# Klickitat Subbasin Monitoring and Evaluation

# - Yakima/Klickitat Fisheries Project (YKFP)

## Adult Salmon and Steelhead Monitoring Report

1/1/2016 - 12/31/2020

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# I. Executive Project Summary/Abstract

This report describes the results of monitoring and evaluation (M&E) activities for salmonid fish populations and habitat in the Klickitat River subbasin in south-central Washington. The M&E activities described here were conducted as a part of the Bonneville Power Administration (BPA)-funded Yakima/Klickitat Fisheries Project (YKFP). Anadromous salmonid populations present in the Klickitat subbasin on which M&E activities focus include spring Chinook salmon and steelhead (both of which are native populations and focal species in this subbasin), and fall Chinook and coho salmon (which are both nonnative populations primarily sustained in this subbasin by hatchery production for harvest augmentation).

Major tasks described in this report include adult salmonid monitoring (monitoring adult salmonid population sizes, demographics, and spatial distribution via spawner surveys, and adult salmonid trapping at the Lyle Falls Fishway on the lower Klickitat River) and genetic analysis (characterizing genetic traits of salmonid populations, including genetic stock composition, hatchery/wild introgression, and anadromous/resident and summer- and winter-run steelhead relationships). The primary M&E type accomplished by the project is status and trend monitoring of fish populations and habitat, with data collection also occurring to monitor effectiveness of hatchery and habitat actions in the Klickitat subbasin.

Results of mark-recapture run size estimates at Lyle Falls at rivermile (RM) 2.4 on the Klickitat River indicate a depressed adult return of wild spring Chinook, averaging about 500 fish including adults and jacks from 2007-2018. Current returns are not consistent with historical reports of a large run of spring Chinook on the Klickitat River; these results are a continued cause for significant concern regarding the status and trend of this native population. Estimates of hatchery spring Chinook return to Lyle Falls are considerably higher, averaging about 3700 adults and jacks for 2007-2018. Run reconstruction estimates of spring Chinook run size (which use a combination of hatchery returns, harvest estimates, and redd counts) generally produce lower run size estimates than the mark-recapture methods, and support the depressed status determination for wild spring Chinook.

Mark-recapture estimates for steelhead returns to Lyle Falls for run years 2005-06 through 2019-20 indicate an average of about 1400-1600 wild (summer and winter) steelhead and 2600 hatchery steelhead. This population may be close to meeting National Marine Fisheries Service (NMFS)-recommended mean minimum abundance criteria for this ESA-listed stock, but likely does not meet broader-sense recovery goals as defined by regional recovery partners and co-managers.

Results from spawning ground surveys (redd counts) indicate that majority of wild spring Chinook spawning occurs in the upper middle Klickitat River between Big Muddy Creek (RM 54) and Castile Falls (RM 64), but that a potentially large percentage of spawners on natural spawning grounds in the Klickitat River are hatchery-origin fish. Redd counts also agree with other adult monitoring methods in the determination that wild spring Chinook currently have low escapement numbers to natural spawning grounds. Trends in spring Chinook redd counts over the past 25 years have been either declining or somewhat stable but at very low levels (averaging about 100-120 redds per

year), and true trends in natural-origin spawners are difficult to accurately assess due to the presence of hatchery-origin fish on spawning grounds. Results also suggest that spring Chinook recolonization in the upper Klickitat River above Castile Falls following enhancements to past anthropogenically-impaired passage has been slow.

Redd count and carcass recovery results for fall Chinook and coho indicate both populations are largely sustained by hatchery production. Large numbers of fall Chinook escape to spawning grounds in most years (recent 10-year average redd count of about 1400), with most spawning occurring from the Klickitat Hatchery (RM 42) downstream to the Twin Bridges (RM 18) area near the town of Klickitat. Redd counts for coho are highly variable due to frequent high flows during surveys and variation in actual returns above Lyle Falls; in many years coho (generally much lower numbers than fall Chinook) spawn up to and around Klickitat Hatchery and in multiple tributaries in the middle and lower subbasin.

Spawning ground surveys indicate a fairly spatially diverse steelhead population in the Klickitat subbasin, with spawning occurring in many geographic locations throughout the middle and lower Klickitat subbasin, including multiple tributary streams, with the most use observed in the White Creek watershed and the middle and lower mainstem from RM 11 to 42. There is also some use (likely a low amount, but with uncertainty due to limited survey access) in the upper Klickitat River above Castile Falls.

Genetic sampling and analysis conducted under this project has provided valuable data in monitoring hatchery/wild interactions, stock identification of fish use of the lower Klickitat River, subpopulation structure within the subbasin, anadromous/resident relationships, and adult run timing characteristics. The summary of results for steelhead to date suggests the following: natural-origin and hatchery-origin steelhead sampled as adults and juveniles in the Klickitat appear to remain genetically distinct suggesting low introgression/interbreeding rates (with further monitoring to determine introgression rates between the stocks underway); multiple anadromous subpopulations (at least 6 or 7) exist within different areas of the Klickitat subbasin; primarily anadromous populations reside in the mid and lower subbasin downstream of major passage obstructions; resident populations use upstream areas but intermix with some anadromous populations; and there is a fairly high rate of use of the lower Klickitat River by out-of-subbasin populations. Additional analysis has identified multiple candidate genetic markers associated with anadromy and with summer/winter run timing in steelhead.

Conclusions from spring Chinook genetic analysis are that hatchery interbreeding with Wells Hatchery summer Chinook in the late 1970s and 1980s is the most likely cause of a hybridized genotype observed in Klickitat spring Chinook. Present hatchery releases of upriver bright fall Chinook stocks in the Klickitat do not appear to be exacerbating this status; but this finding does highlight the need for changes to the current spring Chinook program at Klickitat Hatchery (which are proposed in the Klickitat Master Planning process).

Scale age analysis has provided the following conclusions to date: for spring and fall Chinook, 4-year-olds continue to be the most common age of returning adults; for coho, 3-year-olds continue to dominate the returning adult population; for steelhead, 3- and 4-year-olds comprise similar percentages of returning adults with 5-year-olds making up a small percentage of the population.

Smolt-to-adult return rate estimates to date (from PIT tagging) for Klickitat Hatchery spring Chinook are fairly low (approximately 0.4%). Smolt-to-adult return rate estimates for Skamania Hatchery steelhead released in the Klickitat River are higher, at approximately 2.6%. Both of these are at or below other Middle Columbia populations.

## II. Acknowledgements

YN Fisheries/YKFP technicians (Sandy Pinkham, Rodger Begay, Scott Spino, John Washines, Dean Antone, Jeremy Takala, Roger Stahi, Jacob Richards, Bennie Martinez, Steven Begay) collected most of the field data presented in this report. YN Fisheries/YKFP Southern Territories coordinator Bill Sharp provided oversight and management. Flo Wallahee, Winna Switzler, and Jeff Trammel of YN/YKFP provided fish video counts for Castile Falls. Jerod Bartholomew, Gregg Knott, and Duane Spino of YN/YKFP maintained facilities and equipment at Lyle Falls and Castile Falls. Nicolas Romero and David Lindley of YN/YKFP assisted with data collection and management and database report development. Jeanette Burkhardt, YN/YKFP watershed planner/outreach coordinator, provided website content development and assisted with field data collection. Shawn Narum and Jon Hess with Columbia River Inter-Tribal Fish Commission (CRITFC) provided genetic analysis information. Lyle adult trap operation and population estimation began as a joint project between WDFW and YN/YKFP – methods have been adapted from that effort as begun by Steve Gray and Dan Rawding of WDFW.

## III. Introduction

This report describes the results of monitoring and evaluation (M&E) activities for salmonid fish populations and habitat in the Klickitat River subbasin in south-central Washington (map in Figure 1). The M&E activities described here were conducted as a part of the Bonneville Power Administration (BPA)-funded Yakima/Klickitat Fisheries Project (YKFP) and were designed by consensus of the scientists with the Yakama Nation (YN) Fisheries Program. YKFP is a joint project between YN and Washington Department of Fish and Wildlife (WDFW). Overall YKFP goals are to increase natural production of and opportunity to harvest salmon and steelhead in the Yakima and Klickitat subbasins using hatchery supplementation, harvest augmentation and habitat improvements. Klickitat subbasin M&E activities have been subjected to scientific and technical review by members of the YKFP Science/Technical Advisory Committee (STAC) as part of the YKFP's overall M&E proposal. Yakama Nation YKFP biologists have transformed the conceptual design into the tasks described. YKFP biologists have also been involved in various Columbia basin regional efforts to standardize M&E data collection and reporting protocols, and are working towards keeping Klickitat M&E activities consistent with applicable standards.

