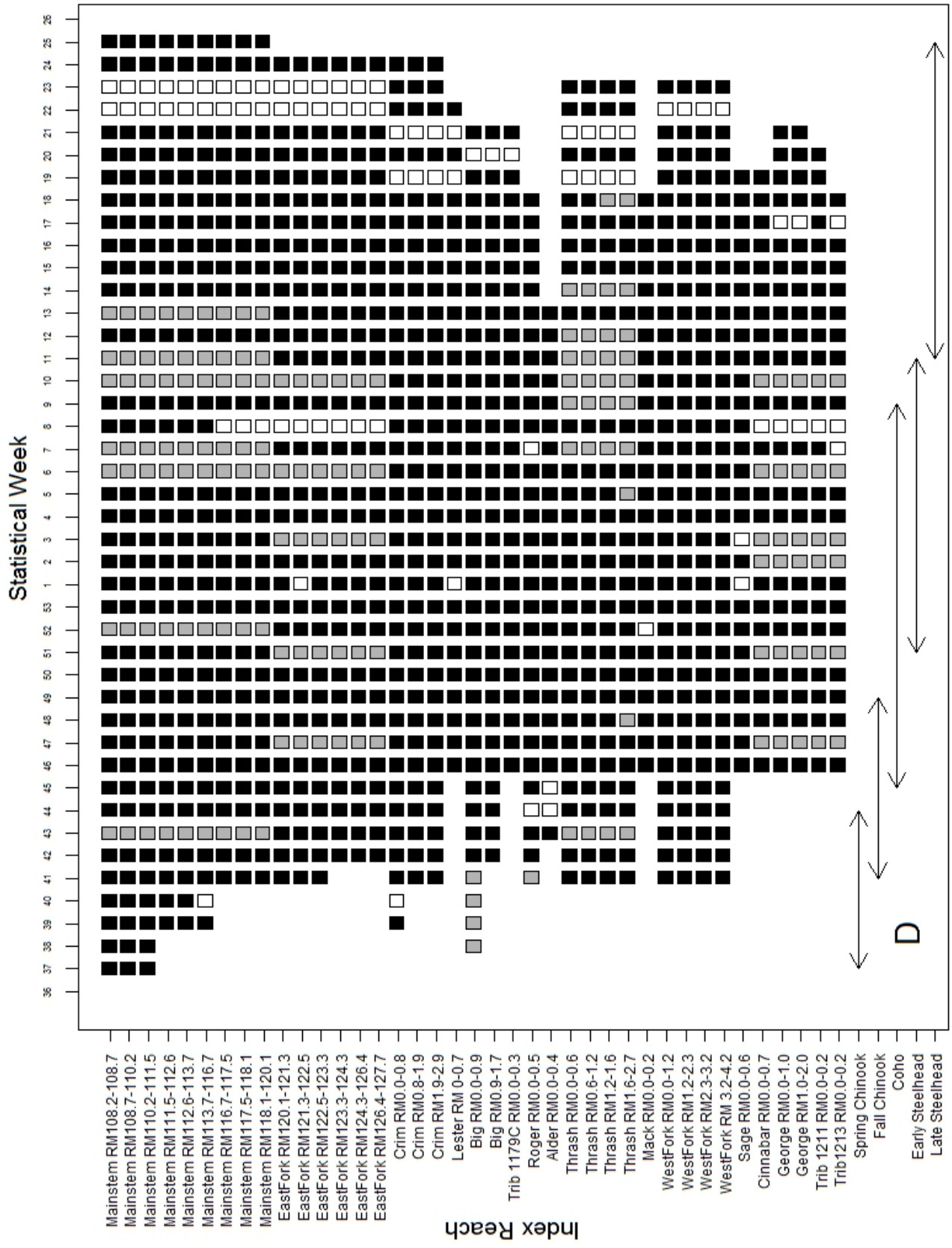
2. Logging restricted access to the entirety of Thrash Creek for SW 9-12, and 14, and a portion on other occasions (RM 1.6-2.7, SW48, 5; RM 1.2-1.6, SW 18), so no surveys were completed. There was no access at the mouth of Big Creek until SW 42 due to low water flows. Missed surveys mostly occurred after Steelhead peak spawning when there was less activity.

Figure 2. Status of index surveys by statistical week for the A) 2013-2014 and B) 2014-2015 survey season, C) 2015-2016 survey season, and D) 2016-2017 survey season. Each square indicates a survey's status showing: statistical weeks surveyed (black), did not survey due to time constraints or no fish activity (white), and did not survey due to high flows/low visibility or logging activity (grey). Areas where no squares are present indicate no effort made to survey, i.e., before or after activity in index reach. Timing arrows along the bottom of the figure are based on the earliest and latest recorded new redd of that species for the spawning season.




Statistical Week
Index Reach
Mainstem RM108.2-108.7
Mainstem RM108.7-110.2
Mainstem RM110.2-111.5
Mainstem RM111.5-112.6
Mainstem RM112.6-113.7
Mainstem RM113.7-116.7
Mainstem RM116.7-117.5
Mainstem RM117.5-118.1
Mainstem RM118.1-120.1
EastFork RM120.1-121.3
EastFork RM121.3-122.5
EastFork RM122.5-123.3
EastFork RM123.3-124.3
EastFork RM124.3-126.4
EastFork RM126.4-127.7
Crim RM0.0-0.8
Crim RM0.8-1.9
Crim RM1.9-2.9
Big RM0.0-0.9
Big RM0.9-1.7
Roger RM0.0-0.5
Alder RM0.0-0.4
Thrash RM0.0-0.6
Thrash RM0.6-1.2
Thrash RM1.2-1.6
Thrash RM1.6-2.7
Mack RM0.0-0.2
WestFork RM0.0-1.2
WestFork RM1.2-2.3
WestFork RM2.3-3.2
WestFork RM 3.2-4.2
Sage RM0.0-0.6
Cinnabar RM0.0-0.7
George RM0.0-1.0
Trib 1211 RM0.0-0.2
Trib1213 RM0.0-0.2
Spring Chinook
Fall Chinook
Coho
Early Steelhead
Late Steelhead
B


Statistical Week
Index Reach
Mainstem RM108.2-108.7
Mainstem RM108.7-110.2
Mainstem RM110.2-111.5
Mainstem RM111.5-112.6
Mainstem RM112.6-113.7
Mainstem RM113.7-116.7
Mainstem RM116.7-117.5
Mainstem RM117.5-118.1
Mainstem RM118.1-120.1
EastFork RM120.1-121.3
EastFork RM121.3-122.5
EastFork RM122.5-123.3
EastFork RM123.3-124.3
EastFork RM124.3-126.4
EastFork RM126.4-127.7
Crim RM0.0-0.8
Crim RM0.8-1.9
Crim RM1.9-2.9
Big RM0.0-0.9
Big RM0.9-1.7
Roger RM0.0-0.5
Alder RM0.0-0.4
Thrash RM0.0-0.6
Thrash RM0.6-1.2
Thrash RM1.2-1.6
Thrash RM1.6-2.7
Mack RM0.0-0.2
WestFork RM0.0-1.2
WestFork RM1.2-2.3
WestFork RM2.3-3.2
WestFork RM 3.2-4.2
Sage RM0.0-0.6
Cinnabar RM0.0-0.7
George RM0.0-1.0
Trib 1211 RM0.0-0.2
Trib1213 RM0.0-0.2
Spring Chinook
Fall Chinook
Coho
Early Steelhead
Late Steelhead
C


Statistical Week
Index Reach
Mainstem RM108.2-108.7
Mainstem RM108.7-110.2
Mainstem RM110.2-111.5
Mainstem RM111.5-112.6
Mainstem RM112.6-113.7
Mainstem RM113.7-116.7
Mainstem RM116.7-117.5
Mainstem RM117.5-118.1
Mainstem RM118.1-120.1
EastFork RM120.1-121.3
EastFork RM121.3-122.5
EastFork RM122.5-123.3
EastFork RM123.3-124.3
EastFork RM124.3-126.4
EastFork RM126.4-127.7
Crim RM0.0-0.8
Crim RM0.8-1.9
Crim RM1.9-2.9
Lester RM 0-0.7
Big RM0.0-0.9
Big RM0.9-1.7
Trib 1179C RM0.0-0.3
Roger RM0.0-0.5
Alder RM0.0-0.4
Thrash RM0.0-0.6
Thrash RM0.6-1.2
Thrash RM1.2-1.6
Thrash RM1.6-2.7
Mack RM0.0-0.2
WestFork RM0.0-1.2
WestFork RM1.2-2.3
WestFork RM2.3-3.2
WestFork RM 3.2-4.2
Sage RM0.0-0.6
Cinnabar RM0.0-0.7
George RM0.0-1.0
George RM1.0-2.0
Trib 1211 RM0.0-0.2
Trib1213 RM0.0-0.2
Spring Chinook
Fall Chinook
Coho
Early Steelhead
Late Steelhead
D

Abundance

Over four seasons the estimated abundance of spring Chinook ranged between 3 and 65 adults, and fall Chinook ranged between 297 and 424 adults (Table 3, Figure 3). Coho spawner abundance ranged between 174 and 1590 adults (Table 3, Figure 3). Early Steelhead spawner abundance ranged between 28 and 300 adults and late Steelhead spawner abundance ranged between 976 and 1550 adults. The percent of Steelhead redds observed on or before March 15th ranged between 2% and 16% (2013-2014: 7%, 2014-2015: 16%, 2015-2016: 14%, and 2016-2017: 2%).

Table 3. Number of total redds and estimated abundance of adult salmon and steelhead spawners in the Chehalis River above the proposed dam site. Redds include those observed in index reaches and estimated from supplemental reaches.

	Spring Chinook		Fall Chinook		Coho		Early Steelhead		Late Steelhead	
Year	Redds	Adults	Redds	Adults	Redds	Adults	Redds	Adults	Redds	Adults
2013-2014	13	34	117	297	87	174	43	72	603	976
2014-2015	25	65	123	302	795	1590	185	300	956	1550
2015-2016	1	3	169	424	505	1010	138	222	777	1264
2016-2017	2	6	133	338	140	280	14	28	654	1062

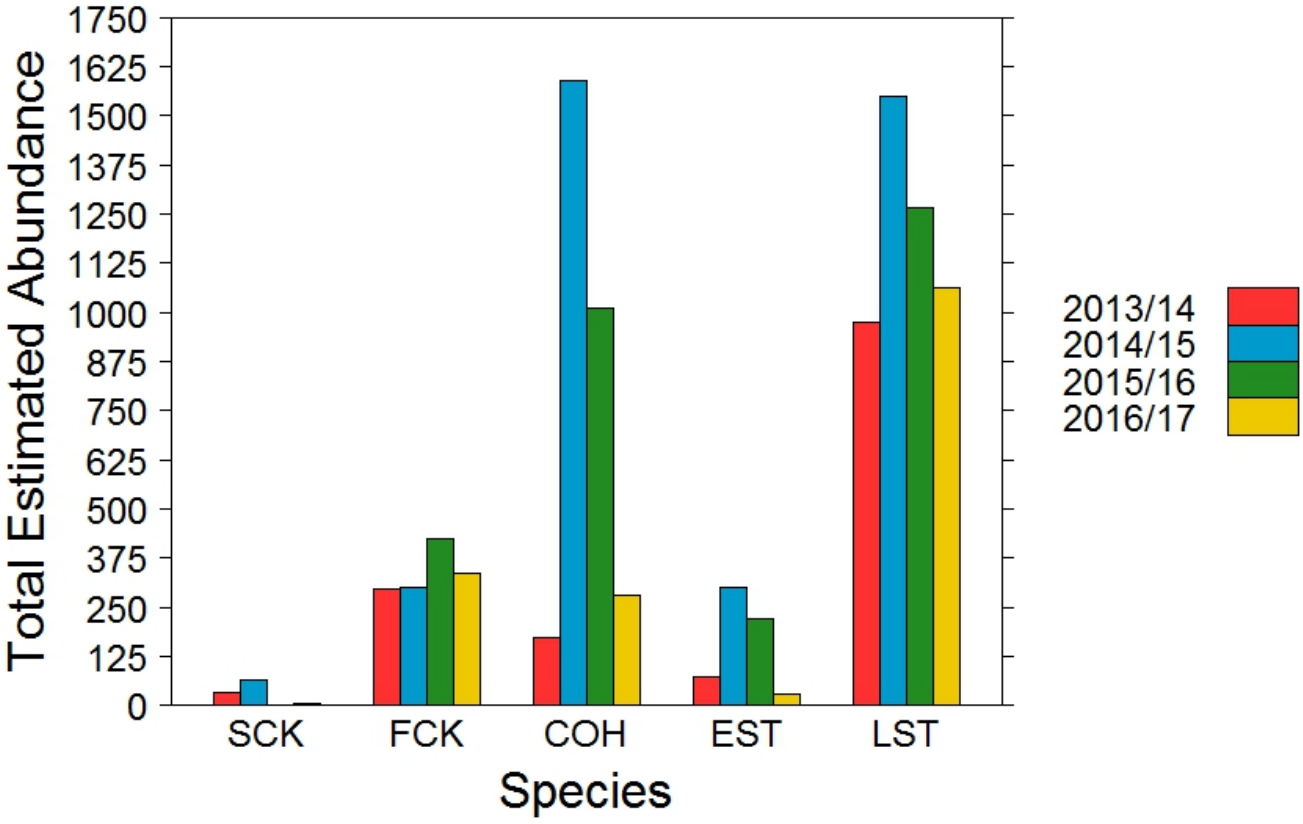
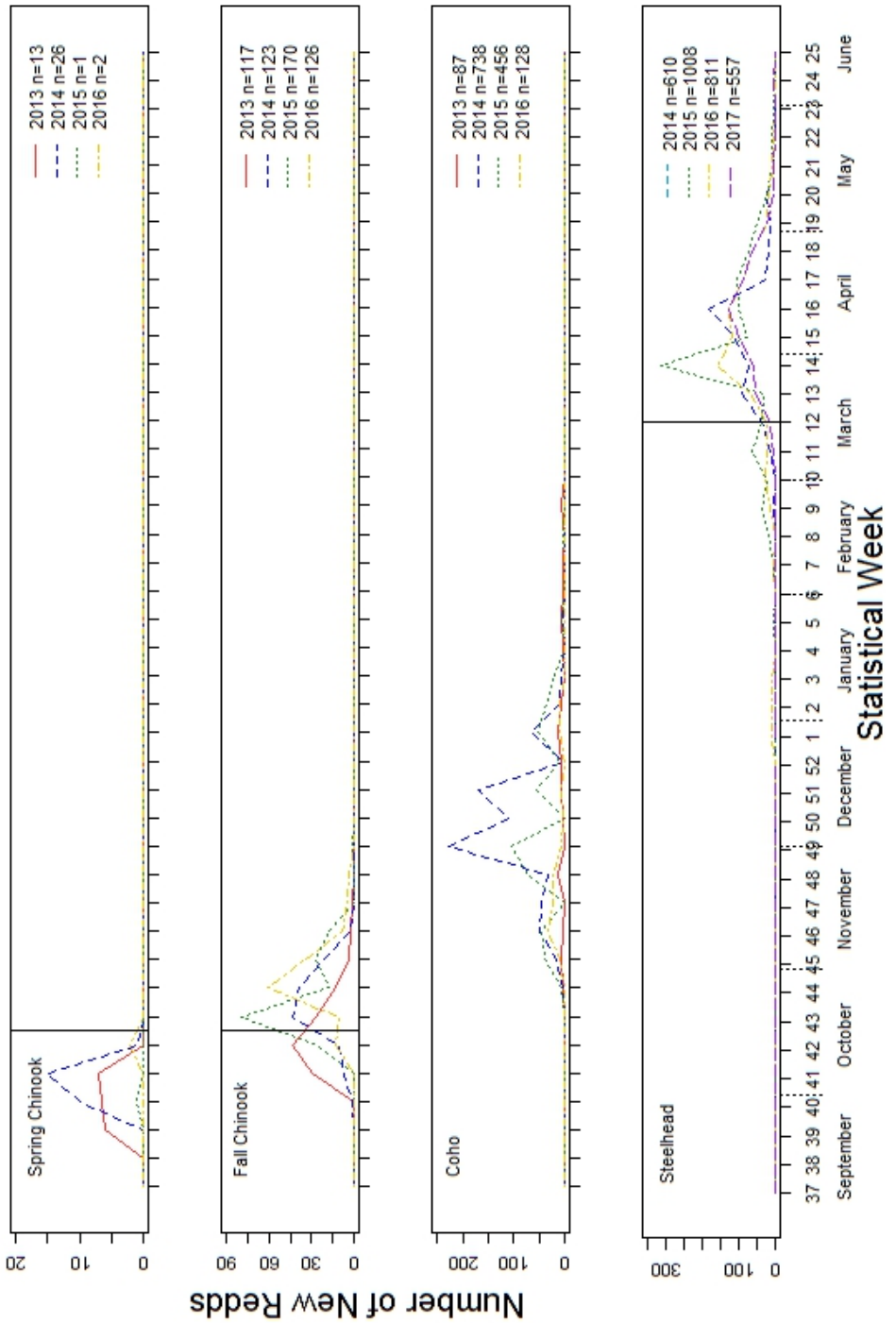


Figure 3. Total estimated abundance of spring Chinook, fall Chinook, Coho, early Steelhead (on/before March 15th) and late Steelhead (on/after March 15th) over four and a half survey seasons (2013-2014, 2014-2015, 2015-2016, and 2016-2017). SCK: Spring Chinook, FCK: Fall Chinook, COH: Coho, EST: Early Steelhead, LST: Late Steelhead.