Anadromous salmonid populations present in the Klickitat subbasin on which M&E activities focus include spring and fall Chinook salmon (*Oncorhychus tshawytscha*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*). Spring Chinook salmon and steelhead are both native populations and focal species in this subbasin; fall Chinook and coho salmon are nonnative populations primarily sustained in this subbasin by hatchery production for harvest augmentation (NPCC 2004). Steelhead in the Klickitat subbasin are part of the Endangered Species Act (ESA)-listed (threatened) Middle Columbia River distinct population segment.

Other important salmonid populations present in the Klickitat subbasin include resident rainbow trout (*O. mykiss*), cutthroat troat (*O. clarkii*), ESA-threatened bull trout (*Salvelinus confluentus*) and nonnative brook trout (*S. fontinalis*).

This report describes progress and results for the following major categories of YN-managed tasks under this contract:

- Adult salmonid monitoring – monitoring adult salmonid population sizes, demographics, and spatial distribution via spawner surveys, adult salmonid trapping at the Lyle Falls Fishway on the lower Klickitat River, and video monitoring at the Castile Falls fishway on the upper Klickitat River
- Genetic analysis – characterizing genetic traits of salmonid populations, including genetic stock composition, hatchery/wild introgression, anadromous/resident and summer- and winter-run steelhead relationships, refining methods of detecting within-stock and between-stock variation

Other monitoring categories and tasks – juvenile and resident salmonid population monitoring and habitat monitoring – are covered in separate reports.

These tasks have elements of status and trend monitoring of fish populations and habitat, as well as incorporating designs aimed at monitoring effectiveness of hatchery and habitat actions in the Klickitat subbasin.

Additional and updated information for this project is also available at the YKFP website (www.ykfp.org/klickitat/).

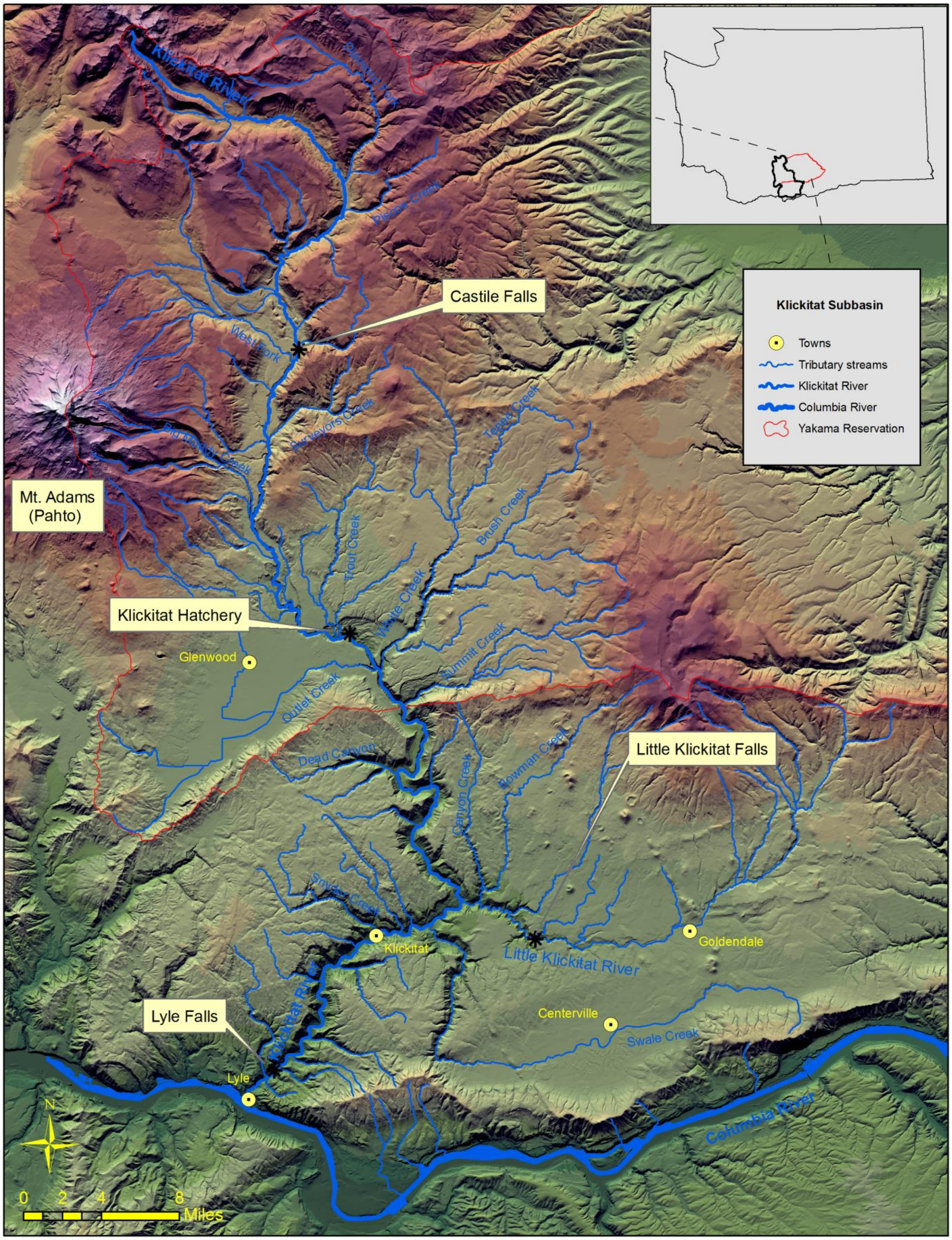


Figure 1. Map of the Klickitat subbasin with major landmarks.

# IV. Work Elements / Tasks

## Adult salmonid monitoring at Lyle Falls fishway

### Introduction

Monitoring adult salmonid run size, run timing, and passage, and collecting biological data from returning adults are ongoing key objectives in the Klickitat River. The Lyle Falls fishway at RM 2.4 (Figure 1) on the Klickitat River was constructed in the early 1950s to improve fish passage; however the natural falls are not a complete barrier and many adult salmonids do ascend the falls (counts of fish in the fish ladder are not a census of fish returning to the Klickitat River). This facility provides a key monitoring site via operation of an adult salmonid fish trap in the fishway. During 2010-2013, significant construction improvements to the fishway and adult trap were completed under BPA Project # 1988-115-35 (YKFP Klickitat River Design and Construction Project); major tasks included upstream extension of the fishway to an improved fish exit location, screened auxiliary water intake to allow for improved attraction flow; modified weirs in the lower fishway to improve hydraulic conditions, and an offline adult trap that allows for mechanical crowding, lifting, and water-to-water transfer (via a false weir and flume system) to a fish handling and sampling facility (a mobile trailer that can be moved during flood flows). The improved adult trap and fish handling facility were operational in early 2013; during this period operations were tested and modified to allow for efficient fish handling and collection of biological data.

Adult run size monitoring, especially with mark-recapture methods of abundance at Lyle Falls, focuses on spring Chinook and steelhead as these are native focal species in the Klickitat subbasin (NPCC 2004). Fall Chinook and coho are important production stocks providing harvest opportunities and are also monitored, but adequate sample sizes of marks and recaptures are not achieved in all years to establish mark-recapture estimates for those stocks.

### Methods

Adult salmonids were trapped, enumerated, sampled, and then released in the Lyle Falls fish ladder. Under previous trap operations (through 2012), water levels inside the fishway were lowered via gate operation to allow personnel to enter the fishway trap area and capture adult salmonids with dipnets. Beginning in early 2013, new trap facilities allowed for mechanical crowding and lifting from the offline trap, followed by volitional attraction via false weir into a flume that transported fish into a mobile trailer that serves as the fish handling and sampling area. Inside the trailer fish were held in 325-gallon holding tanks lined and covered with custom-made soft mesh nets that allowed for fish retrieval and handling. A low-voltage electronarcosis system (Hudson et al. 2011) with fixed electrodes in the holding tanks was used to immobilize fish for sampling. After sampling, fish were released via the flume system into a low-velocity area of the fishway which allowed for continued upstream migration. Details of the electronarcosis system as well as results of an evaluation of effects of this technique are found in Keep et al. (2015). This evaluation found no differences in travel times, after release to points 10 and 20 miles upstream, between fish treated either with electronarcosis or carbon dioxide (another widely-used fish sedative). Hudson et al. (2014) also found a lack of effect on embryo mortality and fry growth from adult coho salmon treated with electronarcosis prior to spawning. Other chemical sedatives were deemed inappropriate for use due to the fact that fish can be harvested after release from this facility, and most chemical agents require a withdrawal period prior to human consumption. Biological data were collected from individual fish including fork length, sex, scales, genetic samples, body and gill color, existing marks, and presence of CWT (coded wire tag) and PIT (passive integrated transponder) tags. Because counts of fish in the adult trap are not a census of fish returning to the Klickitat River, mark-recapture methods are used to monitor run size. Marks (opercle punches and floy tags) were administered and subsequently used along with a second sampling event to develop mark-recapture population estimates. Spring Chinook population estimates were made following recapture of hatchery fish that voluntarily returned to the adult holding pond at the Klickitat Hatchery. Carcass recovery during spawner surveys also potentially provides recapture data on marked fish for salmon species, but in most years too few marked carcasses have been observed to yield precise population estimates with that method. Steelhead recaptures occurred via anglers; a select group of anglers fishing at various locations on the middle and lower Klickitat River (but upstream of Lyle Falls) recorded total numbers of steelhead caught and numbers of tagged steelhead caught during the sport steelhead fishing season (June 1 – November 30). Steelhead in the Klickitat River are listed as threatened under the Endangered Species Act (ESA), and only hatchery steelhead were tagged with floy tags at Lyle Falls. For population estimation, wild steelhead were assumed to use the fish ladder in the same proportion as hatchery fish, and the same capture-recapture ratio was used to generate wild steelhead estimates (using the total number of wild steelhead trapped at Lyle Falls as the "marked" fish). Steelhead were also divided into two runs for estimation purposes: summer run (those passing Lyle Falls from May 1 through November 30) and winter run (those passing Lyle Falls December 1 through April 30). The mark-recapture population estimates were generated for summer steelhead (hatchery and wild), but for winter steelhead due to the lack of a recapture effort (there is no sport steelhead angling season during the winter run), trap counts for the December-April period were used as a census count. This assumes all steelhead during the winter period use the fish ladder and do not ascend the natural falls; although this is what is believed to occur at falls on other nearby rivers such as the Wind and Kalama due to low water temperatures (Gray 2006), this assumption requires further evaluation on the Klickitat River. Winter steelhead ascending the natural falls on the Klickitat River likely leads to a winter steelhead estimate that is biased low. Hatchery steelhead passing Lyle Falls December 1 through April 30 were counted as summer steelhead because all hatchery juveniles released in the Klickitat River are summer-run Skamania Hatchery stock. The counts of these hatchery fish were simply added to the mark-recapture estimates for summer hatchery steelhead.

Population estimates were generated using the Peterson estimator with modification for small sample size (Chapman 1951, as described in Seber 1982):

$$N = \frac{(m-1)(c-1)}{(r-1)} - 1$$

where N = population estimate (in this case N represents the population/run size estimate at Lyle Falls), m = the number of fish marked or tagged and released back into the population, c = total number of fish captured at the second sampling event, and r = number of fish captured in the second sampling event that were marked or tagged (recaptures). Variance was estimated as:

$$S^2 = \frac{(m+1)(c+1)(m-r)(c-r)}{(r+1)^2(r+2)}$$

(Seber 1982). Normal confidence intervals (CI) can be calculated as:

$$95\%\ CI = 1.96 * S$$

However, a non-normal, asymmetric confidence interval calculation with improved coverage was generally used (Arnason et al. 1991):

$$T = N^{-1/3}$$

$$S(T) = T * \frac{S(N)}{3N}$$

$$(T_L, T_U) = T \pm 1.96 * S(T)$$

$$(N_L, N_U) = (1/T_L^3, 1/T_U^3)$$

where $N_L$ and $N_U$ are the lower and upper 95% confidence limits.

In cases where winter steelhead trap counts were added to population estimates (as described above), these assumed census counts were also simply added to the upper and lower confidence limits that resulted from the above equations.

### Results

Results of mark-recapture population/run size estimates at Lyle Falls for spring Chinook are shown in Figure 2 below and in Table 3 (Appendix B). The first year that all returning adults were 100% adipose fin marked was 2007. Estimates of total run size (adults and jacks) for 2007-2018 indicate an average of approximately 3700 hatchery spring Chinook (ranging from about 1100 to 5900) and approximately 500 wild spring Chinook (ranging from about 180 to 685). The 2018 wild spring Chinook estimate (179) is on the low end of that range, while the 2011 and 2015 estimates (685 and 663 respectively) represent the high end. Jacks averaged 20% of the run at Lyle Falls in those years. Mark-recapture estimates for spring Chinook were not generated in 2019 and 2020 due to capture of hatchery broodstock at Lyle Falls (implemented because of very low return forecasts) limiting the number of fish available for mark and release.

Results for summer steelhead are in Figure 3 below; total wild and hatchery steelhead estimates are shown in Table 4 (Appendix B). For run years 2005-06 through 2019-20 (estimates were generated for all but 2 years during that period), wild steelhead (summer and winter) returns to Lyle Falls averaged approximately 1600 fish (ranging from 540 to 3270) and hatchery steelhead returns averaged about 2600 fish (ranging from 1250 to 5150). The geometric mean of wild steelhead (summer and winter) returns to Lyle Falls for the same time period is 1440 fish.

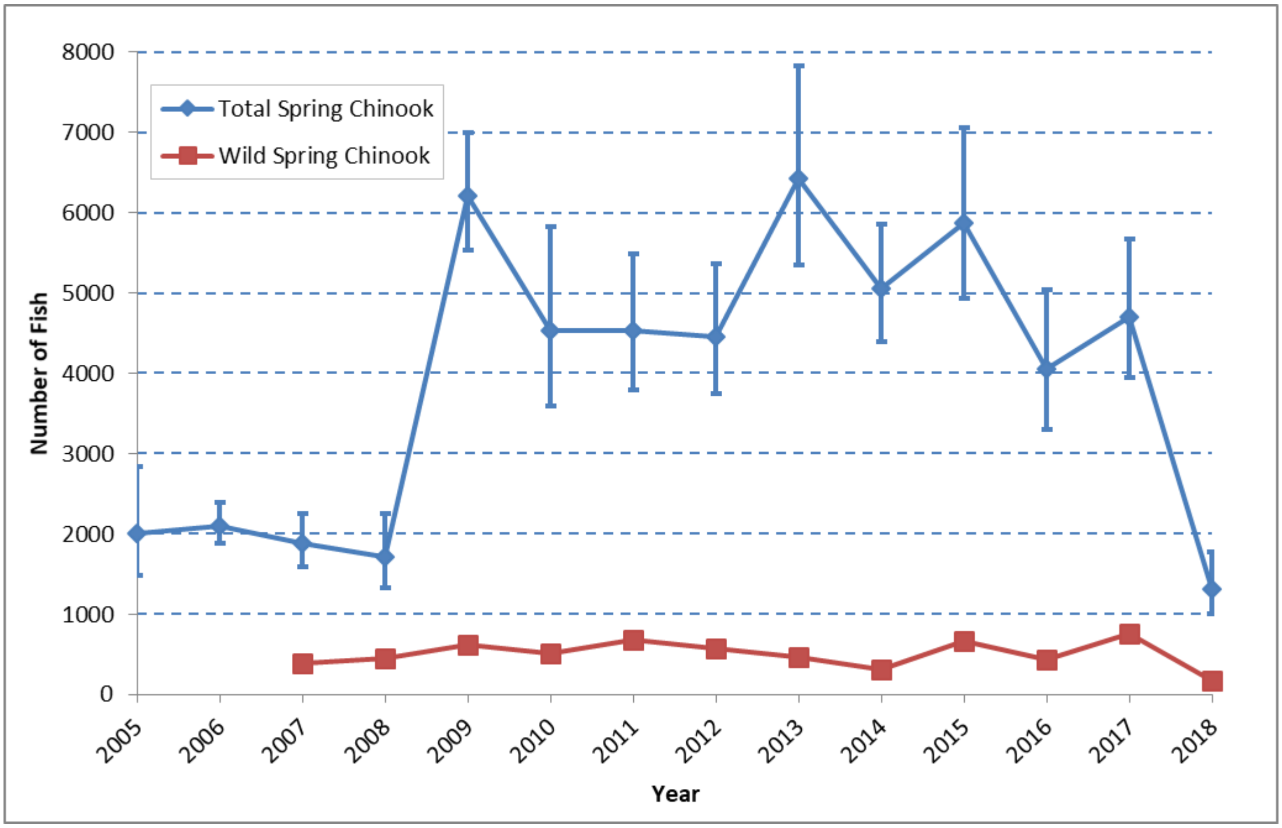


**Figure 2. Mark-recapture estimates of spring Chinook run size at Lyle Falls on the lower Klickitat River. Error bars represent 95% confidence intervals. Estimates were not generated in 2019 and 2020 due to hatchery broodstock collection.**