Timing

Spawn timing for spring Chinook began in mid-September (SW 39-40) and ended in mid-October (SW 42-44) with peak spawning occurring in early October (SW 41-43) (Figure 4). Fall Chinook spawn timing began in early October (SW 40-42) and ended in mid-December (SW 49-50) with peak spawning occurring in mid-October (SW 42-44). Spawn timing for Coho began in mid-October (SW 43-45) and ended in late February (SW 3-9) with peak spawning occurring in late December/early January (SW 46-2). Steelhead spawn timing began in late December/early January (SW 49-3) and ended in mid-June (SW 23-25) with peak spawning occurring in late March/early April (SW 14-16).

Figure 4. Spawn timing for spring Chinook, fall Chinook, Coho, and Steelhead in the upper Chehalis sub-basin. The number of new redds (n) indicates new redds observed each statistical week for index reaches only. The vertical line in the spring and fall Chinook spawn timing graphs indicate the WDFW October 15th threshold date for run identification (spring/fall). The vertical line in the Steelhead spawn timing graph indicates the WDFW March 15th threshold date for origin identification (hatchery:wild).



Spatial Distribution

Across all four years, spring Chinook spawning mainly occurred (83% of redds observed) in the main stem Chehalis River downstream of Fisk Falls (Figure 5). For the 17% of observed redds not in the main stem downstream of Fisk Falls, 7% were observed upstream on the main stem, 5% were observed in Big Creek (2013), and 5% were observed in Crim Creek (2013, 2016). Over the four survey seasons, 96% - 100% of spring Chinook redds observed were located within the FRFA dam inundation footprint (Table 4).

Fall Chinook spawning distribution varied among the four seasons surveyed with 55% - 93% of redds observed located in the main stem Chehalis River (Figure 5). The distribution of fall Chinook in 2015 season was spatially constricted compared to previous years; Crim Creek and Big Creek were the only tributaries where fall Chinook redds were observed and no redds were observed in the main stem river upstream of Fisk Falls. In 2016, fall Chinook distribution increased into Lester Creek, and the upper reaches of Crim and Big creeks where they had not been observed in previous seasons. Over four survey seasons, 72% - 100% of fall Chinook redds were located within the FRFA dam inundation footprint (Table 4).

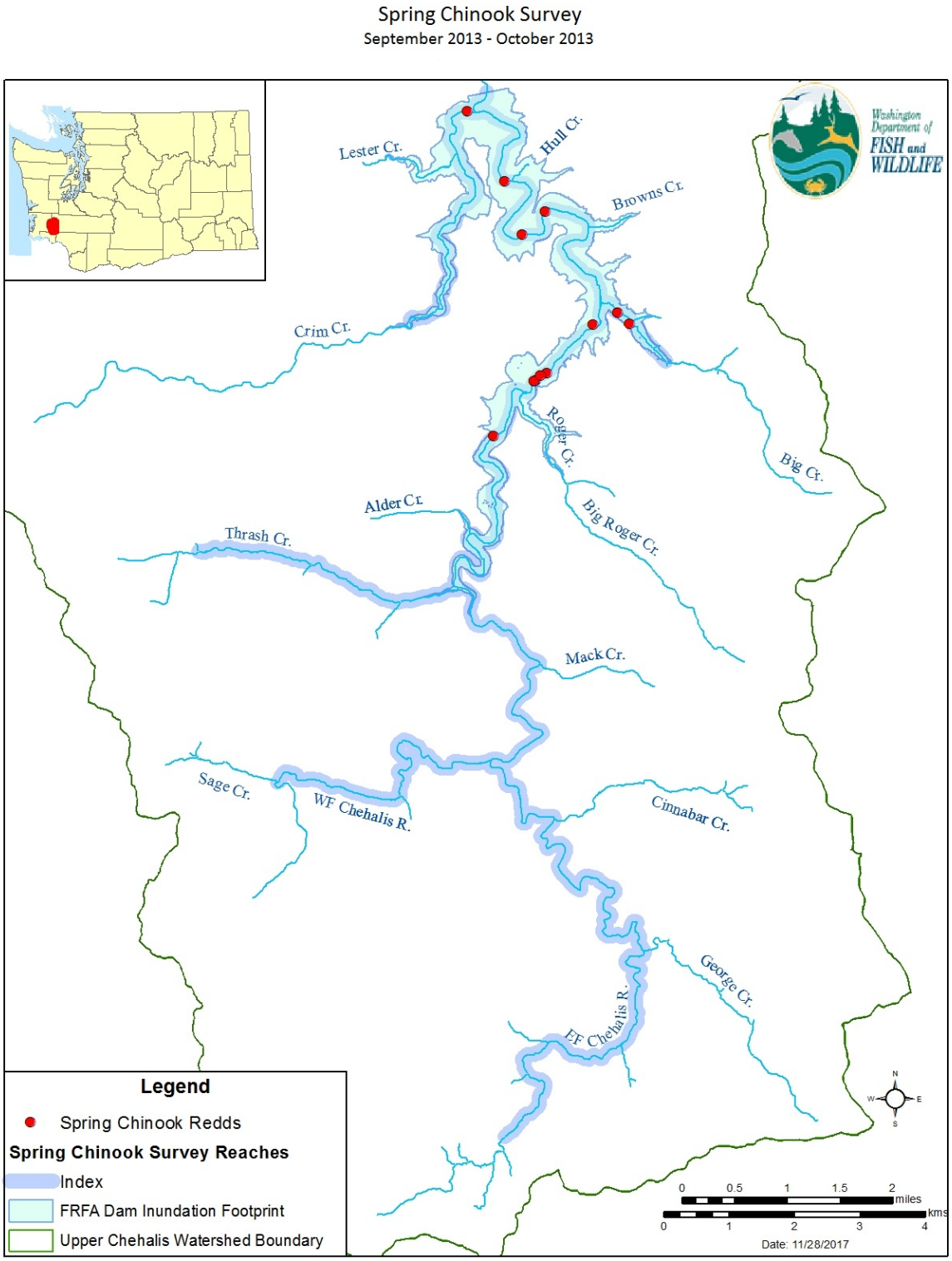
Coho spawning distribution varied over the four seasons surveyed with 12.5% - 52% of redds observed in the main stem Chehalis River (Figure 5). The number of redds observed in the tributaries differed among the survey seasons. In the 2013-2014 survey season, Coho redds were observed in the EF and WF Chehalis, Big, Crim, Thrash, and Cinnabar creeks. In 2014-2015 survey season, most of the redds observed were located in the EF and WF Chehalis and their tributaries (34% and 27% respectively) and an additional 22% of the redds were observed in the main stem tributaries (Big, Crim, Thrash, Alder, Roger, and Mack creeks). In the 2015-2016 survey season, more redds were observed in the main stem tributaries (37%) than were observed in the EF and WF Chehalis and their tributaries (14.5% and 10% respectively). The supplemental reaches represented 10% of Coho redds observed. Over four survey seasons, 28% - 67% of Coho redds were located within the FRFA dam inundation footprint (Table 4).

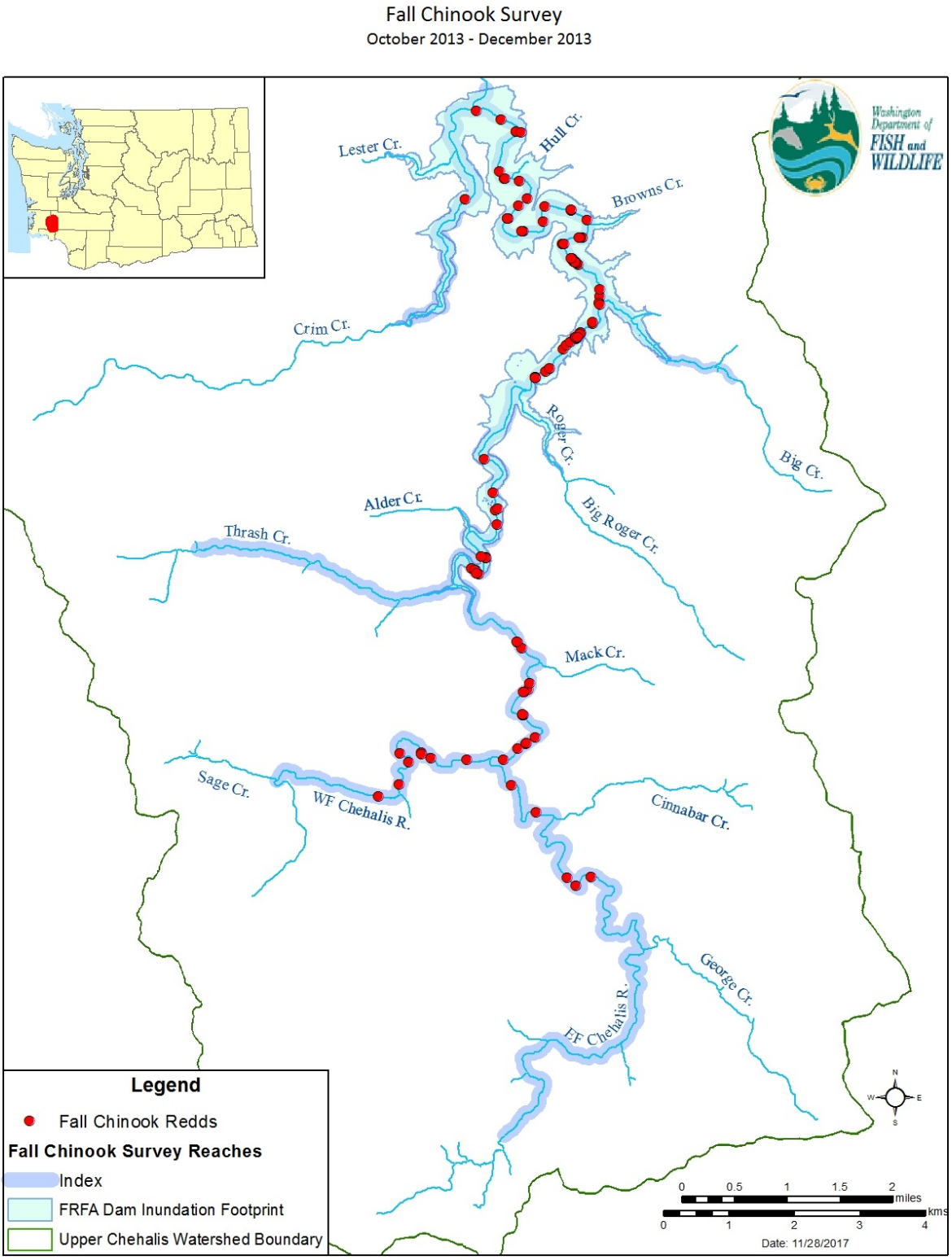
Steelhead spawning distribution was separated into early redds (observed on/before March 15th) and late redds (observed on/after March 15th), with 2% - 16% of redds observed in the early time period (Figure 5). In 2013-2014, of the 'early' redds, 40% were observed in the main stem and the other 60% were observed in EF and WF Chehalis and main stem tributaries (Crim, Big, and Thrash creeks). Comparatively, 29% of the 'late' redds were observed in the main stem Chehalis. The rest were located in the EF and WF Chehalis and their tributaries, 29.5% and 22% respectively, and 19.5% were in the main stem tributaries (Crim, Big, Roger, Thrash, and Mack creeks). The supplemental reaches represented 3% of redds observed. In 2014-2015 'early' redds, 53% were observed in the main stem and the other 47% were observed in the EF and WF Chehalis and main stem tributaries (Crim, Big, Roger, Alder, and Thrash creeks). Comparatively, 36% of the 'late' redds were observed in the main stem Chehalis. The rest were observed in the EF and WF Chehalis and their tributaries, 35% and 17% respectively, and 12% were observed in the main stem tributaries (Crim, Big, Roger, and Thrash creeks). The supplemental reaches represented 10% of redds observed. In 2015-2016 'early' redds, 48% were observed in the main stem and the other 52% were observed in the EF and WF Chehalis and main stem tributaries (Crim, Big, Roger, Alder, and Thrash creeks). Comparatively, 45% of the 'late' redds were observed in the main stem Chehalis. The rest were observed in the EF and WF Chehalis and their tributaries, 34% and 14% respectively, and 7% were observed in the main stem tributaries (Crim, Big, Roger, and Thrash creeks). The supplemental reaches represented 7% of redds observed. In 2016-2017 'early' redds, 15% were observed in the main stem and the other 85% were observed in the EF and WF Chehalis and main stem tributaries (Crim, and Thrash creeks). Comparatively, 22% of the 'late' redds were observed in the main stem Chehalis. The rest were observed in the EF and WF Chehalis and their tributaries, 39% and 16% respectively, and 23% were observed in the main stem tributaries (Crim, Lester, Big, Roger, Thrash, and Mack creeks). Supplemental reaches represented 11% of redds observed. Over the four survey seasons, 27% - 40% of Steelhead redds were located within the FRFA dam inundation footprint (Table 4).

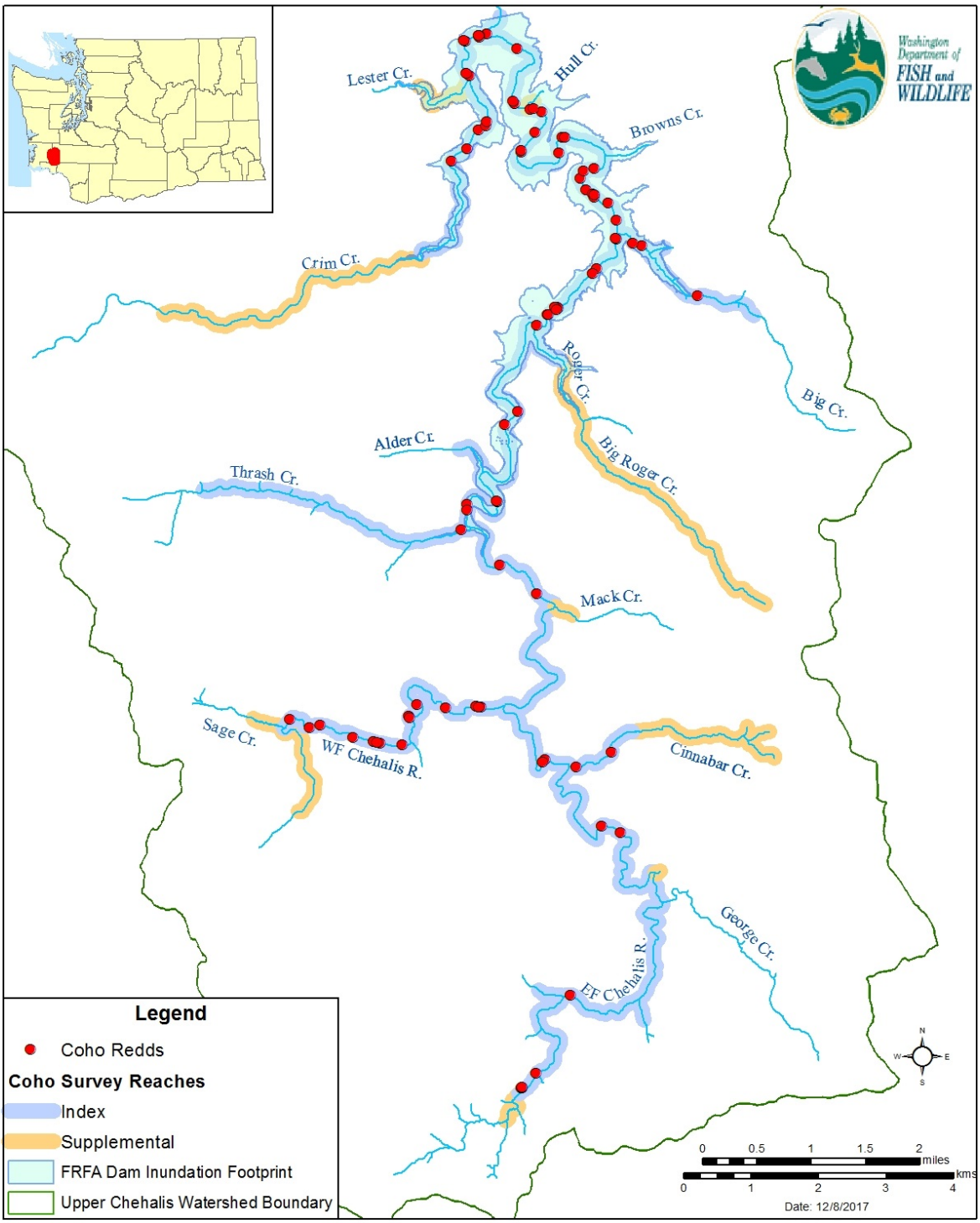
Table 4. Number of redds observed in the upper Chehalis River sub-basin within the inundation footprint of the proposed Flood Retention Flow Augmentation dam site at river mile 108.2 and the number of redds estimated in index and supplemental reaches outside of the dam inundation footprint.