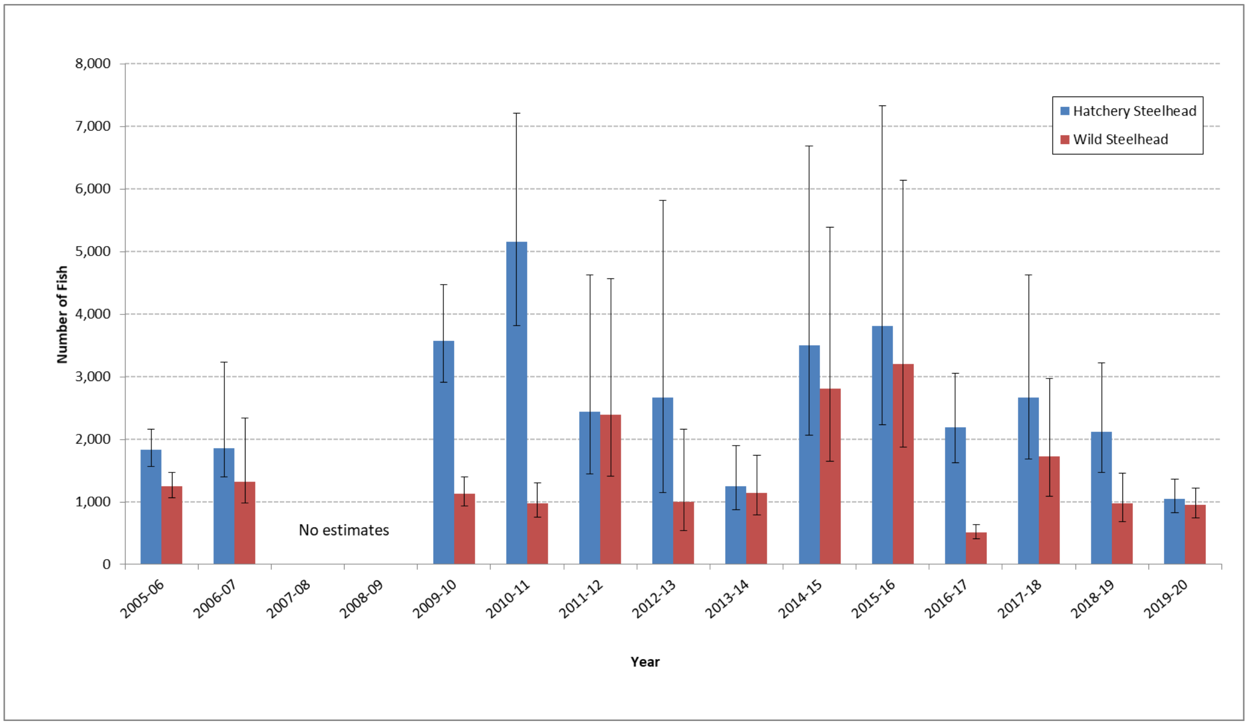


**Figure 3. Mark-recapture estimates of summer steelhead run size at Lyle Falls on the lower Klickitat River. Error bars represent 95% confidence intervals.**

Current updated daily and annual trap count data are available at the YKFP website (http://www.ykfp.org/klickitat/Data_lyleadulttrap.htm).

### Conclusions

With an average run size of about 500 fish at Lyle Falls, current wild spring Chinook returns do not seem consistent with historical reports of a "large run of spring chinook" (Bryant 1949). Although Klickitat spring Chinook, as part of the Middle Columbia River evolutionarily significant unit, are not listed under the ESA, they have been rated as "depressed" by WDFW's Salmonid Stock Inventory (SaSI) due to chronically low returns (WDFW 2002). These results continue to cause significant concern to co-managers regarding the status and trend of this native population. Hatchery reforms are planned and in design stages which would change the Klickitat Hatchery spring Chinook program from segregated to integrated (using some wild fish for broodstock under certain percentage limits to protect wild returns).

For steelhead, which in the Klickitat subbasin are part of the Middle Columbia River distinct population segment and are listed under the ESA as threatened, a National Marine Fisheries Service (NMFS)-recommended recovery goal for delisting includes, among other criteria, a mean minimum abundance threshold of 1,000 naturally-produced spawners in order to achieve viable status or a 5% or less risk of extinction over a 100-year timeframe (NMFS 2009). In addition, broad-sense recovery goals can be defined, and the Yakama Nation has proposed the achievement of a highly viable status for this population (which corresponds to a 1% risk of extinction in a 100-year period) as a recovery goal (NMFS 2009). The 2005-2019 estimates yield a mean and a geometric mean of about 1400-1600 total wild steelhead return to Lyle Falls (Table 4 in Appendix B); whether or not this constitutes achievement of the abundance criteria would require a determination by NMFS and regional recovery partners and co-managers. Important additional factors in that analysis would include: the mark-recapture estimates reported here are estimates of population size at Lyle Falls on the lower Klickitat River and not necessarily the resulting spawner abundance as specified in NMFS criteria (i.e., pre-spawning mortality likely results in an actual spawner abundance somewhat less than the Lyle Falls run size); genetic analysis and tagging data indicate some out-of-subbasin temporary stray (dip-in) steelhead migrate past Lyle Falls before exiting the Klickitat River and would be included in the mark-recapture estimates (see Genetic Analysis section below); and the fact that winter steelhead abundance estimates are likely biased low at Lyle Falls (see Methods description above).

## Adult salmonid monitoring at Castile Falls fishway

### Introduction

Monitoring adult salmonid passage into the upper Klickitat River is an important ongoing objective. Castile Falls is a series of 11 falls on the upper Klickitat River (Figure 1) which limited but did not preclude natural passage of native spring Chinook and steelhead; fishways were constructed in the early 1960s to improve passage but likely limited natural passage further (NPCC 2004). Passage improvements (weir reconstruction) at the Castile Falls #10 and 11 fishway at RM 64.6 were completed in 2005. Additional upgrades (video monitoring, PIT tag detection, and on-site power generation) were completed in 2012 under BPA Project # 1988-115-35 (YKFP Klickitat River Design and Construction Project).

Adult passage monitoring focuses on spring Chinook and steelhead, as these are native focal species in the Klickitat subbasin (NPCC 2004), and other anadromous species rarely ascend above Castile Falls. Video counts in the Castile Falls 10/11 fishway are currently presumed to be census counts as virtually all passage is through this fishway; a weir above Falls 10 limits natural upstream passage in the river.

### Methods

A digital video camera in the below-grade observation room adjacent to the upper end of the Castile Falls 10/11 fishway was used to record video footage through a window into the fishway; a vertical aluminum picket crowder crowds fish to within approximately 1 foot of the observation window. Video footage with detected motion was transferred via satellite internet connection to technicians who then viewed the video and enumerated upstream migrating anadromous salmonids, recording species, adult/jack status, and adipose clip status.

### Results

Video monitoring began at the Castile Falls 10/11 fishway on June 28, 2012. Because of its location high in the subbasin and the fact that the vast majority of fish passing Castile Falls in a given run year do so in summer through early fall, the run year is considered as June 1 through May 31. To date relatively low numbers of fish per return year have been observed; the highest overall counts were during the first return year of 2012-13 when 40 steelhead (33 wild and 7 hatchery fish) and 12 spring Chinook (11 wild and 1 hatchery) were observed. Most years since then have seen fewer than 10 fish of a given species/origin per return year with occasional slightly higher numbers of both wild and hatchery steelhead (Figure 4). To date only spring Chinook and steelhead have been counted; no other anadromous salmonid species has been observed. For spring Chinook, the majority passes through the fishway in July and the run is generally complete by the end of August. For steelhead, most fish pass in July-August, with small numbers passing in winter and spring months.

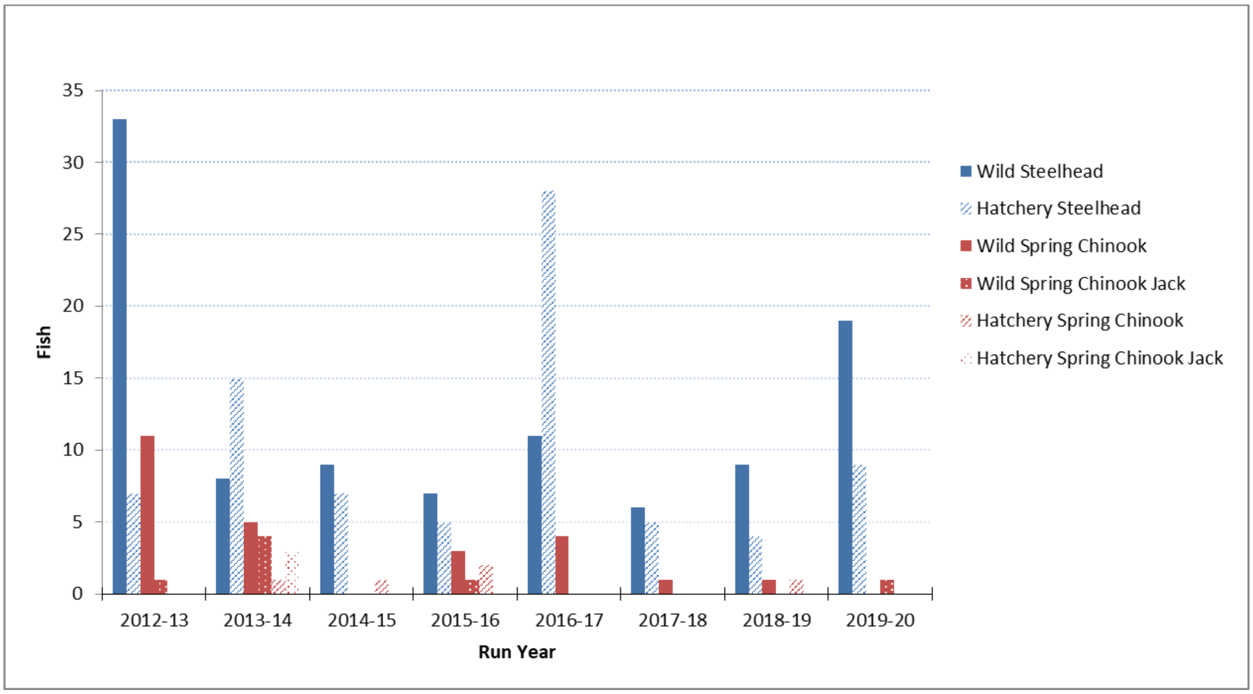


**Figure 4. Video counts by run year of anadromous salmonids at the Castile Falls 10/11 fishway on the upper Klickitat River. Run year is June 1 – May 31.**

## Conclusions

With overall low numbers of fish observed to date at the Castile Falls 10/11 fishway video monitoring facility, results suggest (and generally agree with results from spawning ground surveys) that large numbers of fish are not utilizing the upper Klickitat subbasin, despite now having enhanced access to significant amounts of high quality spawning habitat. The role of the hatchery steelhead that are observed at the Castile Falls 10/11 fishway is unknown; since these fish are mostly migrating in the summer and early fall, it is unknown if they remain in the upper Klickitat River to spawn or move to other areas prior to spawning season.

## Spawning ground surveys (redd counts)

### Introduction

In order to monitor spatial and temporal redd distribution of spring and fall Chinook, coho, and steelhead, and to collect biological data from carcasses, spawning ground surveys are conducted throughout the Klickitat subbasin. Spawning ground surveys provide a means of monitoring annual adult spawner escapement as well as spawner distribution.

### Methods

Regular foot and/or raft surveys were conducted within the known geographic range for each species. Surveys were generally conducted every two weeks in each river reach. Individual redds were counted and their locations recorded using handheld GPS units. Counts of live fish and carcasses were also recorded. Carcasses were examined for sex determination, egg/milt retention (percent spawned), and presence of CWT tags or external experimental marks. Observations of carcasses with floy tags (inserted into adult salmon and hatchery steelhead at the Lyle Falls adult trap at RM 2.4) aided in population estimation. Scale samples were also taken from carcasses using methods outlined in Crawford et al. (2007).

Spawning ground surveys were conducted as follows: spring Chinook – mid August through early October; fall Chinook – late October through mid December; coho – late October through late January; steelhead – late February through mid June. Attempts were made to cover the entire known spawning range of each species, although in some cases, access, flows, and visibility limited surveys. Stream reaches were surveyed multiple times during the spawning periods, with most reaches receiving at least 2-3 passes, and survey passes being conducted approximately two weeks apart in each reach. Subsequent survey passes generally continued in each reach until no live spawners were observed. Methods generally followed those of Gallagher et al. (2007).

### Results

Spawner survey results are briefly discussed by species below. Figure 5 through Figure 8 show the observed spawning distribution for spring Chinook, fall Chinook, coho, and steelhead, respectively. Additional tabular and graphical summaries of spawning ground survey results are presented in Appendix B.

#### *Spring Chinook*

Observed spring Chinook spawning distribution for 2011 through 2020 is shown in Figure 5. Natural spring Chinook spawning typically occurs in the Klickitat mainstem upstream of the Little Klickitat River confluence (RM 20), with most of the spawning occurring upstream of the Big Muddy Creek confluence (RM 54) up to Castile Falls (RM 64). Additional spawning occurs above Castile Falls which historically had some natural passage and had also been seeded in recent years (2000 and 2002-4) by transporting and releasing surplus adult spring Chinook that returned to the Klickitat Hatchery. No adult fish have been transported above Castile Falls since 2004. Recently completed (summer 2005) improvements at the Castile Falls fish ladders have enhanced fish passage, correcting problems with the original 1960s ladders which had actually impaired natural passage and had likely reduced fish numbers above the falls from historic levels.

Surveys in 2016-2020 began in early to mid August and ended in early to mid October each year (late October in 2020). Surveys each year covered 75 river miles, except in 2017 and 2018 when Diamond Fork Creek was not surveyed and total mileage was 67. In 2019, extended high turbidity significantly limited surveys in mid-late August thru mid-late September (including preventing a first survey pass in key spawning reaches until late September). In 2020, high turbidity limited surveys from late August through mid September, and poor air quality (due to wildfire smoke) restricted surveys for a week in mid September. Surveys were extended into late October in under-surveyed reaches. These conditions resulted in redd counts that were biased very low in 2019 and somewhat low in 2020; visibility in 2016-2018 was generally better with only limited periods of high turbidity that likely did not bias redd counts significantly. Table 6 in Appendix B shows results of spring Chinook redd counts for 1989-2020 by river reach. Surveys for the 2010-2018 period years show a general increase over counts from the 2004-2009 period, during which some of the lowest redd counts on record were recorded. This could be partly due to larger numbers of hatchery-origin fish on the natural spawning grounds (see description below). The average redd count for 1996-2015 (the time period with the most consistency in geographic coverage of redd surveys) is 118 (using total redd counts minus counts above Castile Falls in years of hatchery adult releases there, assuming virtually no passage above Castile in those years); the average redd count for 2013-2018 is 129.

As in other recent years, results of spawner surveys above Castile Falls showed relatively low numbers of redds in the upper Klickitat River, with 2 redds observed in 2016 and zero in 2017-2020. A peak number of redds of 36 was observed in 2007; some of the returning fish in that year may have resulted from the past releases of surplus hatchery adults in that area. Figure 10 in Appendix B shows results of redd counts above Castile Falls.

Spring Chinook redd counts provide a more accurate indicator of annual spawner escapement than other species in the Klickitat due to the fairly limited geographic area of spawning and relatively good survey conditions in most years (low flows and good visibility). Spring Chinook redd counts also provide one of the longest-term datasets for anadromous salmonids in the Klickitat. The total redd counts minus hatchery adult releases above Castile Falls (in Table 6, Appendix B) provides the most consistent year-to-year comparison and these data were used for trend analysis. Trends in redd counts from 1996 to 2018 (a time period with consistency in geographic coverage of redd surveys and excluding 2019-20 data due to survey limitations) do not currently show a significant downward trend, as had been observed in previous years. Regression analysis of natural logarithm-transformed redd counts (methods described in Thompson et al. 1998) yields a slope estimate of +0.1% with a 95% confidence interval (CI) of -2.3 to +2.6% and one-sided p-value for the slope of 0.46 (i.e., the 95% CI for the slope includes 0 and the null hypothesis that there is no decline in redd counts over time cannot be rejected).

However, one significant factor in the redd count trends is the presence of hatchery-origin fish on spring Chinook spawning grounds. From 2007-2018 (2007 is the first year in which all returning 4- and 5-year-old hatchery spring Chinook adults were 100% ad-clipped), the percentage of hatchery-origin carcasses recovered on spawner surveys has averaged 38% (Table 7 in Appendix B). Sample sizes of recovered spring Chinook carcasses are quite low due to typically low overall returns and fast river conditions in some reaches, so uncertainty exists in annual estimates, but results to date indicate a significant percentage of hatchery-origin adults, including in core wild spring Chinook spawning reaches.