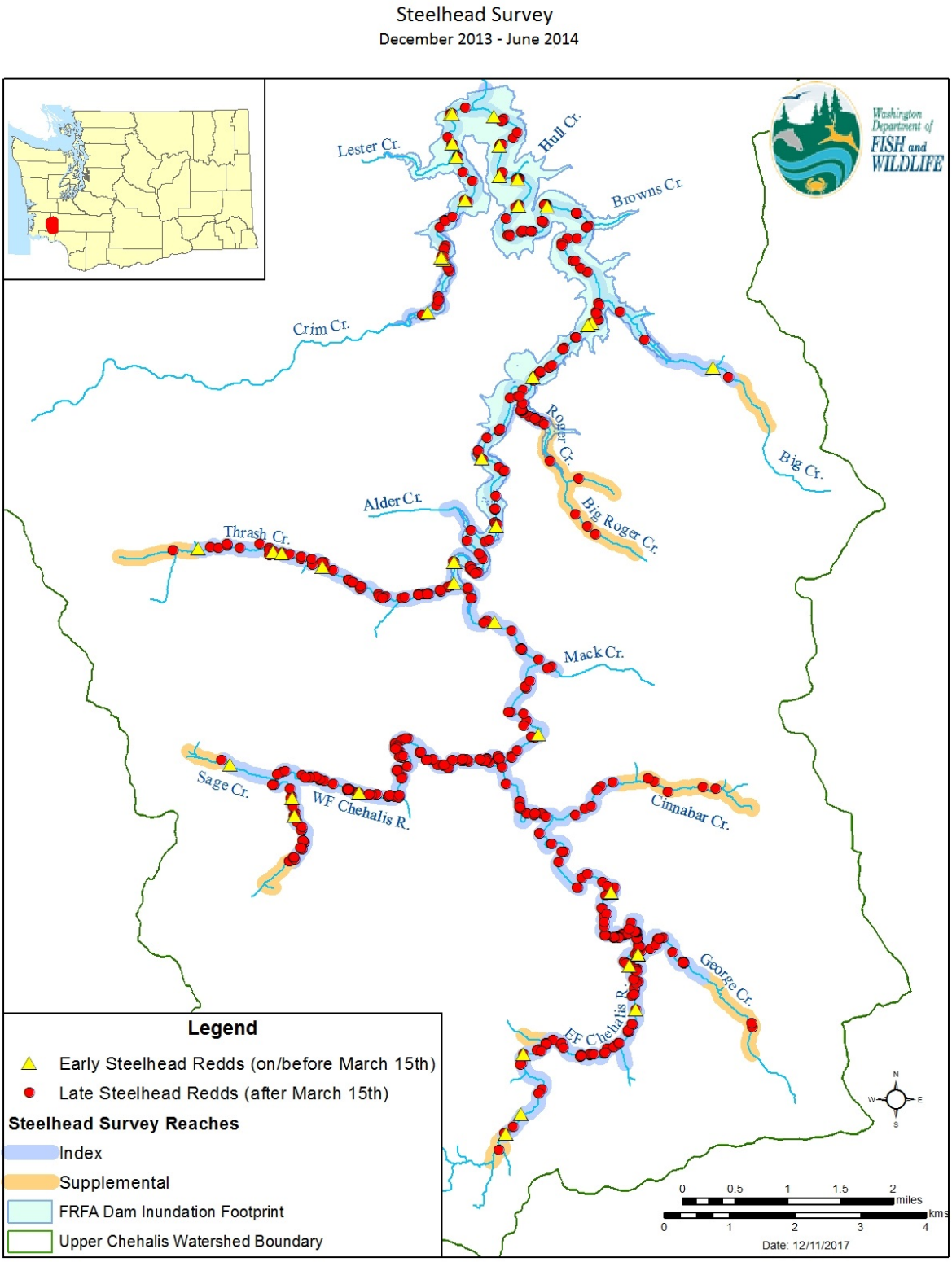
	Spring Chinook		Fall Chinook		Coho		Steelhead	
Survey Season	Within	Outside	Within	Outside	Within	Outside	Within	Outside
2013-2014	13	0	89	28	58	29	217	410
2014-2015	24	1	89	34	224	571	394	729
2015-2016	1	0	169	0	322	183	354	532
2016-2017	2	0	110	23	47	93	173	446

Figure 5. Maps of the spatial distribution of redds for each species and each survey season (2013-14, 2014-15, 2015-16, 2016-2017) in the Chehalis River upstream of river mile 108.2. Maps show the predicted inundation footprint of Flood Retention Flow Augmentation dam.

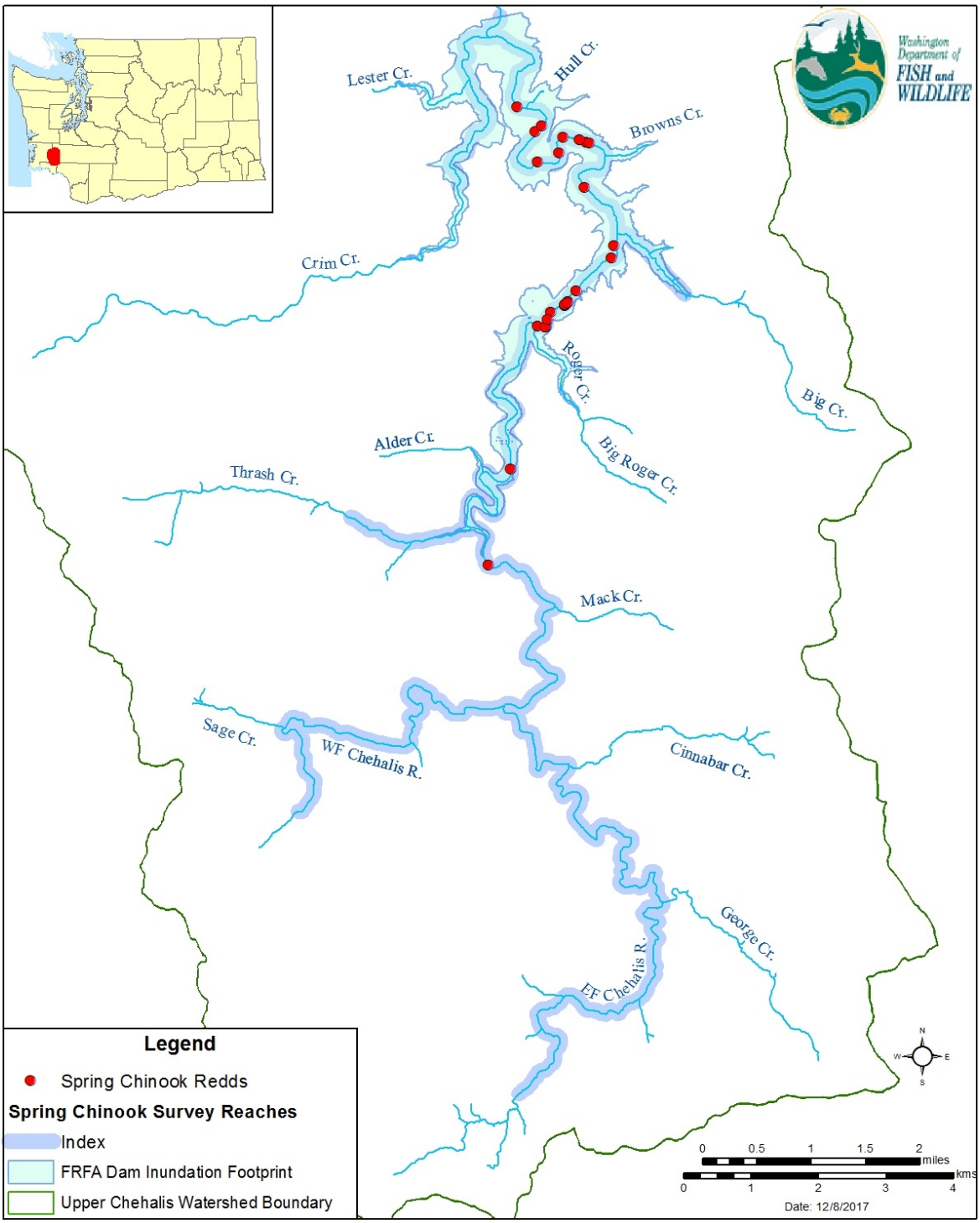


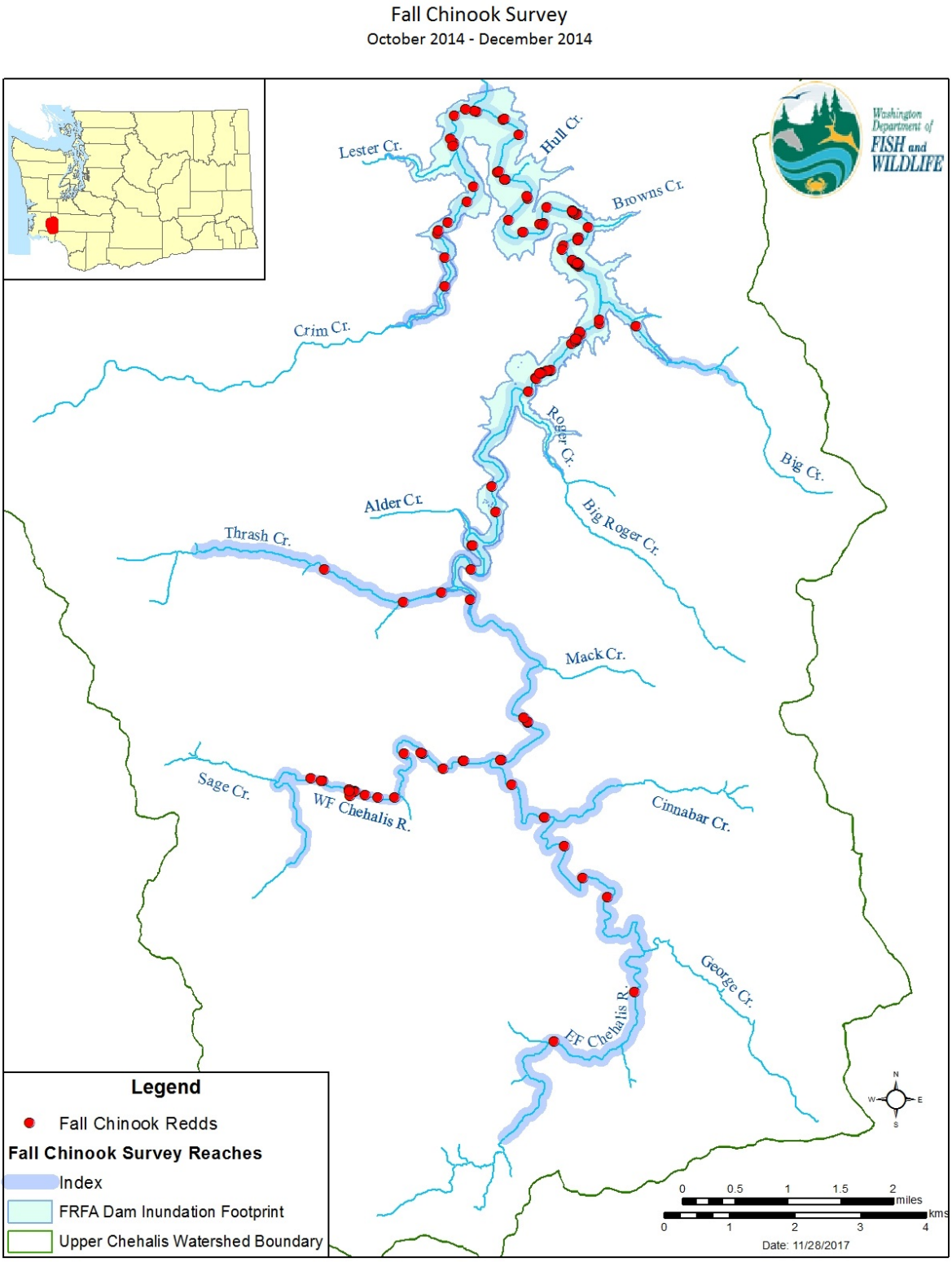

Fall Chinook Survey
October 2013 - December 2013
Washington Department of FISH and WILDLIFE
Lester Cr.
Hull Cr.
Browns Cr.
Crim Cr.
Roger Cr.
Big Cr.
Alder Cr.
Big Roger Cr.
Thrash Cr.
Mack Cr.
Sage Cr.
WF Chehalis R.
Cinnabar Cr.
George Cr.
EF Chehalis R.
Legend
Fall Chinook Redds
Fall Chinook Survey Reaches
Index
FRFA Dam Inundation Footprint
Upper Chehalis Watershed Boundary
N
W
E
S
0 0.5 1 1.5 2 miles
0 1 2 3 4 kms
Date: 11/28/2017


Coho Survey
October 2013 - February 2014
Washington Department of FISH and WILDLIFE
Lester Cr.
Hull Cr.
Browns Cr.
Crim Cr.
Roger Cr.
Big Cr.
Alder Cr.
Big Roger Cr.
Thrash Cr.
Mack Cr.
Sage Cr.
WF Chehalis R.
Cinnabar Cr.
George Cr.
EF Chehalis R.
Legend
Coho Redds
Coho Survey Reaches
Index
Supplemental
FRFA Dam Inundation Footprint
Upper Chehalis Watershed Boundary
N
W
E
S
0 0.5 1 1.5 2 miles
0 1 2 3 4 kms
Date: 12/8/2017


Steelhead Survey
December 2013 - June 2014
Washington Department of FISH and WILDLIFE
Lester Cr.
Hull Cr.
Browns Cr.
Crim Cr.
Roger Cr.
Big Cr.
Big Roger Cr.
Alder Cr.
Thrash Cr.
Mack Cr.
Sage Cr.
WF Chehalis R.
Cinnabar Cr.
George Cr.
EF Chehalis R.
Legend
Early Steelhead Redds (on/before March 15th)
Late Steelhead Redds (after March 15th)
Steelhead Survey Reaches
Index
Supplemental
FRFA Dam Inundation Footprint
Upper Chehalis Watershed Boundary
N
W
E
S
0 0.5 1 1.5 2 miles
0 1 2 3 4 kms
Date: 12/11/2017

Spring Chinook Survey
September 2014 - October 2014




Fall Chinook Survey
October 2014 - December 2014
Washington Department of FISH and WILDLIFE
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Crim Cr.
Roger Cr.
Big Cr.
Alder Cr.
Big Roger Cr.
Thrash Cr.
Mack Cr.
Sage Cr.
WF Chehalis R.
Cinnabar Cr.
George Cr.
EF Chehalis R.
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0 1 2 3 4 kms
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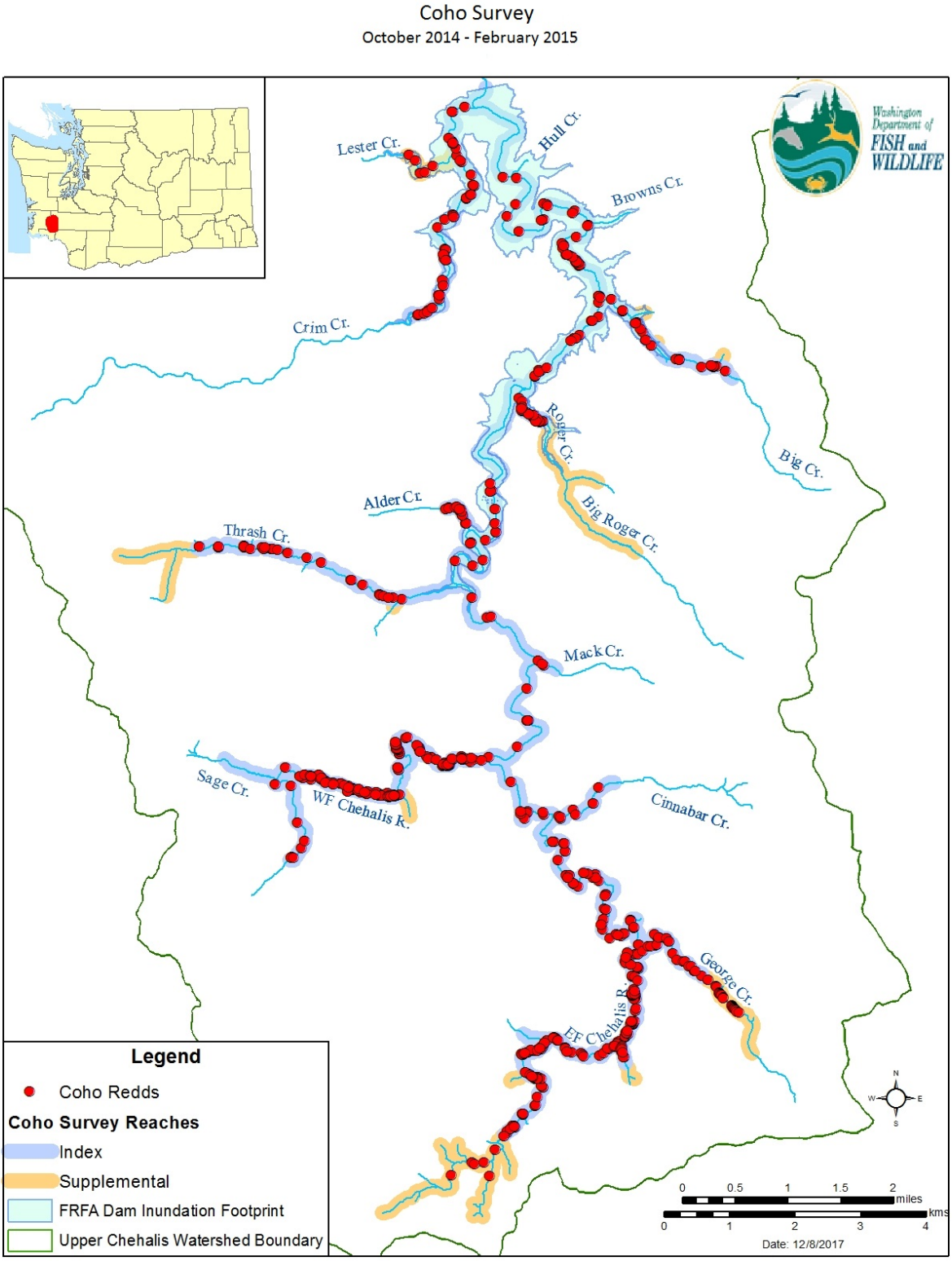
Coho Survey
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Washington Department of FISH and WILDLIFE
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Big Roger Cr.
Thrash Cr.
Mack Cr.
Sage Cr.
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Cinnabar Cr.
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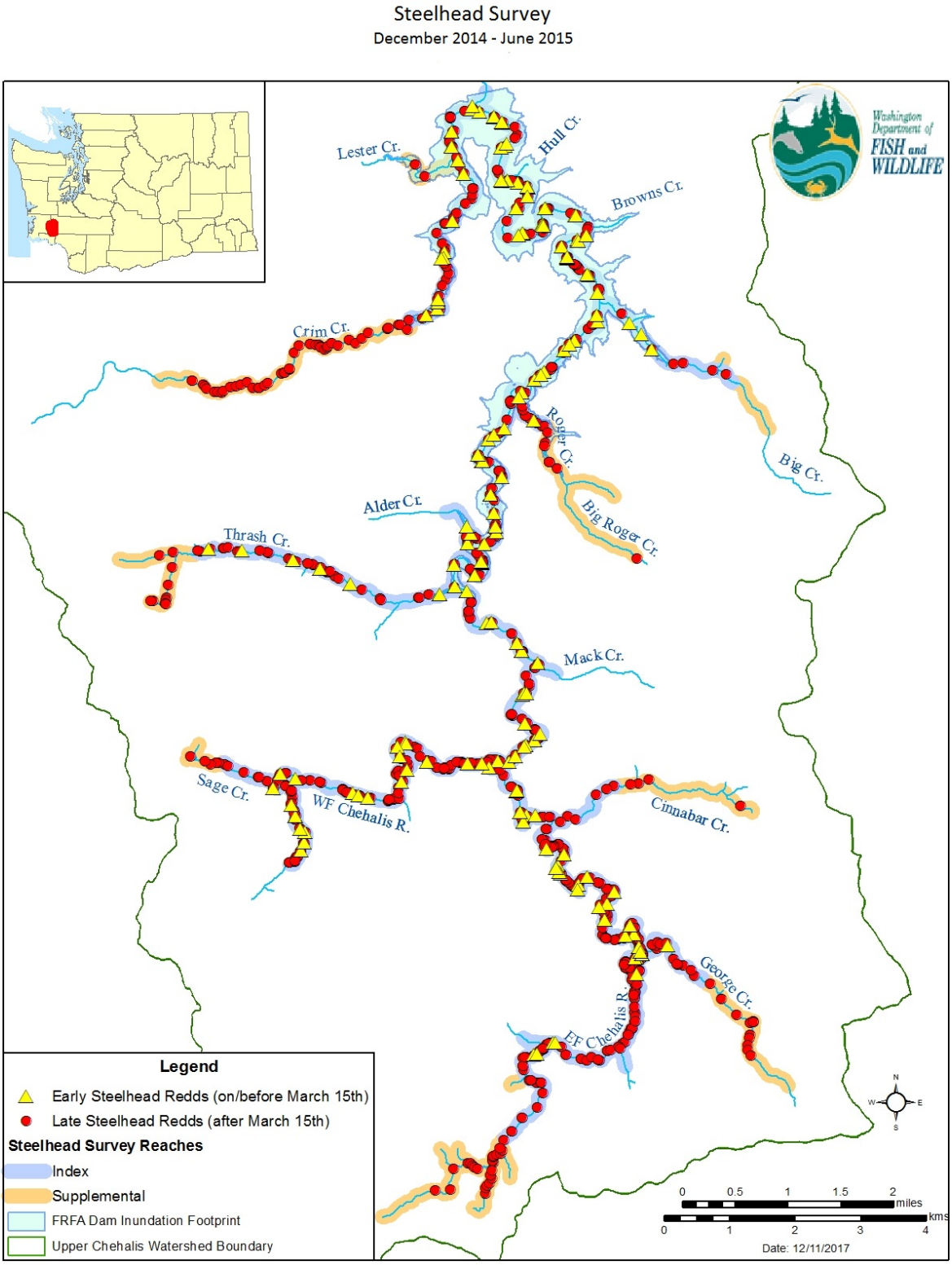
0 1 2 3 4 kms
Date: 12/8/2017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Washington Department of FISH and WILDLIFE
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Big Roger Cr.
Alder Cr.
Thrash Cr.
Mack Cr.
Sage Cr.
WF Chehalis R.
Cinnabar Cr.
George Cr.
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0 1 2 3 4 kms
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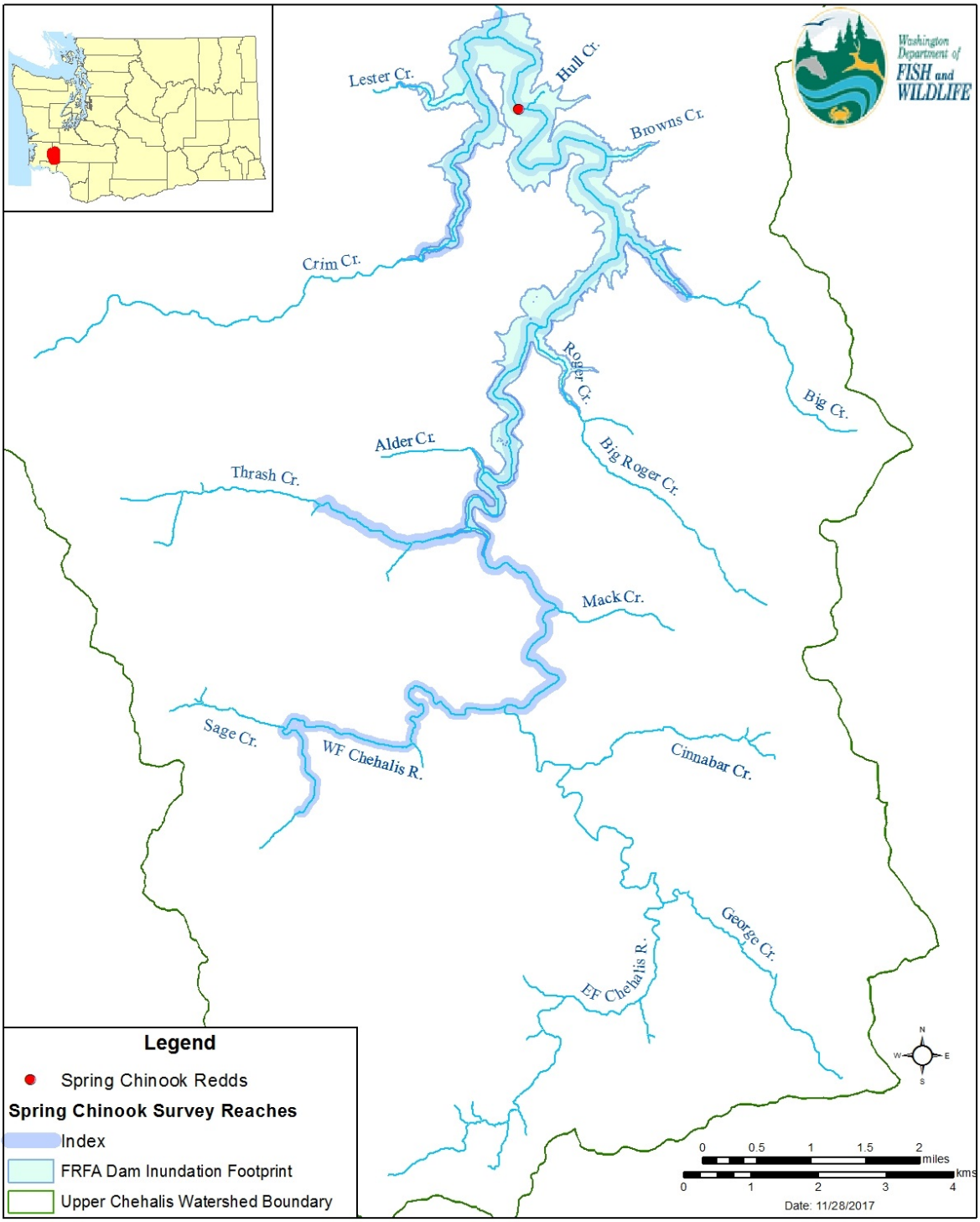
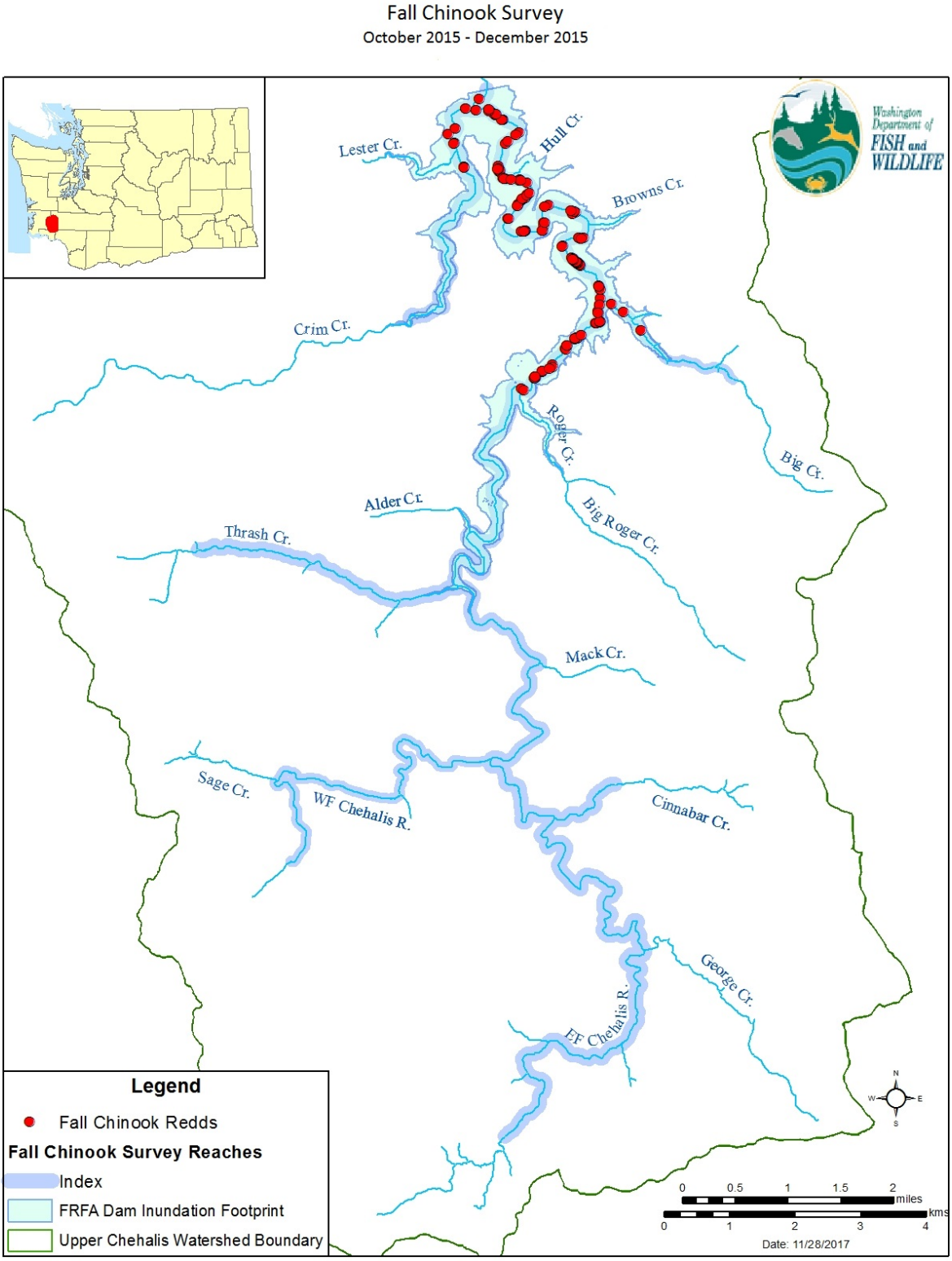
Spring Chinook Survey
September 2015 - October 2015