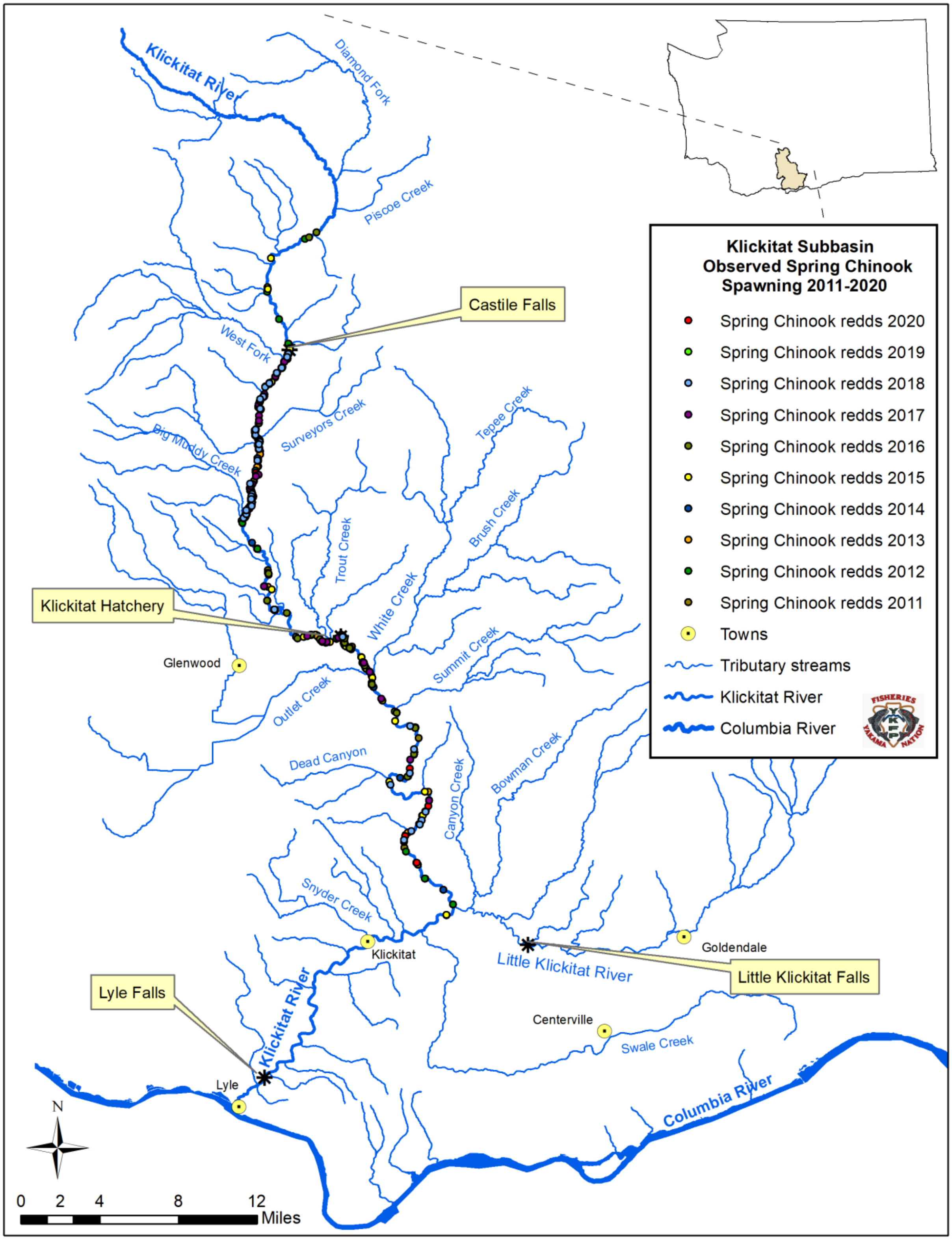


**Figure 5. Observed spring Chinook spawning distribution in the Klickitat subbasin for 2011-2020.**

### *Fall Chinook*

Fall Chinook are mainstem spawners and generally utilize the lower portion of the river, downstream of the Klickitat Hatchery. Observed fall Chinook spawning distribution for 2011 through 2020 is shown in Figure 6.

Table 8 in Appendix B shows results of fall Chinook redd counts in the Klickitat subbasin for 1995-2020 by river reach. After record highs in 2013-2014 (along with very high overall Columbia River basin fall Chinook returns) with 3600-3800 redds observed, counts dropped to near record lows in 2017-2018 at around 200 redds, also similar to basinwide returns. The recent ten-year (2011-2020) average redd count is 1449. Surveys in 2016-2020 conducted from late October until mid December (2017 surveys went into late December). Surveys covered approximately 49 river miles. High turbidity following rain events limited surveys somewhat in late October to mid November of 2016, 2017, 2018, and 2019; these may have biased redd counts somewhat but likely not significantly low. The highest redd densities occurred in the river reach from Klickitat Hatchery (RM 42) downstream to Stinson Flats (RM 29), as well as just upstream of the Little Klickitat River confluence (RM 20).

Fewer carcasses were recovered on fall Chinook surveys in 2016-2020 than in recent previous years. For 2016, of the carcasses for which adipose fin presence/absence could be determined, 61 out of 111 (55.0%) were ad-clipped (the rest were either wild or unmarked hatchery fish). Percentages of ad-clipped fish in other years were as follows: 46.2% (6/13) in 2017; 48.0% (12/25) in 2018; 76.0% 19/25) in 2019; and 49.3% (36/73) in 2020. Very few floy-tagged fish (from the Lyle Falls adult trap) were observed: 3 in 2016 and 1 in 2018. As in recent previous years, these observed percentages of ad-clipped carcasses are somewhat similar to ad-clipped percentages of hatchery juveniles released in years that would produce adults for these return years (in this case, release years 2012-2017). On average 60.8% (ranging from 24.4% for release year 2017 to 100% in 2016) of fall Chinook juveniles released in the Klickitat were ad-marked in those release years (Fish Passage Center data), while the average of ad-clipped carcasses across the return years was 54.9%. Overall these results would suggest that, despite observed spawning activity and relatively high redd counts in some years, fall Chinook natural production in the Klickitat River in most years does not successfully produce high numbers of returning adults.