Fall Chinook Survey
October 2015 - December 2015
Washington Department of FISH and WILDLIFE
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Browns Cr.
Crim Cr.
Roger Cr.
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Alder Cr.
Big Roger Cr.
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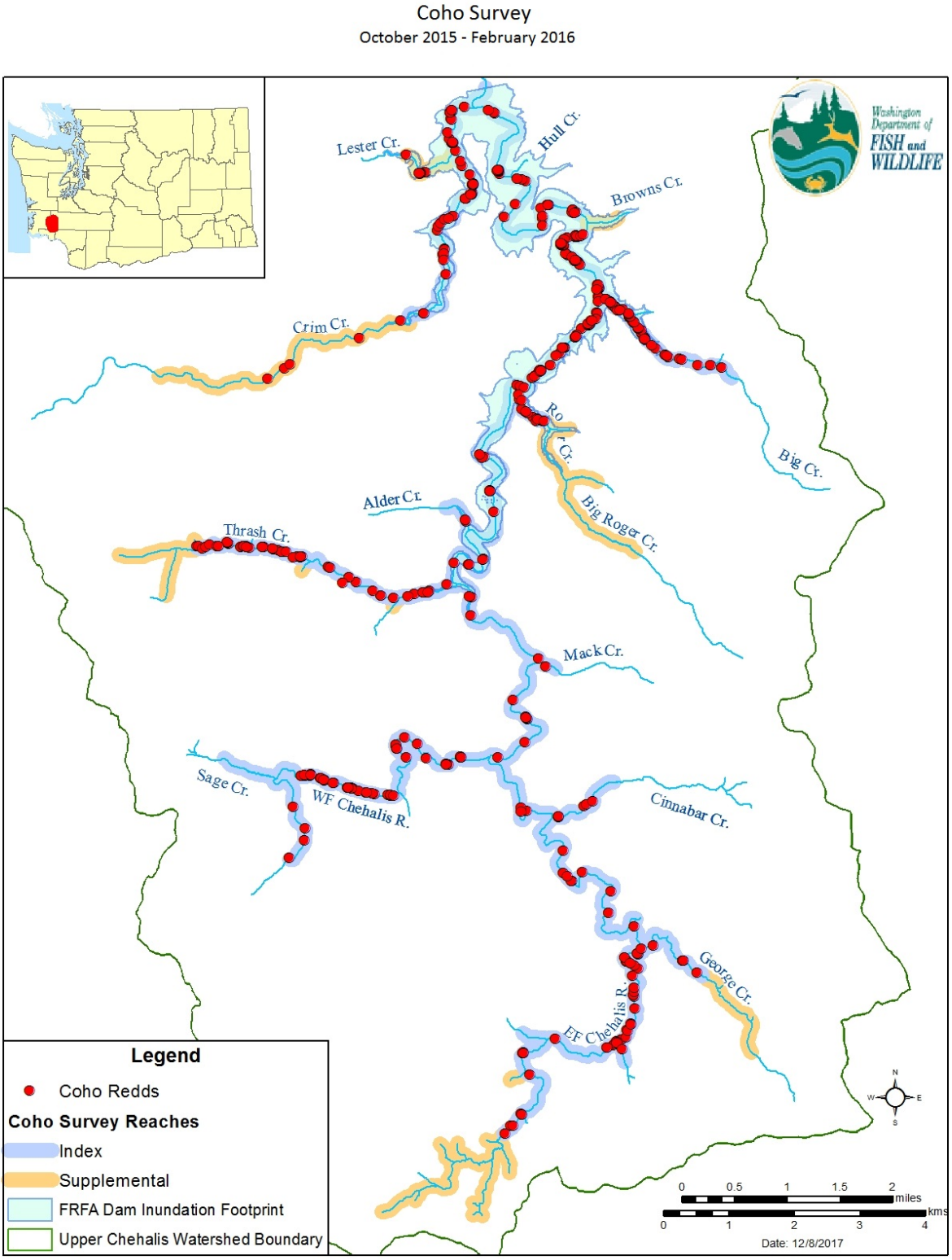
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Mack Cr.
Sage Cr.
WF Chehalis R.
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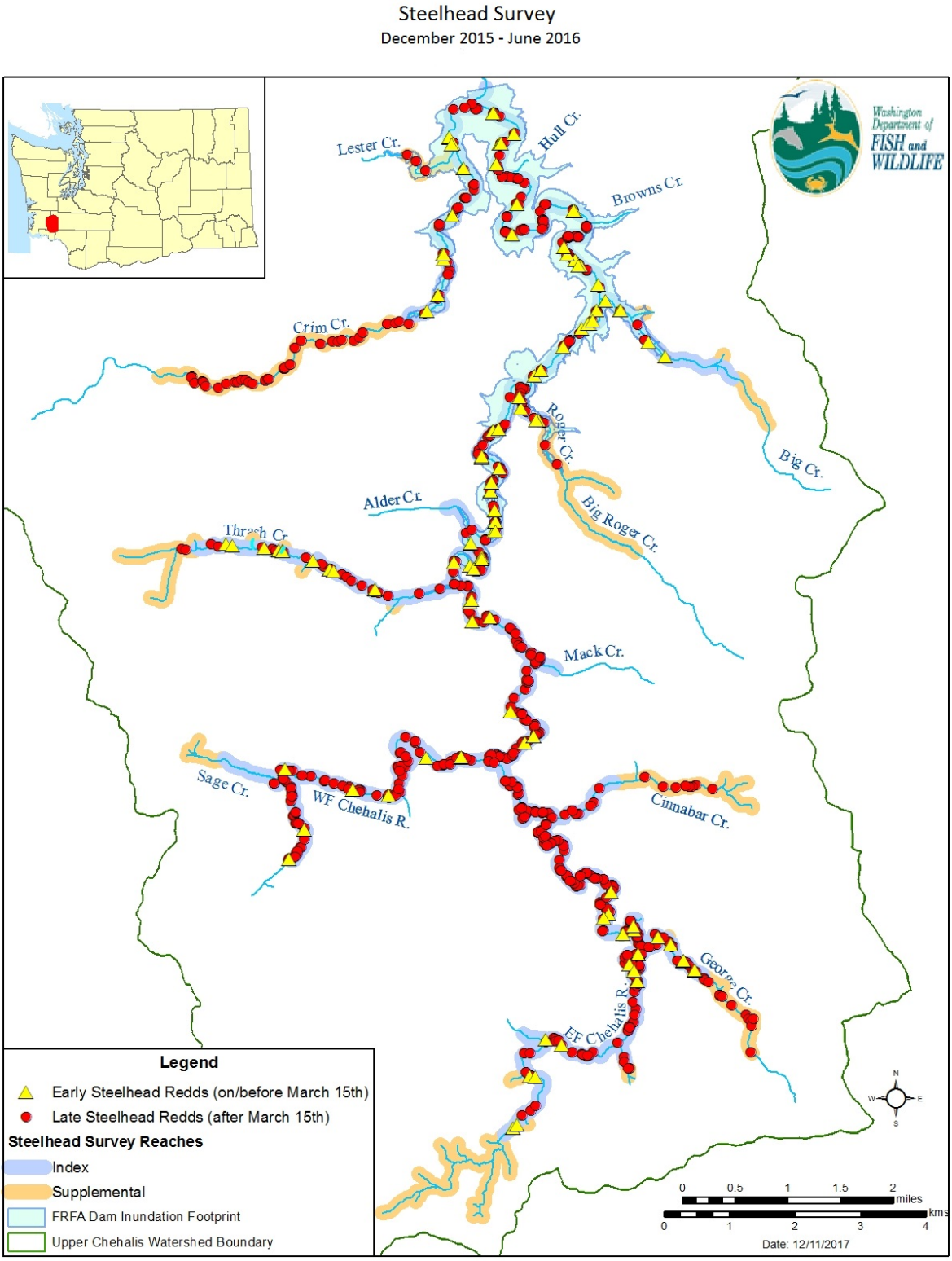
Steelhead Survey
December 2015 - June 2016
Washington Department of FISH and WILDLIFE
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Crim Cr.
Roger Cr.
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Alder Cr.
Thrash Cr.
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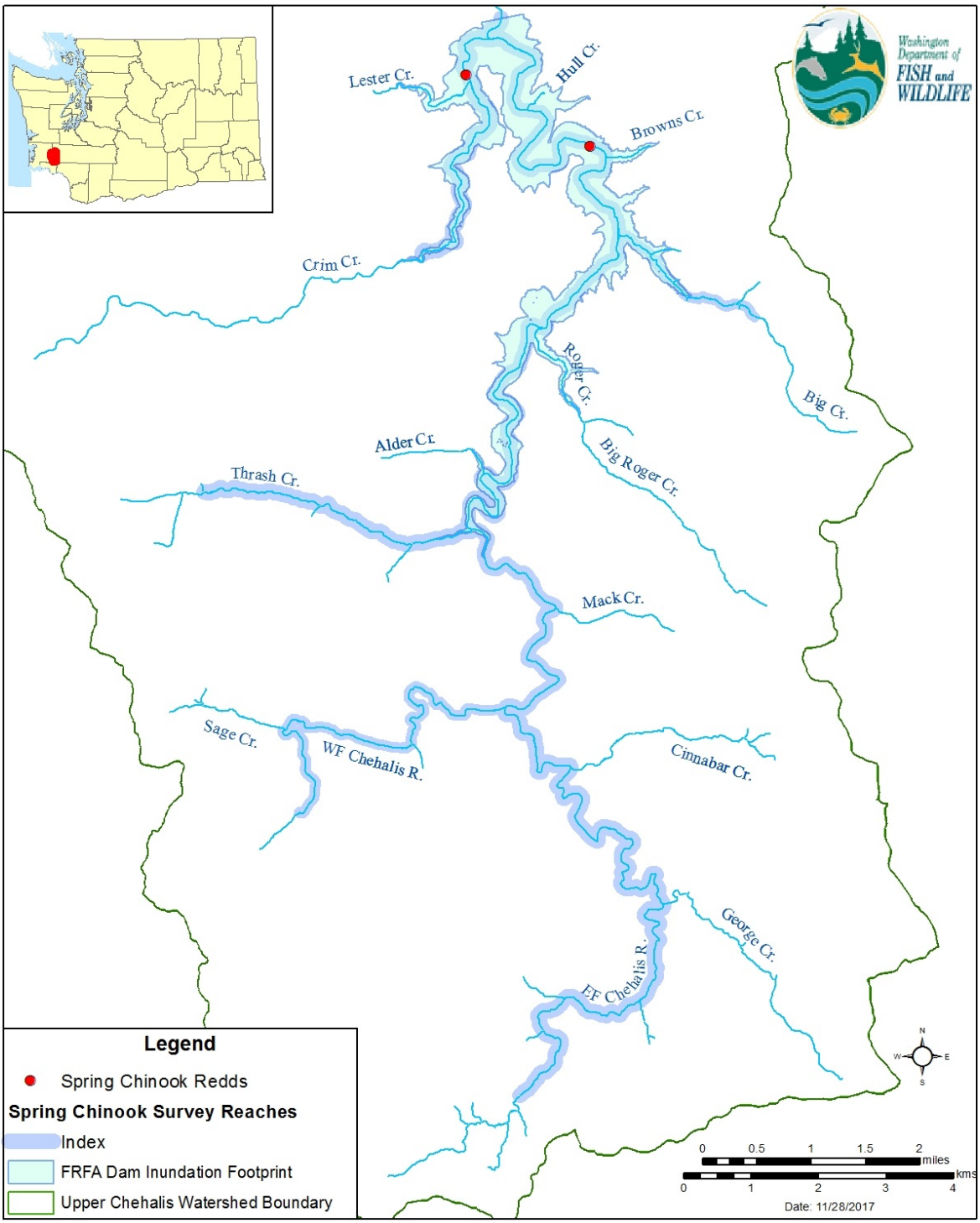
Spring Chinook Survey
September 2016 - October 2016
Washington Department of FISH and WILDLIFE
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Big Roger Cr.
Thrash Cr.
Mack Cr.
Sage Cr.
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Cinnabar Cr.
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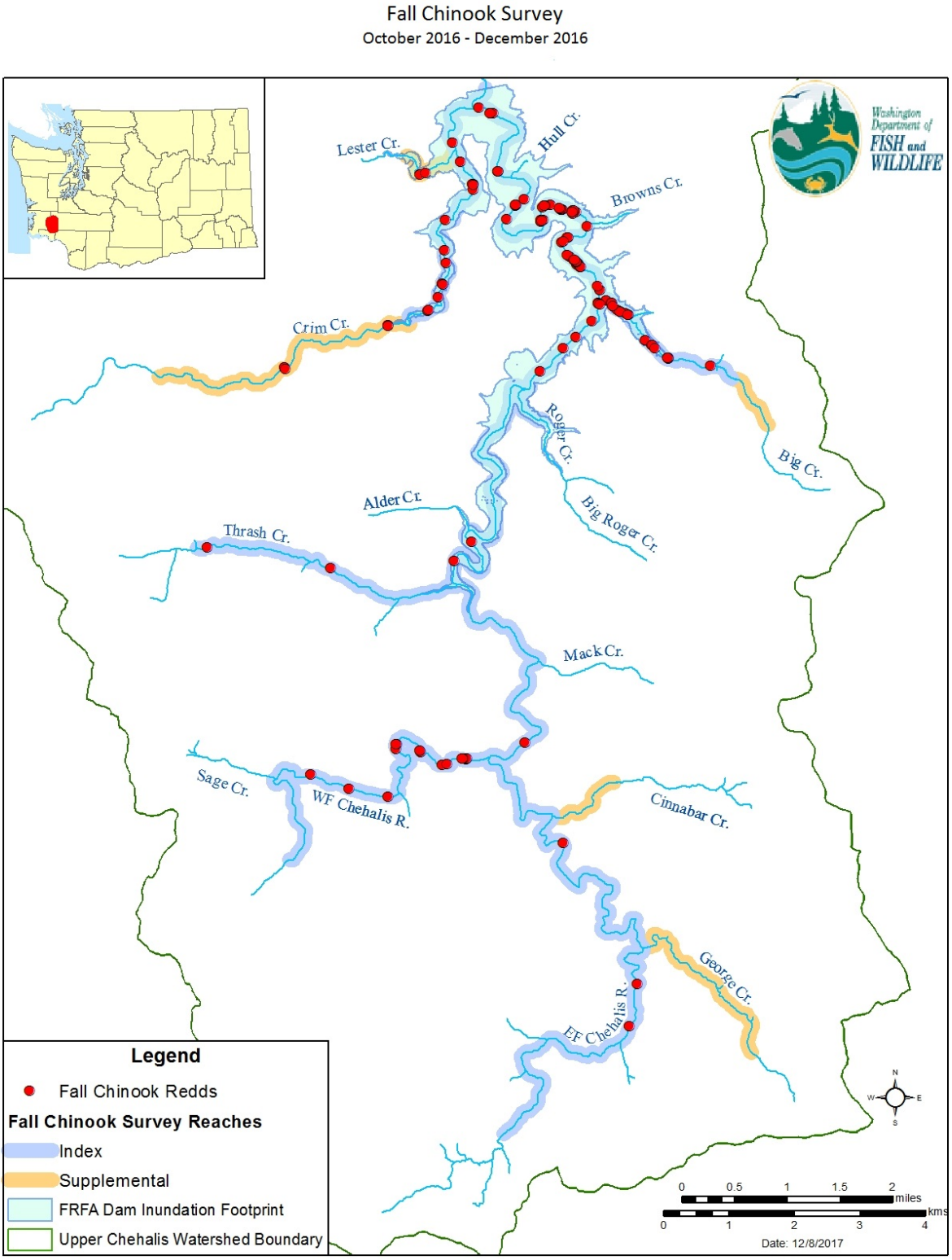
Fall Chinook Survey
October 2016 - December 2016
Washington Department of FISH and WILDLIFE
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Hull Cr.
Browns Cr.
Crim Cr.
Roger Cr.
Big Cr.
Big Roger Cr.
Alder Cr.
Thrash Cr.
Mack Cr.
Sage Cr.
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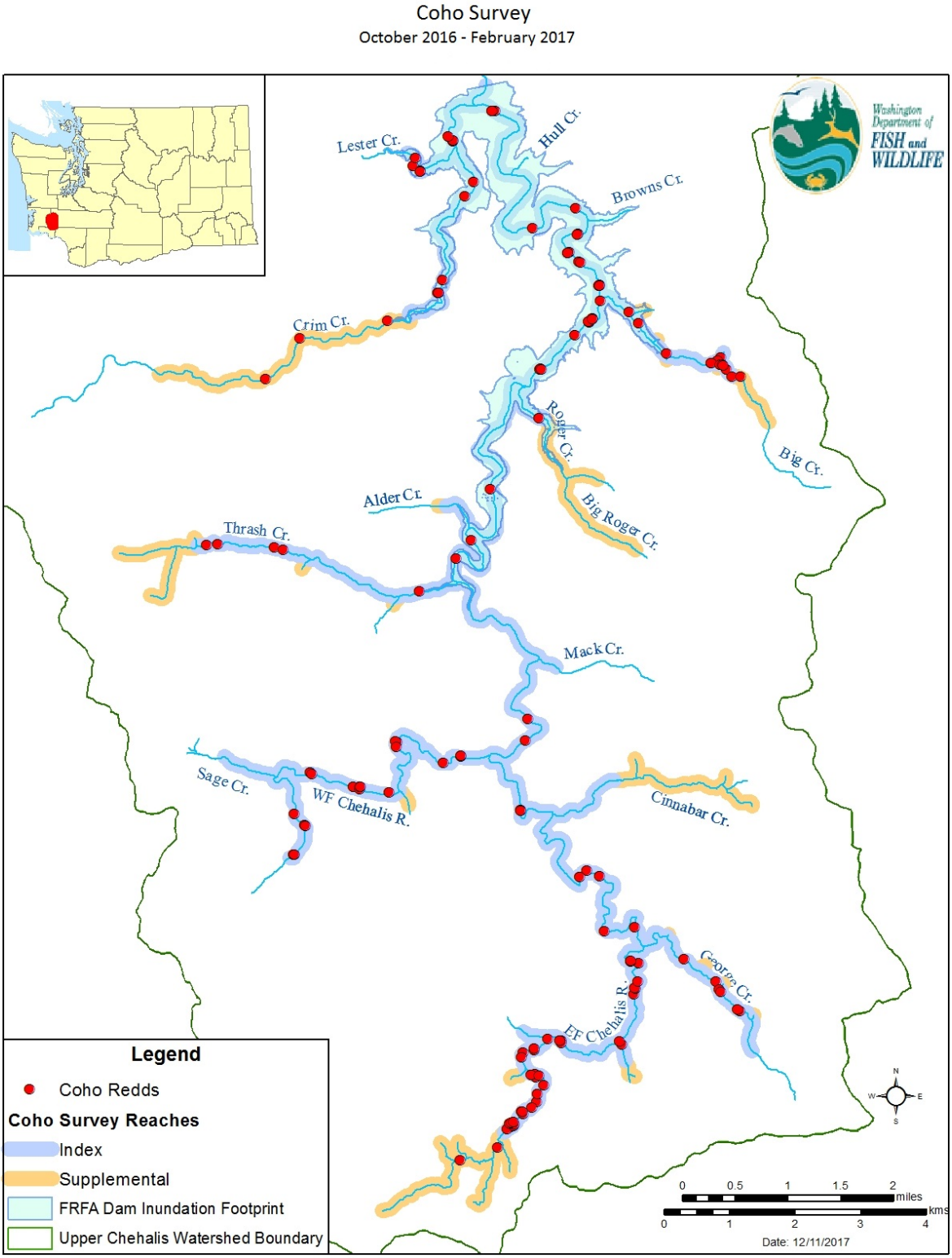
Coho Survey
October 2016 - February 2017
Washington Department of FISH and WILDLIFE
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Hull Cr.
Browns Cr.
Crim Cr.
Roger Cr.
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Big Roger Cr.
Alder Cr.
Thrash Cr.
Mack Cr.
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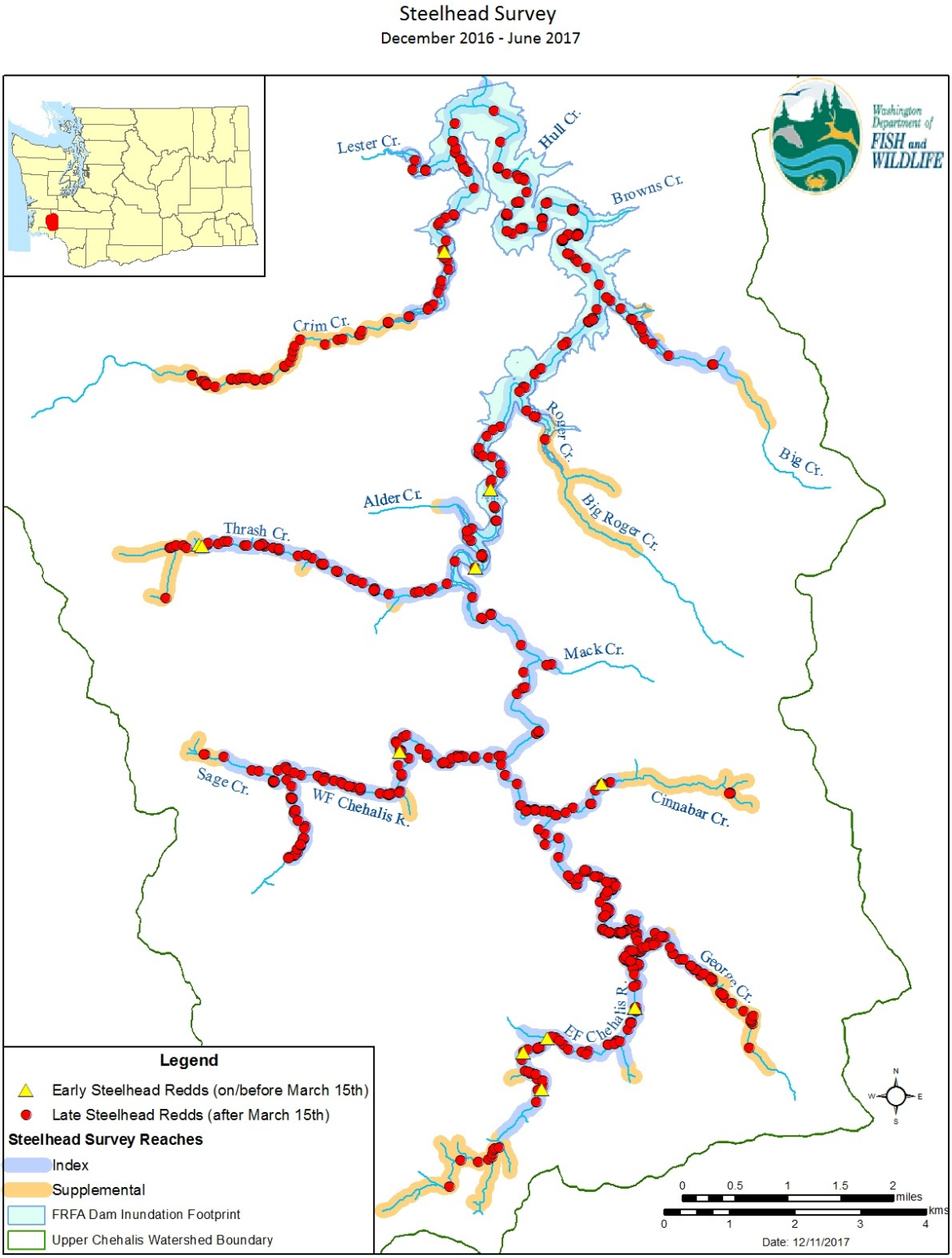
Steelhead Survey
December 2016 - June 2017
Washington Department of FISH and WILDLIFE
Lester Cr.
Hull Cr.
Browns Cr.
Crim Cr.
Roger Cr.
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Alder Cr.
Thrash Cr.
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Diversity

During the 2013-2014 survey season, a total of 55 carcasses were recovered (1 spring Chinook, 42 fall Chinook, 3 Coho, 9 Steelhead, Table 5). The one spring Chinook carcass had an intact adipose fin indicating that the fish was wild. For fall Chinook, all carcasses that were sampled had intact adipose fins and no CWTs (unmarked, no CWT=24, unmarked, unknown CWT=13) indicating they were wild fish. No mark status could be determined from the remaining five fall Chinook carcasses and CWT status could only be determined on three of them (unknown, no CWT=3, unknown, unknown CWT=2). For Coho, the three carcasses recovered had intact adipose fins and no CWTs (unmarked, no CWT=1, unmarked, unknown CWT=2) indicating they were wild fish. For Steelhead, one of the nine carcasses (11%) had a clipped adipose fin, indicating hatchery (adipose-clipped, unknown CWT=1). The remaining Steelhead carcasses had intact adipose fins (unmarked, no CWT=5, unmarked, unknown CWT=1) indicating they were wild fish, or were of unknown status with respect to marks and CWT (n= 2).

During the 2014-2015 survey season, a total of 191 carcasses were recovered and an additional four live Steelhead were captured via hook-and-line (7 spring Chinook, 38 fall Chinook, 140 Coho, 10 Steelhead, Table 5). For spring Chinook, all carcasses that were sampled had intact adipose fins and no CWTs (n=6) indicating they were wild fish. One spring Chinook carcass was not sampled due to its decomposed condition. For fall Chinook, all carcasses that could be sampled had intact adipose fins and no CWTs (unmarked, no CWT=31, unmarked, unknown CWT=7) indicating they were wild fish. For Coho, all carcasses that were sampled except one had intact adipose fins (unmarked, no CWT=73, unmarked, unknown CWT=45) indicating they were wild fish. One of the unmarked Coho carcasses had a CWT but the tag was unreadable (unmarked, CWT=1) meaning that its origin could not be determined. Two additional Coho carcasses could not be sampled for mark status but also did not have any CWT (n=2) and nineteen carcasses could not be sampled for either mark status or CWT due to their decomposed condition. For Steelhead, all 10 fish sampled had an intact adipose fin (unmarked, no CWT=7, unmarked, unknown CWT=3) indicating they were wild fish.

During the 2015-2016 survey season, a total of 166 carcasses were recovered and an additional 37 live Steelhead were captured via hook-and-line (0 spring Chinook, 115 fall Chinook, 40 Coho, 48 Steelhead, Table 5). No spring Chinook carcasses were sampled during the 2015-2016 season. For fall Chinook, all carcasses that were sampled had intact adipose fins and no CWTs (unmarked, no CWT=102, unmarked, unknown CWT=11) indicating they were wild fish. One additional carcass was not sampled for mark status and did not have a CWT, and one carcass was not sampled for either mark status or CWT due to its decomposed condition for Coho, all carcasses that were sampled had intact adipose fins (unmarked, no CWT=16, unmarked, unknown CWT=6) indicating they were wild fish. One additional Coho carcass was not sampled for mark status and did not have a CWT, and seventeen carcasses were not sampled for either mark status or CWT. For Steelhead, seven carcasses and 36 live fish had intact adipose fins (unmarked, no CWT=38, unmarked unknown CWT=5) indicating they were wild fish. Three carcasses were unmarked but were not sampled for CWT. There were two Steelhead with a clipped adipose fin, indicating hatchery fish.

During the 2016-2017 survey season, a total of 45 carcasses were recovered (0 spring Chinook, 28 fall Chinook, 11 Coho, and 6 Steelhead, Table 5). There were no spring Chinook carcasses sampled. For fall Chinook, most carcasses that were sampled had intact adipose fins and no CWTs (unmarked, no CWT=21, unmarked, unknown CWT=6) indicating they were wild fish. One fall Chinook carcass had the adipose area missing (unknown, no CWT) and was therefore of unknown origin. For Coho, all carcasses that were sampled except one had intact adipose fins (unmarked, no CWT=3, unmarked, unknown CWT=7) indicating they were wild fish. One of the sampled Coho carcasses did not have mark status identified (unknown, unknown CWT=1). Six Steelhead carcasses were recovered, of those six, four had intact adipose fins but no head (unmarked, unknown CWT=4) indicating they were wild fish. The remaining two were missing heads and had unknown adipose fin status (unknown, unknown CWT=2).

Table 5. Detailed mark status of spring and fall Chinook, Coho, and Steelhead over four survey seasons. Chinook and Coho data were obtained from carcasses; Steelhead data were obtained from carcass and hook-and-line sampling of live fish. ADNB: Adipose-clipped No Beep, ADB: Adipose-clipped Beep, ADUK: Adipose-clipped Unknown Beep, UMNB: Unmarked No Beep, UMB: Unmarked Beep, UMNH: Unmarked No Head, UMUK: Unmarked Unknown (not established in the 2013/14 survey season), UKNB: Unknown mark status No Beep, UKB: Unknown mark status Beep, UKNH: Unknown mark status No Head

2013-2014

Total	ADNB	ADB	ADUK	UMNB	UMB	UMNH	UMUK	UKNB	UKB	UKNH	Total
Spring Chinook	0	0	0	0	0	1	NA	0	0	0	1
Fall Chinook	0	0	0	24	0	13	NA	3	0	2	42
Coho	0	0	0	1	0	2	NA	0	0	0	3
Steelhead	0	0	1	5	0	1	NA	0	0	2	9
Total	0	0	1	30	0	17	NA	3	0	4	55

2014-2015

	ADNB	ADB	ADUK	UMNB	UMB	UMNH	UMUK	UKNB	UKB	UKNH	Total
Spring Chinook	0	0	0	6	0	0	0	0	0	1	7
Fall Chinook	0	0	0	31	0	7	0	0	0	0	38
Coho	0	0	0	73	1	45	0	2	0	19	140
Steelhead	0	0	0	7	0	3	0	0	0	0	10
Total	0	0	0	117	1	55	0	2	0	20	195

2015-2016

	ADNB	ADB	ADUK	UMNB	UMB	UMNH	UMUK	UKNB	UKB	UKNH	Total
Spring Chinook	0	0	0	0	0	0	0	0	0	0	0
Fall Chinook	0	0	0	102	0	11	0	1	0	1	115
Coho	0	0	0	16	0	6	0	1	0	17	40
Steelhead	1	0	1	38	0	5	3	0	0	0	48
Total	1	0	1	156	0	22	3	2	0	18	203

2016-2017

	ADNB	ADB	ADUK	UMNB	UMB	UMNH	UMUK	UKNB	UKB	UKNH	Total
Spring Chinook	0	0	0	0	0	0	0	0	0	0	0
Fall Chinook	0	0	0	21	0	6	0	1	0	0	28
Coho	0	0	0	3	0	7	0	0	0	1	11
Steelhead	0	0	0	0	0	4	0	0	0	2	6
Total	0	0	0	24	0	17	0	1	0	3	45

For spring Chinook, eight carcasses were sampled and two had no age determined or fork length measured (Table 6). All sampled spring Chinook emigrated to saltwater as sub-yearlings. Of the spring Chinook for which ages were determined from scale samples, the majority of returning spawners (83%) were four years (total age) with 17% being five years. No spring Chinook scale samples were collected in the 2013-2014 season and no carcasses were recovered in the 2015-2016 or 2016-2017 seasons.

Table 6. Age structure of spring Chinook by fork length (cm) for each run year in the upper Chehalis River sub-basin above the proposed dam site. Total number of samples is given under the run year. Age is shown as total age (freshwater age was sub yearling for all samples taken). Sex: M=Male, F=Female, SND=Sex Not Determined; FL=Fork Length. Data are mean fork length (±standard deviation, sample size) for each spawn year.

Run Year	**Sex**	**Total Age**		
		4	**5**	**No Age**
2013				
	M			
(n=1)	F			
	SND			
	No FL			1M
2014		91		
	M	(±1.8,4)		
		75	78	
(n=7)	F	(---,1)	(---,1)	
	SND			
	No FL			1M

For fall Chinook, 223 carcasses were sampled, 38 had no age determined, and 72 had no fork length measured (Table 7). All sampled fall Chinook, where age could be determined, emigrated to saltwater as sub-yearlings. Most (65%) were total age four, with 25% age five, 9% age three, and <1% age two. No fall Chinook scale samples were collected in the 2013-2014 season

Table 7. Age structure of fall Chinook by fork length (cm) for each run year in the Upper Chehalis basin above the proposed dam site. Total number of samples is given under the run year. Age is total age (freshwater age was sub yearling for all samples taken). Sex: M=Male, F=Female, SND=Sex Not Determined; FL=Fork Length. Data are mean fork length (±standard deviation, sample size) for each spawn year.

Run	**Sex**	**Total Age**				
Year		**2**	**3**	**4**	**5**	**No Age**
2013						
	M					
(n=42)	F					
	SND					
	No FL		3M	12M/13F/2SND	4M/4F	1M/1F/2SND
2014			71	84	91	84
	M		(±5.5,3)	(±10.0,3)	(±5.6,4)	(±7.1,4)
				83	81	87
(n=38)	F			(±6.1,3)	(±4.4,3)	(---,1)
	SND					
	No FL			5M/1F/1SND		4M/5F/1SND
2015			70	84	91	86
	M		(±7.4,5)	(±5.4,33)	(±4.9,11)	(±7.2,8)
				79	84	80
(n=115)	F			(±3.8,29)	(±3.8,14)	(±2.9,5)
	SND					
				4M/3F		
	No FL				1M/1F	1M
2016		52	68	87	79	94
	M	(---,1)	(±2.3,3)	(±6.3,4)	(---,1)	(±7.1,2)
			77	78	84	83
(n=28)	F		(---,1)	(±2.6,7)	(±3.1,4)	(±2.8,2)
	SND					
	No FL		1M/1SND			1SND

For Steelhead, 32 carcasses and 41 live fish were sampled for age composition, 32 (44%) had no age determined, and 27 (40%) had no fork length measured (Table 8). Of the 41 samples with age data, 24 (58%) were 4 years (total age) including 1 repeat spawning wild fish and 2 hatchery fish. An additional 15 (37%) were 5 years (total age), all of which were wild origin. Of the 5-year old Steelhead, 13 spent 2 winters in freshwater and 2 winters in saltwater, 1 spent 1 winter in freshwater and 3 in saltwater, and the other fish spent 3 winters in freshwater and 1 in saltwater. The other 2 fish (5%) were a hatchery and a wild 3-year old that each spent 1 winter in freshwater and 1 in saltwater. No samples were collected for age composition in the 2013-2014 season.

Table 8. Age structure of winter-run Steelhead by fork length (cm) for each run year in the Upper Chehalis basin above the proposed dam site. 2015 and 2016 includes age data from hook-and-line sampling. Total number of samples is given under the run year. Sex: M=Male, F=Female, SND=Sex Not Determined; FL=Fork Length; Data are mean fork length (±standard deviation, sample size) for each spawn year. Age is shown as freshwater age. saltwater age.