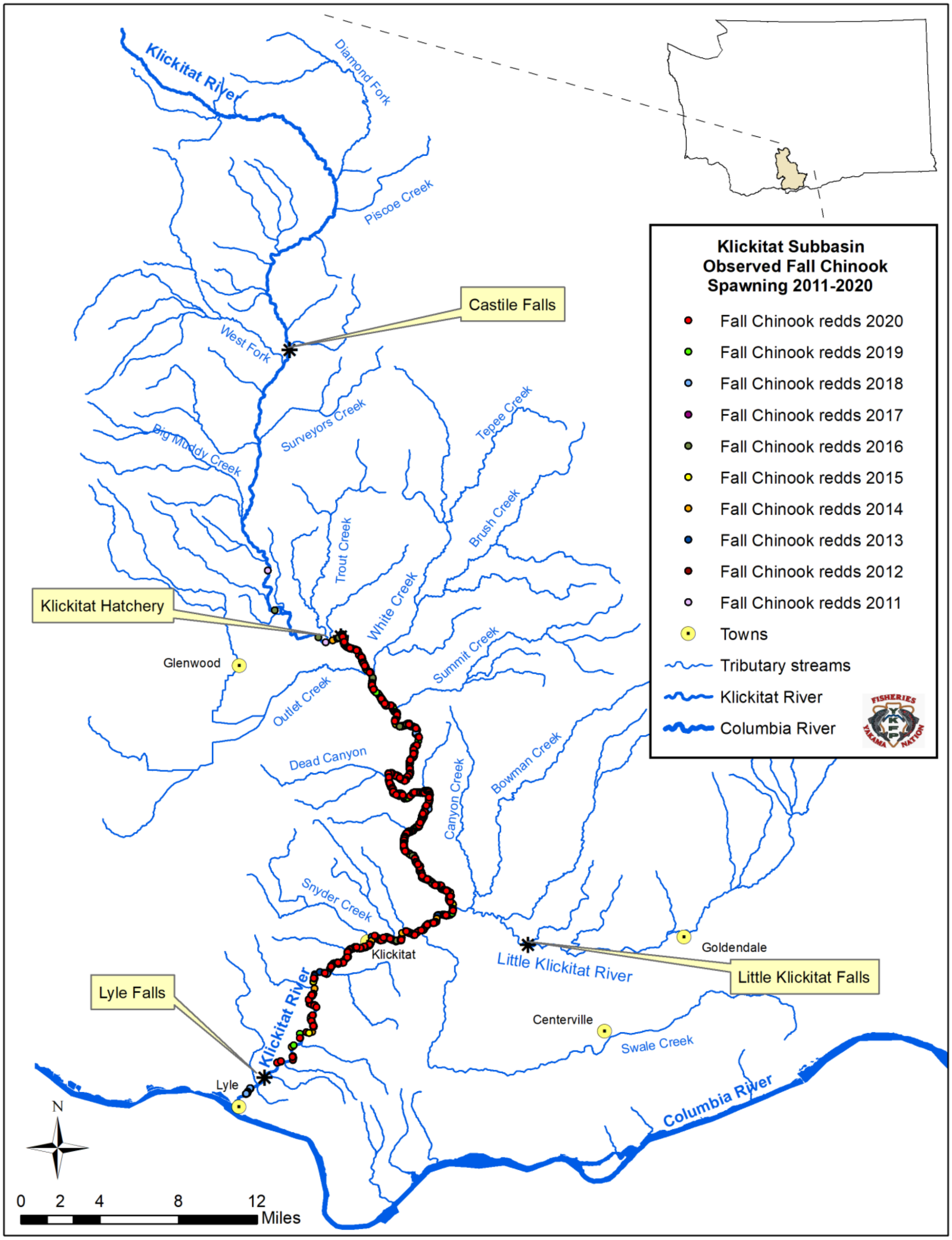


**Figure 6. Observed fall Chinook spawning distribution in the Klickitat subbasin for 2011-2020.**

### *Coho*

Coho spawning generally occurs in the lower reaches of most lower river tributaries and the mainstem below Parrott's Crossing (RM 49.4). Observed coho spawning distribution for 2011 through 2020 is shown in Figure 7. Coho surveys started in late October or early November and concluded in mid to late February. Coho redd counts vary significantly from year to year based on survey conditions and actual returns. Redd counts for this report period are as follows: 20 in 2015-16; 213 in 2016-17; 16 in 2017-18; 147 in 2018-19; 24 in 2019-20; and 166 in 2020-21. Surveys covered from 60-69.5 river miles in the mainstem and tributaries. The 2015-16 and 2017-18 surveys were both impacted by rain, high flows, and turbidity for extended or multiple periods which likely biased redd counts low. Snow and ice limited survey access in much of January 2017 affecting the 2016-17 surveys. In 2015-16, 2017-18, and 2019-20, the majority of redds were observed in tributaries (80%, 94%, and 63% respectively). In 2016-17 and 2018-19 the majority was in the mainstem (90% and 86% respectively). In 2020-21 it was 48% tributaries and 52% mainstem. Tributary streams in which coho spawning was observed included Dead Canyon Creek, lower Little Klickitat River, Bowman Creek, Swale Creek, Snyder Creek, Logging Camp Creek, Wheeler Creek, Dillacort and Canyon Creek (below Lyle Falls).

Small numbers of carcasses were recovered in most years during this report period. For 2015-16, of the carcasses for which adipose fin presence/absence could be determined, 100% (3 out of 3) were ad-clipped. Percentages of ad-clipped fish in other years were as follows: 88.9% (16/18 in 2016-17; 100% (2/2) in 2017-18; 100% (12/12) in 2018-19; 100% (2/2) in 2019-20; and 98.0% (50/51) in 2020-21. One floy-tagged fish (from the Lyle Falls adult trap) each year in 2015-16 and 2016-17 was observed; no others were observed in this reporting period. Similar to fall Chinook, the correspondence in the percentages of ad-clipped carcasses to ad-clipped percentages of hatchery juveniles in release years that produce returning adults for these years (which average 97.5% for release years 2014-18 [Fish Passage Center data]) suggest that natural coho production in the Klickitat subbasin in most years does not successfully produce large numbers of returning adults. Small sample sizes and difficult sampling conditions may also result in higher year-to-year variation in this metric.

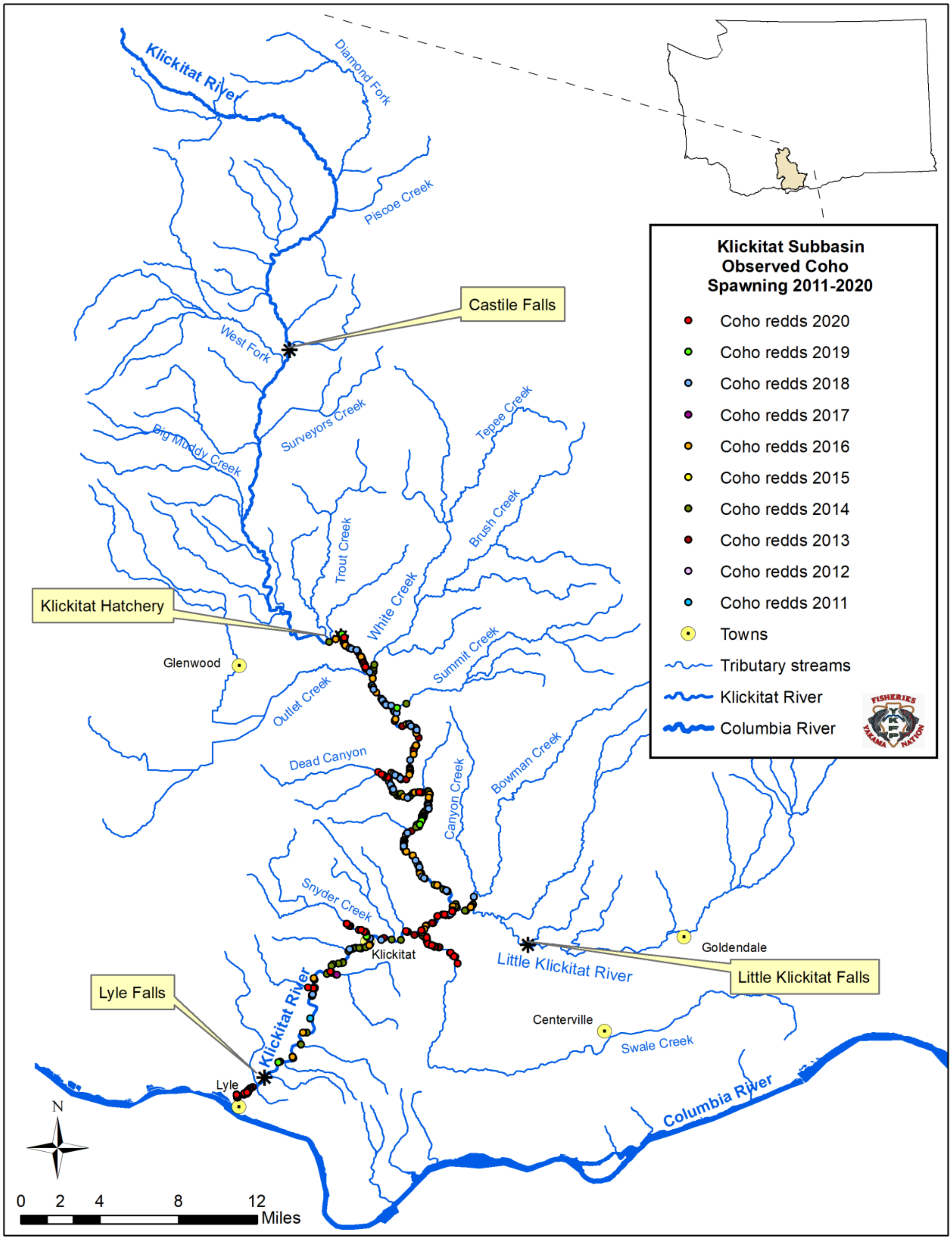


Figure 7. Observed coho spawning distribution in the Klickitat subbasin for 2011-2020.

### *Steelhead*

Steelhead spawner surveys are typically conducted from February through mid June. Attempts are made to cover the entire known spawning range of the species, although in some cases, access, flows, and visibility limited surveys. In most years, high spring flows and turbidity limit the effectiveness of the mainstem Klickitat steelhead redd surveys, leading to an unavoidable bias toward undercounting of redds. Several areas are undersurveyed in most years; these include the mid and upper Klickitat River above Big Muddy Creek (including the area above Castile Falls which frequently has limited access due to snow), and the Little Klickitat River from Little Klickitat falls to Goldendale (with surveys being limited due to landowner access).

Observed steelhead spawning distribution for 2010 through 2019 is shown in Figure 8. Surveys in 2020 were not completed due to COVID-19. Key steelhead spawning areas include the mainstem Klickitat from just downstream of the town of Klickitat to the Klickitat Hatchery (RM 11 to 42), with tributary spawning occurring in the White Creek watershed, Summit Creek, Dead Canyon Creek, the lower Little Klickitat watershed (including Bowman and Canyon Creeks), Swale Creek, Snyder Creek, and occasional use of tributaries below the town of Klickitat. The White Creek watershed (including Brush and Tepee creeks) is one of the most heavily used tributary watersheds, accounting for an average of 40% of the observed steelhead redds from 2002-2018 (excluding 2014, 2017, and 2019 due to limited surveys in the mainstem Klickitat and likely bias in estimates for those years).

Surveys in 2016-2019 started in early to mid February and ended in early June. Redd counts by year were as follows: 151 in 2016 (with 75% in tributaries and 25% in the mainstem Klickitat); 57 in 2017 (no mainstem surveys); 83 in 2018 (58% tributaries and 42% mainstem); and 72 in 2019 (limited mainstem surveys). Surveys in 2017 were especially limited by high flows in many streams in March and April; survey mileage that year was 77.3. Surveys from other years covered 114-132 river miles.