		Age Composition										
		Wild								**Hatchery**		
Run Year	**Sex**	**W1.1+**	**W1.2+**	**2.1S+**	**2.1+**	**1.3+**	**3.1+**	**2.2+**	**No Age**	**1.1+**	**1.2+**	**No Age**
2015 (n= 10)	M				67 (±3.2,3)			83 (---,1)	83 (---,1)			
	F				70 (---,1)			92 (---,1)				
	SND								61 (±14.1,2)			
	No FL								1SND			
2016 (n = 48)	M	75 (---,1)	86 (±2.1,2)		68 (±3.5,5)	92 (---,1)		79 (±4.9,3)	73 (±7.8,7)		76 (---,1)	
	F		74 (±2.8,2)	61 (---,1)	66 (±3.5,3)			73 (±6.4,2)	67 (±3.8,3)			
	SND		76 (---,1)					91 (---,1)	76 (±19.5,3)			
	No FL				2M		1M	4M	1F/1M	1M	1M	1SND
2017 (n = 6)	M											
	F								62 (---,1)			
	SND											
	No FL				2SND			1SND	1SND/1M			

*Total ages: 1.1+ = 3 years, 1.2+ = 4 years, 2.1S+ = 4 years and 2nd time spawner, 1.3+ = 5 years, 2.2+ = 5 years

Discussion

This report includes the results of four complete survey seasons (2013-2014, 2014-2015, 2015-2016, and 2016-2017). Results from these surveys show that upstream of RM 108.2, the Chehalis River supports spawning for spring and fall Chinook salmon, Coho salmon, and Steelhead. Spawner abundances of Coho and Steelhead were higher than Chinook, which may be due to the broader spatial extent of spawning habitat used by Coho and Steelhead (i.e., smaller tributaries). Steelhead were consistently the most numerous, averaging roughly three times more spawners than Coho, and four times more spawners than Chinook over the four survey seasons. The spring Chinook numbers were the fewest and most variable ranging more than twenty fold from a high of 65 fish in 2014 to an estimated 3 fish in 2015. The fall Chinook run was more consistent in numbers than all other species, varying by just 53 redds over 4 years. The Steelhead adult abundance on/before March 15th ('hatchery' Steelhead) was much smaller than the Steelhead adult abundance after March 15th ('wild' Steelhead).

Hatchery fish were rare to absent in our surveys indicating that the majority of spawners in this area of the Chehalis River watershed were wild fish. There are no releases of hatchery salmon or steelhead above the proposed dam 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 location for hatchery Coho and Steelhead is located in Elk Creek (Chehalis RM 100.2). A potential error in estimating hatchery:wild composition of Coho from mark status is the presence of Remote Site Incubation (RSI) in which hatchery Coho would resemble wild Coho based on their mark status. However, the nearest RSI location is downstream in the Chehalis River at RM 75, and straying to the surveyed area of the watershed is unlikely.

Adult salmonids spawn in the Chehalis River upstream of RM 108.2 almost continuously between the months of September and June. The earliest arrivals are spring Chinook, which spawn in September and October, followed by fall Chinook, which spawn in October to November. Spawning of spring Chinook peaked around the threshold date of October 15th, and their spawn timing was very short in length, lasting only 3-4 weeks. Fall Chinook spawning also peaked around mid-October, but their spawning time was twice as long as spring Chinook, about 7-8 weeks. The overlap in spawning location and timing of spring and fall Chinook means that field calls are necessarily subjective and additional investigation on the distinctions between these runs is being conducted as part of a separate project. This additional work should help to clarify the proportion of spring and fall Chinook spawners using information not available to field surveyors such as genetics and otoliths (microchemistry composition).

Coho had a more protracted spawning period (15-19 weeks) than Chinook with spawning activity observed between October and February. Coho spawning peaked twice during this period, once in late November/early December and again in late December/early January. Redds associated with the first peak were more numerous than those associated with the second peak. The bimodality of Coho spawning is consistent with spawn timing of this species observed elsewhere in the Chehalis River basin.

Steelhead had the most protracted spawning period (20-27 weeks) of all species with spawning activity observed between the months of December and June, three times as long as the duration of fall Chinook spawning. Even though the overall spawning period for Steelhead was longer than Coho, peak spawning of Steelhead between late March and early April is more condensed than Coho allowing for more precise estimates of visible:cumulative ratios to be calculated. Environmental conditions are much different between the Steelhead and Coho spawning season (i.e., lower flows in the spring) and Steelhead redds often remain visible for weeks after spawning with algae growth as one of the primary factors in declining redd visibility. Between 2% and 16% of the Steelhead run was 'early' (on/before March 15th); however, the mark status data indicated that hatchery Steelhead proportions above RM 108.2 are likely to be lower than those represented by the spawning date cutoffs. Of the 73 total Steelhead carcasses and live fish that were sampled across years, we recovered just two adipose-clipped Steelhead carcasses (one in 2013-2014, one in 2015-2016), one adipose-clipped live steelhead captured via hook and line, and two unclipped live Steelhead captured via hook and line with scale data that suggested hatchery origin.

Snorkeling efforts conducted in early March also suggested that the majority of Steelhead returning to the Upper Chehalis sub-basin are of wild origin.

Chinook spawned primarily in the main stem river and less commonly in the tributaries. Spring and fall Chinook had fairly similar spawn distributions in 2013 and 2014 but their spawning distribution differed in 2015 and 2016. In 2015, low water during early fall months limited the spawning distribution of Chinook to less than half the area used in other years. In 2016, high water increased the spawning distribution of fall Chinook beyond that used by spring Chinook allowing the fall-run fish access into the upper reaches of the larger tributaries. Over the four survey seasons, the majority of the spring (99%) and fall (83%) Chinook redds were located within the FRFA dam inundation footprint. In comparison, spawning of Coho and Steelhead occurred throughout the main stem Chehalis and its tributaries to the upper most extent of known anadromy. A smaller proportion of Coho (41%) and Steelhead (35%) than Chinook spawning activity occurred within FRFA dam inundation footprint. This is consistent with the spawning habitat preferences of Coho and Steelhead in smaller tributaries than Chinook.

Almost all of the upper Chehalis River above RM 108.2 is within a private tree farm and is logged frequently. There are logging roads that allow for easy access to the stream reaches, but the logging activity sometimes creates a safety concern that leaves us unable to survey a particular stream reach during active logging. This occurred rarely during the first two survey seasons, but impacted the third and fourth survey season. In 2015-2016, two index survey reaches during the fall Chinook and Coho spawning period were affected causing a data gap in two additional index survey reaches also during this period. In 2016-2017, Thrash Creek surveys were affected during the transition period between early and late Steelhead. While constant water conditions during this period make it unlikely that any redds were missed, the origin of the redds (based on date of construction) was uncertain. In both these cases, the lack of access affected how we interpreted the information collected from these reaches since they were surveyed more than a supplemental survey but not as regularly as an index survey. Heavy snowfall in 2016-2017 also affected our ability to survey the EF Chehalis for multiple weeks in the winter time. Pairing this with the higher flows, observed Coho redds may have been missed during this time which could cause us to underestimate the true abundance.

Heavy and consistent rain along with the steeply sloping hills can cause high water events creating fast-moving and turbid water in the upper Chehalis River. The run-off from the logging roads and active logging sites can also cause a visibility problem due to the added sedimentation in the water column and can restrict the ability to survey downstream. This was a common occurrence in the 2016-2017 season due to the large amount and nearly constant frequency of rainfall from November to March. High water events mixed with logging activity can create natural log jams that form in some stream reaches that can temporarily impede or block spawning fish from moving further up into these reaches. There are also other migration barriers (seasonal and complete) in this area including extended areas of bedrock in combination with low water flow, cascades that are unpassable at many times of the year (i.e., impassable without a high water event) and beaver dams that intermittently block migration upstream.

Conclusion

The Chehalis River basin above RM 108.2 supports spawning of wild spring Chinook, fall Chinook, Coho, and Steelhead, during most of the year from mid-September to mid-June. This area of the watershed is diverse enough to provide spawning and pre-spawn holding habitat for each of these four species. All four species of salmonids could be affected with the introduction of a dam that creates an inundation footprint the size of the flood retention flow augmentation dam alternative reflected in Figure 5. Both spring and fall runs of Chinook, while low in abundance, prefer to spawn almost entirely within this footprint, though fall Chinook will expand into the upper reaches of the tributaries when high flows provide access to additional habitat. While the spawning habitat of Coho and Steelhead may be less impacted by dam inundation than Chinook, this area of the watershed supports higher numbers of these species. As a result, Coho and Steelhead can be expected to have larger fish passage requirements than Chinook.

Continuation of this work is planned for the next two years (fall 2017- spring 2019). Additional planned work will include snorkel counts of hatchery:wild steelhead and surveys of spawning distribution the main stem river below the proposed dam site. Snorkel surveys will be performed during statistical weeks 9, 11, and 13 (late February to late March) to increase understanding of in-river proportions of hatchery vs. wild Steelhead present before, during, and after the March 15th threshold in the upper Chehalis River. Spawner surveys will be conducted from RM 108.2 downstream to the town of Adna to determine spatial distribution below the proposed dam site of current spawning activity for all four species.

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Appendices

Appendix 1. Survey reaches for the 2013-2014 survey season in the upper Chehalis river basin. RM: River Mile, Trib: Tributary, SCH: Spring Chinook, FCH: Fall Chinook, COH: Coho, STD: Steelhead, I: Index survey, and S: Supplemental survey

Water Bodies Surveyed	Survey Reach	RM Surveyed	SCH	FCH	COH	STD
Main stem Chehalis River	RM 108.2 – 108.7	0.5	I	I	I	I
	RM 108.7 – 110.2	1.5	I	I	I	I
	RM 110.2 – 111.5	1.3	I	I	I	I
	RM 111.5 – 112.6	1.1	I	I	I	I
	RM 112.6 – 113.7	1.1	I	I	I	I
	RM 113.7 – 116.7	3.0	I	I	I	I
	RM 116.7 – 117.5	0.8	I	I	I	I
	RM 117.5 – 118.1	0.6	I	I	I	I
	RM 118.1 – 120.1	2.0	I	I	I	I
East Fork Chehalis River	RM 120.1 – 121.3	1.2	I	I	I	I
	RM 121.3 – 122.5	1.2	I	I	I	I
	RM 122.5 – 123.3	0.8	I	I	I	I
	RM 123.3 – 124.3	1.0	I	I	I	I
	RM 124.3 – 126.4	1.9	I	I	I	I
	RM 126.4 – 127.7	1.3	I	I	I	I
	RM 127.7 – 128.1	0.4			S	S
Cinnabar Creek	RM 0.0 – 0.7	0.7			I	I
	RM 0.7 – 2.1	1.3			S	S
Trib1204	RM 0.0 – 0.1	0.1			S	
Trib1205	RM 0.0 – 0.2	0.2			S	
Trib1207	RM 0.0 – 0.1	0.1			S	
George Creek	RM 0.0 – 1.0	1.0			I	I
	RM 1.0 – 2.0	1.0				S
Trib1211	RM 0.0 – 0.2	0.2			I	I
Trib1213	RM 0.0 – 0.2	0.2			I	S
Crim Creek	RM 0.0 – 0.8	0.8	I	I	I	I
	RM 0.8 – 1.9	1.1	I	I	I	I
	RM 1.9 – 2.9	1.0	I	I	I	I
	RM 2.9 – 5.8	2.9			S	
Lester Creek	RM 0.0 – 0.7	0.7			S	
Hull Creek	RM 0.0 – 0.1	0.1			S	
Big Creek	RM 0.0 – 0.9	0.9	I	I	I	I
	RM 0.9 – 1.7	0.8		I	I	I
	RM 1.7 – 1.9	0.2				S
Trib1179A	RM 0.0 – 0.2	0.2			I	
Roger Creek	RM 0.0 – 0.5	0.5			I	I
	RM 0.5 – 1.2	0.7			S	S
	RM 1.2 – 3.9	2.7			S	
	RM 1.2 – 2.2	1.0				S
Little Roger Creek	RM 0.0 – 0.5	0.5				S
Alder Creek	RM 0.0 – 0.4	0.4			I	I
Thrash Creek	RM 0.0 – 0.6	0.6	I	I	I	I
	RM 0.6 – 1.2	0.6	I	I	I	I
	RM 1.2 – 1.6	0.4	I	I	I	I
	RM 1.6 – 2.7	1.1	I	I	I	I
	RM 2.7 – 3.5	0.8				S
Mack Creek	RM 0.0 – 0.2	0.2			S	I
West Fork Chehalis River	RM 0.0 – 1.2	1.2	I	I	I	I
	RM 1.2 – 2.3	1.1	I	I	I	I
	RM 2.3 – 3.2	0.9	I	I	I	I
	RM 3.2 – 4.2	1.0			S	I
	RM 4.2 – 4.8	0.6				S
Sage Creek	RM 0.0 – 0.3	0.3			S	
	RM 0.0 – 0.6	0.6				I
	RM 0.6 – 0.9	0.3				S

Appendix 2. Survey reaches for the 2014-2015 survey season in the upper Chehalis river basin. RM: River Mile, Trib: Tributary, SCH: Spring Chinook, FCH: Fall Chinook, COH: Coho, STD: Steelhead, I: Index survey, and S: Supplemental survey

Water Bodies Surveyed	Survey Reach	RM Surveyed	SCH	FCH	COH	STD
Main stem Chehalis River	RM 108.2 – 108.7	0.5	I	I	I	I
	RM 108.7 – 110.2	1.5	I	I	I	I
	RM 110.2 – 111.5	1.3	I	I	I	I
	RM 111.5 – 112.6	1.1	I	I	I	I
	RM 112.6 – 113.7	1.1	I	I	I	I
	RM 113.7 – 116.7	3.0	I	I	I	I
	RM 116.7 – 117.5	0.8	I	I	I	I
	RM 117.5 – 118.1	0.6	I	I	I	I
	RM 118.1 – 120.1	2.0	I	I	I	I
East Fork Chehalis River	RM 120.1 – 121.3	1.2	I	I	I	I
	RM 121.3 – 122.5	1.2	I	I	I	I
	RM 122.5 – 123.3	0.8	I	I	I	I
	RM 123.3 – 124.3	1.0	I	I	I	I
	RM 124.3 – 126.4	1.9	I	I	I	I
	RM 126.4 – 127.7	1.3	I	I	I	I
	RM 127.7 – 128.6	0.9			S	S
	RM 128.6 – 129.7	1.1			S	S
Trib A	RM 0.0 - 0.3	0.3			S	S
Trib B	RM 0.0 - 0.6	0.6			S	S
Trib C	RM 0.0 - 0.2	0.2			S	S
Trib D	RM 0.0 - 0.2	0.2			S	S
Trib E	RM 0.0 - 0.2	0.2			S	S
Trib G	RM 0.0-0.1	0.1			S	
Trib H	RM 0.0-0.1	0.1			S	
Cinnabar Creek	RM 0.0 – 0.7	0.7		I	I	I
	RM 0.7 – 2.1	1.4				S
George Creek	RM 0.0 – 1.0	1.0			I	I
	RM 1.0 – 2.0	1.0			S	S
	RM 2.0 – 2.4	0.4				S
Trib1210	RM 0.0 – 0.1	0.1				S
Trib1211	RM 0.0 – 0.2	0.2			I	I
	RM 0.2 – 0.4	0.2			S	
Trib1212	RM 0.0 – 0.1	0.1			S	
Trib1213	RM 0.0 – 0.2	0.2			I	I
Crim Creek	RM 0.0 – 0.8	0.8	I	I	I	I
	RM 0.8 – 1.9	1.1	I	I	I	I
	RM 1.9 - 2.9	1.0		I	I	I
	RM 2.9 – 5.8	2.9				S
Lester Creek	RM 0.0 – 0.7	0.7			S	S
Big Creek	RM 0.0 – 0.9	0.9	I	I	I	I
	RM 0.9 – 1.7	0.8		I	I	I
	RM 1.7 - 2.7	1.0				S
Trib1179A	RM 0.0 – 0.2	0.2			S	
Trib1179B	RM 0.0 - 0.1	0.1			S	
Trib1179C	RM 0.0 - 0.3	0.3			S	S
Roger Creek	RM 0.0 – 0.5	0.5			I	I
	RM 0.5 – 1.2	0.7			S	S
	RM 1.2 – 2.2	1.0			S	S
Little Roger Creek	RM 0.0 – 0.3	0.3			S	
	RM 0.0 – 0.5	0.5				S
Alder Creek	RM 0.0 – 0.4	0.4			I	I
Thrash Creek	RM 0.0 – 0.6	0.6	I	I	I	I
	RM 0.6 – 1.2	0.6	I	I	I	I
	RM 1.2 – 1.6	0.4		I	I	I
	RM 1.6 – 2.7	1.1		I	I	I
	RM 2.7 – 3.5	0.8			S	S
Trib1187	RM 0.0 – 0.1	0.1			S	

Appendix 2: Continued.

Water Bodies Surveyed	Survey Reach	RM Surveyed	SCH	FCH	COH	STD
Trib1190	RM 0.0 – 0.7	0.7				S
	RM 0.0 – 0.5	0.5			S	
Mack Creek	RM 0.0 – 0.2	0.2			I	I
West Fork Chehalis River	RM 0.0 – 1.2	1.2	I	I	I	I
	RM 1.2 – 2.3	1.1	I	I	I	I
	RM 2.3 – 3.2	0.9	I	I	I	I
	RM 3.2 – 4.2	1.0	I	I	I	I
Trib1194	RM 0.0 – 0.2	0.2			S	
Sage Creek	RM 0.0 – 0.6	0.6			I	I
	RM 0.6 – 0.9	0.3				S
Trib1196	RM 0.0 – 0.1	0.1				S
Trib1197	RM 0.0 – 0.1	0.1				S

Appendix 3. Survey reaches for the 2015-2016 survey season in the upper Chehalis river basin. RM: River Mile, Trib: Tributary, SCH: Spring Chinook, FCH: Fall Chinook, COH: Coho, STD: Steelhead, I: Index survey, and S: Supplemental survey

Water Bodies Surveyed	Survey Reach	RM Surveyed	SCH	FCH	COH	STHD
Main stem Chehalis River	RM 108.2 – 108.7	0.5	I	I	I	I
	RM 108.7 – 110.2	1.5	I	I	I	I
	RM 110.2 – 111.5	1.3	I	I	I	I
	RM 111.5 – 112.6	1.1	I	I	I	I
	RM 112.6 – 113.7	1.1	I	I	I	I
	RM 113.7 – 116.7	3.0	I	I	I	I
	RM 116.7 – 117.5	0.8	I	I	I	I
	RM 117.5 – 118.1	0.6	I	I	I	I
	RM 118.1 – 120.1	2.0	I	I	I	I
East Fork Chehalis River	RM 120.1 – 121.3	1.2		I	I	I
	RM 121.3 – 122.5	1.2		I	I	I
	RM 122.5 – 123.3	0.8		I	I	I
	RM 123.3 – 124.3	1.0		I	I	I
	RM 124.3 – 126.4	1.9		I	I	I
	RM 126.4 – 127.7	1.3		I	I	I
	RM 127.7 – 128.6	0.9			S	S
	RM 128.6 – 129.7	1.1			S	S
Trib A	RM 0.0 - 0.3	0.3			S	S
Trib B	RM 0.0 - 0.6	0.6			S	S
Trib C	RM 0.0 - 0.2	0.2			S	S
Trib D	RM 0.0 - 0.2	0.2			S	S
Trib E	RM 0.0 - 0.2	0.2			S	S
Trib F	RM 0.0 - 0.1	0.1			S	S
Trib G	RM 0.0 - 0.1	0.1			S	S
Trib H	RM 0.0 - 0.1	0.1			S	S
Trib I	RM 0.0 - 0.1	0.1			S	S
Trib J	RM 0.0 - 0.2	0.2				S
Trib K	RM 0.0 - 0.1	0.1				S
Cinnabar Creek	RM 0.0 – 0.7	0.7		I	I	I
	RM 0.7 – 2.1	1.4				S
Trib 1204	RM 0.0 – 0.1	0.1				S
Trib 1205	RM 0.0 – 0.2	0.2				S
George Creek	RM 0.0 – 1.0	1.0			I	I
	RM 1.0 – 2.0	1.0			S	S
Trib A	RM 0.0 – 0.1	0.1				S
Trib 1209	RM 0.0 – 0.1	0.1				S
Trib 1210	RM 0.0 – 0.1	0.1				S
Trib1211	RM 0.0 – 0.2	0.2			I	I
	RM 0.2 – 0.4	0.2				S
Trib1213	RM 0.0 – 0.2	0.2			I	I
Crim Creek	RM 0.0 – 0.8	0.8	I	I	I	I
	RM 0.8 – 1.9	1.1	I	I	I	I
	RM 1.9 - 2.9	1.0	I	I	I	I
	RM 2.9 – 5.8	2.9			S	S
Lester Creek	RM 0.0 – 0.7	0.7			S	S
Browns Creek	RM 0.0 – 0.3	0.3			S	
Big Creek	RM 0.0 – 0.9	0.9	I	I	I	I
	RM 0.9 – 1.7	0.8		I	I	I
	RM 1.7 – 2.7	1.0				S
Trib A	RM 0.0 – 0.2	0.2				S
Trib C	RM 0.0 – 0.3	0.3				S
Roger Creek	RM 0.0 – 0.5	0.5			I	I
	RM 0.5 – 1.2	0.7			S	S
	RM 1.2 – 2.2	1.0			S	S
Little Roger Creek	RM 0.0 – 0.3	0.3			S	
	RM 0.0 – 0.5	0.5				S
Trib 1182	RM 0.0 – 0.2	0.2			S	

Appendix 3: Continued

Water Bodies Surveyed	Survey Reach	RM Surveyed	SCH	FCH	COH	STHD
Alder Creek	RM 0.0 – 0.4	0.4			I	I
Thrash Creek	RM 0.0 – 0.6	0.6	I	I	I	I
	RM 0.6 – 1.2	0.6	I	I	I	I
	RM 1.2 – 1.6	0.4	I	I	I	I
	RM 1.6 – 2.7	1.1		I	I	I
	RM 2.7 – 3.5	0.8			S	S
Trib A	RM 0.0 – 0.1	0.1				S
Trib B	RM 0.0 – 0.1	0.1				S
Trib1187	RM 0.0 – 0.1	0.1			S	S
Trib1188	RM 0.0 – 0.1	0.1			S	S
Trib1189	RM 0.0 – 0.1	0.1			S	S
Trib1190	RM 0.0 – 0.7	0.7				S
	RM 0.0 – 0.5	0.5			S	
Mack Creek	RM 0.0 – 0.2	0.2			I	I
West Fork Chehalis River	RM 0.0 – 1.2	1.2	I	I	I	I
	RM 1.2 – 2.3	1.1	I	I	I	I
	RM 2.3 – 3.2	0.9	I	I	I	I
	RM 3.2 – 4.2	1.0	I	I	I	I
Sage Creek	RM 0.0 – 0.6	0.6			I	I
	RM 0.6 – 0.9	0.3				S
Trib 1196	RM 0.0 – 0.1	0.1				S
Trib 1197	RM 0.0 – 0.1	0.1				S

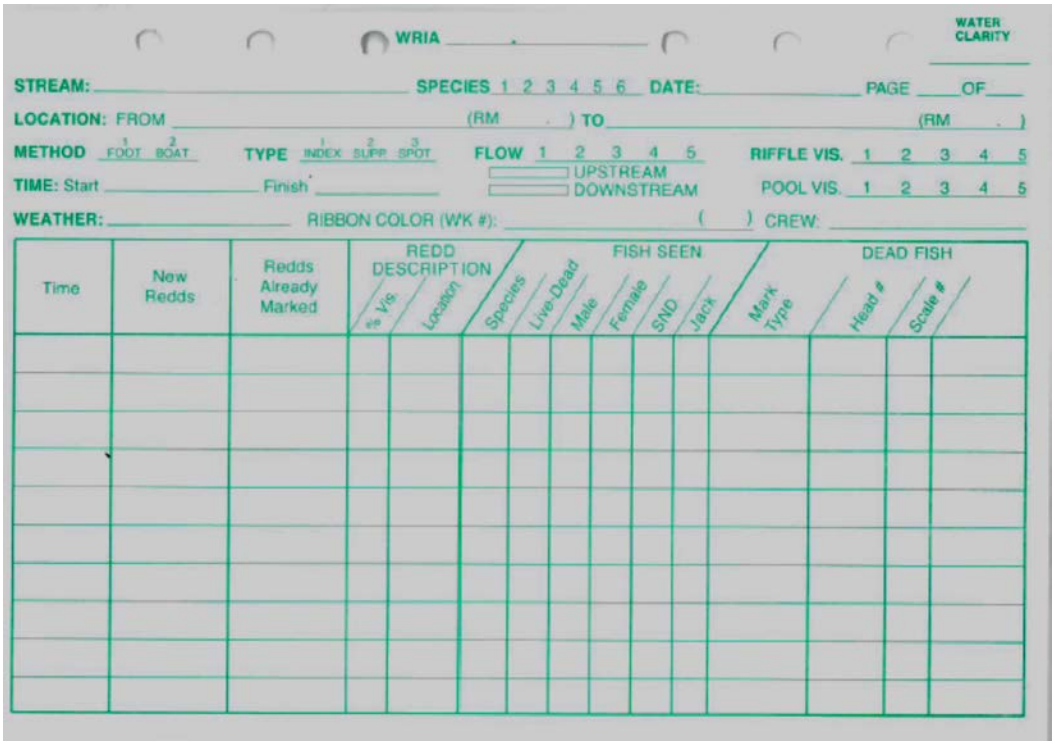
Appendix 4. Survey reaches for the 2016-2017 survey season in the upper Chehalis river basin, excluding Steelhead. RM: River Mile, Trib: Tributary, SCH: Spring Chinook, FCH: Fall Chinook, COH: Coho, I: Index survey, and S: Supplemental survey

Water Bodies Surveyed	Survey Reach	RM Surveyed	SCH	FCH	COH	STHD
Main stem Chehalis River	RM 108.2 – 108.7	0.5	I	I	I	I
	RM 108.7 – 110.2	1.5	I	I	I	I
	RM 110.2 – 111.5	1.3	I	I	I	I
	RM 111.5 – 112.6	1.1	I	I	I	I
	RM 112.6 – 113.7	1.1	I	I	I	I
	RM 113.7 – 116.7	3.0	I	I	I	I
	RM 116.7 – 117.5	0.8	I	I	I	I
	RM 117.5 – 118.1	0.6	I	I	I	I
	RM 118.1 – 120.1	2.0	I	I	I	I
East Fork Chehalis River	RM 120.1 – 121.3	1.2	I	I	I	I
	RM 121.3 – 122.5	1.2	I	I	I	I
	RM 122.5 – 123.3	0.8	I	I	I	I
	RM 123.3 – 124.3	1.0	I	I	I	I
	RM 124.3 – 126.4	1.9	I	I	I	I
	RM 126.4 – 127.7	1.3	I	I	I	I
	RM 127.7 – 128.6	0.9			S	S
	RM 128.6 – 129.7	1.1			S	S
Trib A	RM 0.0 - 0.3	0.3			S	S
Trib B	RM 0.0 - 0.6	0.6			S	S
Trib C	RM 0.0 - 0.2	0.2			S	S
Trib D	RM 0.0 - 0.2	0.2			S	S
Trib E	RM 0.0 - 0.2	0.2			S	S
Cinnabar Creek	RM 0.0 – 0.7	0.7		S	I	I
	RM 0.7 – 2.1	1.4			S	S
Trib A	RM 0.0 – 0.2	0.2			S	
Trib 1204	RM 0.0 – 0.1	0.1			S	S
Trib 1205	RM 0.0 – 0.2	0.2				S
George Creek	RM 0.0 – 1.0	1.0		S	I	I
	RM 1.0 – 2.0	1.0		S	I	I
	RM 2.0 – 2.2	0.2				S
Trib A	RM 0.0 – 0.1	0.1			S	S
Trib B	RM 0.0 – 0.1	0.1			S	
Trib 1209	RM 0.0 – 0.1	0.1			S	S
Trib 1210	RM 0.0 – 0.1	0.1			S	S
Trib1211	RM 0.0 – 0.2	0.2			I	I
	RM 0.2 – 0.4	0.2			S	S
Trib1212	RM 0.0 – 0.1	0.1			S	S
Trib1213	RM 0.0 – 0.2	0.2			I	I
Crim Creek	RM 0.0 – 0.8	0.8	I	I	I	I
	RM 0.8 – 1.9	1.1	I	I	I	I
	RM 1.9 - 2.9	1.0	I	I	I	I
	RM 2.9 – 5.8	2.9		S	S	S
Lester Creek	RM 0.0 – 0.7	0.7		S	I	I
Big Creek	RM 0.0 – 0.9	0.9	I	I	I	I
	RM 0.9 – 1.7	0.8	I	I	I	I
	RM 1.7 – 2.7	1.0		S	S	S
Trib1179A	RM 0.0 – 0.2	0.2			S	S
Trib1179C	RM 0.0 - 0.3	0.3			I	I
Trib1179D	RM 0.0 – 0.1	0.1			S	S
Trib1179E	RM 0.0 – 0.04	0.1			S	
Roger Creek	RM 0.0 – 0.5	0.5		I	I	I
	RM 0.5 – 1.2	0.7			S	S
	RM 1.2 – 2.2	1.0			S	S
Little Roger Creek	RM 0.0 – 0.3	0.3			S	
	RM 0.0 – 0.5	0.5				S

Appendix 4: Continued

Water Bodies Surveyed	Survey Reach	RM Surveyed	SCK	FCK	COH	STHD
Alder Creek	RM 0.0 – 0.4	0.4			I	I
	RM 0.4 – 0.5	0.1			S	S
Thrash Creek	RM 0.0 – 0.6	0.6	I	I	I	I
	RM 0.6 – 1.2	0.6	I	I	I	I
	RM 1.2 – 1.6	0.4	I	I	I	I
	RM 1.6 – 2.7	1.1	I	I	I	I
	RM 2.7 – 3.5	0.8			S	S
Trib1187	RM 0.0 – 0.1	0.1			S	S
Trib1188	RM 0.0 – 0.1	0.1			S	S
Trib1189	RM 0.0 – 0.1	0.1			S	S
Trib1190	RM 0.0 – 0.7	0.7			S	S
Mack Creek	RM 0.0 – 0.2	0.2			I	I
West Fork Chehalis River	RM 0.0 – 1.2	1.2	I	I	I	I
	RM 1.2 – 2.3	1.1	I	I	I	I
	RM 2.3 – 3.2	0.9	I	I	I	I
	RM 3.2 – 4.2	1.0	I	I	I	I
Trib 1194	RM 0.0 – 0.2	0.2			S	
	RM 0.0 – 0.3	0.3				S
Sage Creek	RM 0.0 – 0.6	0.6			I	I
	RM 0.6 – 0.9	0.3				S
Trib1196	RM 0.0 – 0.1	0.1				S
Trib1197	RM 0.0 – 0.1	0.1				S

Appendix 5. 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		FISH SEEN						DEAD FISH			
			Vis. ee	Location	Species	Live-Dead	Male	Female	SND	Jack	Mark Type	Head #	Scale #	

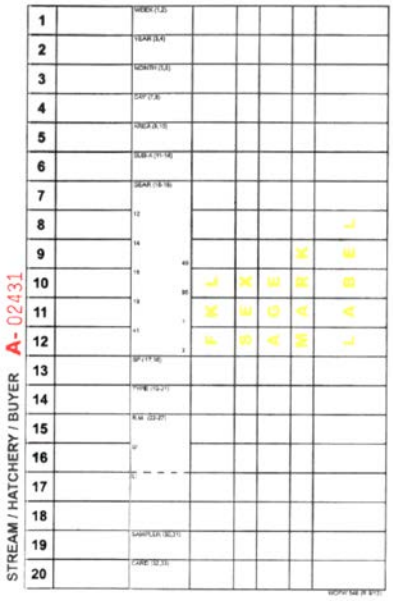
Appendix 6. Description of spring-run Chinook vs. fall-run Chinook characteristics used to distinguish between run-type during their overlapping spawning period around October 15th.

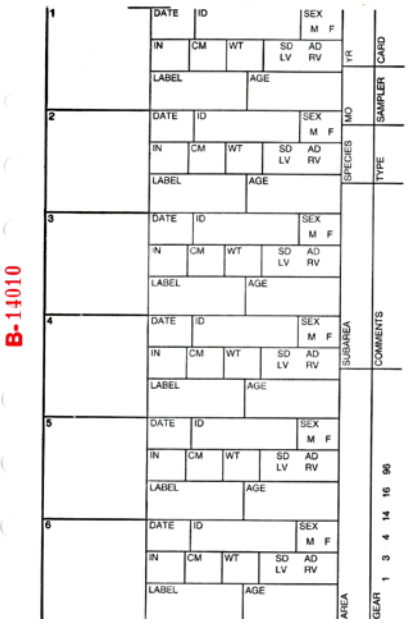
Pre-overlap	Fish/redds seen prior to October 7th are spring-run.	
Overlap		
	Spring Chinook	Fall Chinook
Fish[a]	Grey, olive, or black/dark in color; Dull and/or dusky appearance, not bright and shiny colors;	Red, green, or purple in color; Bright, shiny colors, vivid
	Low energy level, lethargic, exhibiting 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	
	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 use to clarify run type on live fish and associated redds only

Appendix 7. 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.





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