Very few steelhead carcasses are typically recovered on spawner surveys in the Klickitat, as steelhead can survive the spawning process and migrate downstream as kelts. During the 4 years reported here, a total of 5 carcasses were recovered which adipose fin presence/absence could be determined; all were wild (unclipped) fish.

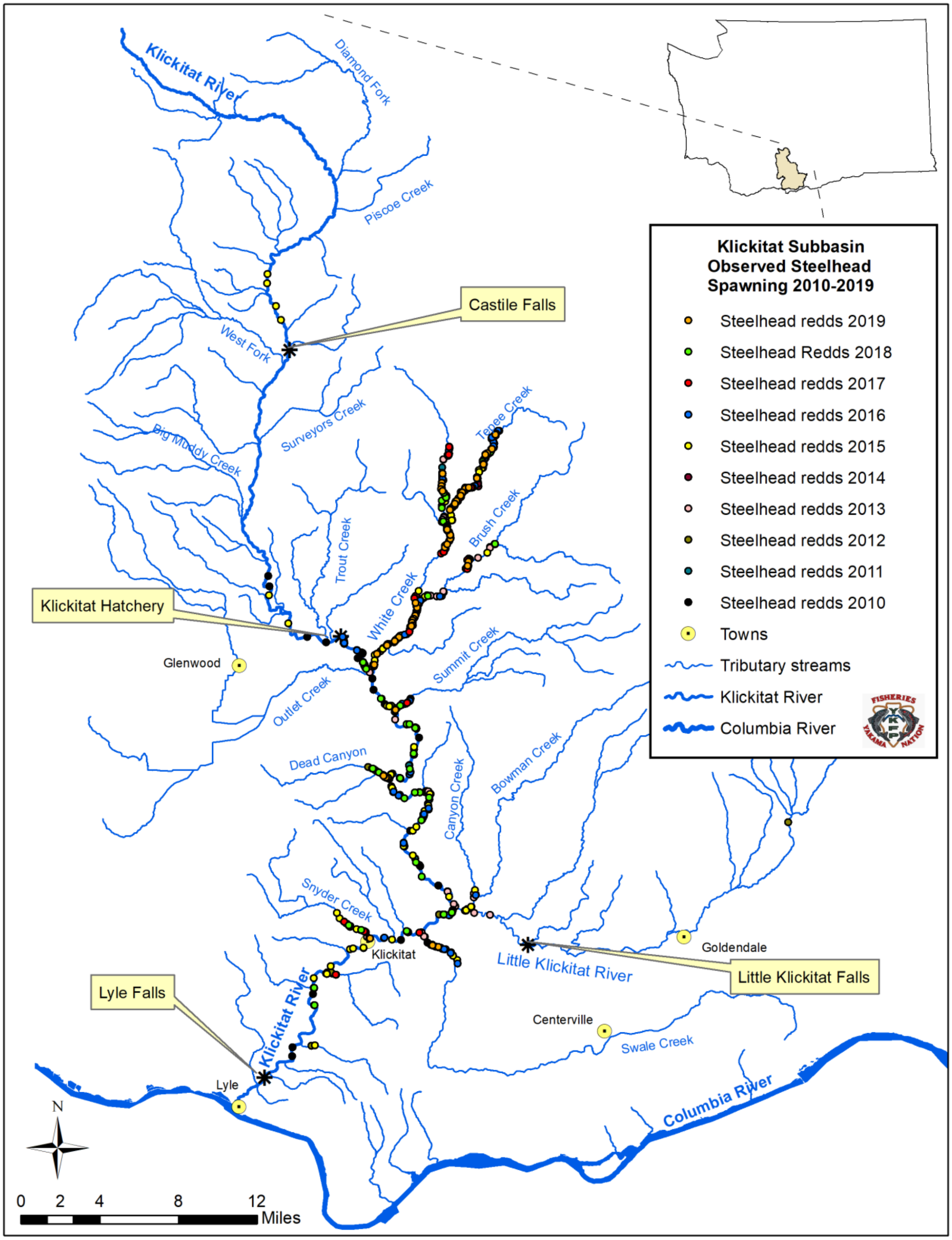


Figure 8. Observed steelhead spawning distribution in the Klickitat subbasin for 2010-2019. Note – the upper Klickitat River upstream of Big Muddy Creek and Little Klickitat River upstream of Bowman Creek) are often not surveyed.

## Conclusions

### *Spring Chinook*

Surveys indicate that majority of wild spring Chinook spawning occurs in the upper middle Klickitat River between Big Muddy Creek (RM 54) and Castile Falls (RM 64), but that a potentially large percentage of spawners on natural spawning grounds in the Klickitat River are hatchery-origin fish. Because of genetic introgression concerns likely caused by hatchery interbreeding with previously-released summer Chinook stocks (see description in Genetic analysis section), and because of overall low numbers of spring Chinook redds observed in most years, the status of the wild population of Klickitat spring Chinook appears to be quite depressed. Spring Chinook redd counts provide a more accurate indicator of annual spawner escapement than other species in the Klickitat due to the fairly limited geographic area of spawning and relatively good survey conditions in most years. Results from redd counts generally agree with results from mark-recapture estimates and other run size monitoring (in Adult salmonid monitoring section) as to this depressed status of this native population, and suggest that current spring Chinook runs are not nearly as large as historic runs (Bryant 1949). Results also suggest that spring Chinook recolonization in the upper Klickitat River above Castile Falls following enhancements to past anthropogenically-impaired passage has been slow. This is most likely due to low overall returns of spring Chinook. Trends in spring Chinook redd counts are currently not showing significant declines as had been observed in recent years, but the redd counts include potential hatchery-origin spawners, which may be masking true trends in natural-origin spawners.

### *Fall Chinook*

Redd counts indicate that a fairly large number of fall Chinook spawners return to the Klickitat River in most years, and that most of the spawning occurs from the Klickitat Hatchery (RM 42) downstream to the Twin Bridges (RM 18) area near the town of Klickitat. Carcass recoveries suggest that, while some natural production may exist, this non-native population is largely sustained by hatchery production.

### *Coho*

Spawner surveys indicate that coho spawners use the lower Klickitat River from the Klickitat Hatchery downstream and many lower subbasin tributaries. Redd counts for coho are highly variable due to frequent high flows during surveys and some variation in actual returns above Lyle Falls, making robust assessments of spawner abundance from redd counts difficult. There are however, large returns of coho evident in some years. Carcass recoveries suggest that, while some natural production does exist in some years, this non-native population is largely sustained by hatchery production.

### *Steelhead*

Surveys indicate that steelhead are spawning in many geographic locations throughout the middle and lower Klickitat subbasin, including multiple tributary streams, with the most use observed in the White Creek watershed and the middle and lower mainstem from RM 11 to 42. There is also some use (likely a lower amount, but with high uncertainty due to limited survey access) in the upper Klickitat River above Castile Falls. These results, along with the finding of multiple genetically distinct subpopulations (see Genetic analysis section) suggest a fairly spatially diverse steelhead population in the Klickitat subbasin. Status and trends in spawner abundance is difficult to assess for steelhead from redd count data due to high variation from flow and visibility limitations. More robust conclusions can be drawn from the mark-recapture estimates of run size (see the Adult salmonid monitoring section) for this native ESA-listed population. Also, due to low numbers of recovered steelhead carcasses, conclusions regarding percentages of hatchery-origin spawners from spawner surveys are not very reliable (although most recent carcass recoveries have been wild fish).

## Spring Chinook run reconstruction

### Introduction

In addition to adult monitoring at the Lyle Falls fishway and on spawner ground surveys, a long-term run reconstruction dataset is maintained for spring Chinook returns to the Klickitat River. Data is compiled from harvest monitoring, age sampling, hatchery returns, and redd counts to populate this dataset, which is provided to co-managers and used for long-term monitoring and run forecasting purposes.

### Methods

Data is compiled from spring Chinook adult returns to the Klickitat Hatchery, harvest from both sport (provided by WDFW) and tribal (provided by YN Fisheries Resource Management Program) fisheries, redd counts (described in the Spawning ground survey section), and scale age sampling at Lyle adult trap and Klickitat Hatchery (described in the Scale and Coded Wire Tag analysis section) to generate a run reconstruction table. Harvest, and escapement (to the hatchery and to natural spawning grounds) by age are estimated from the compiled data, and total returns to the mouth of the Klickitat River are estimating by summing the harvest and escapement estimates. It should be noted that the natural escapements resulting from redd counts may underestimate the actual natural spawner escapement in some years, and that this estimate also includes hatchery-origin fish that spawn on the natural spawning grounds (see Spawning ground survey section).

### Results

See Table 5 in Appendix B for complete results of the run reconstruction estimates. The long-term average for adult (age 4, 5, and 6) spring Chinook return to the mouth of the Klickitat River under these methods is just over 1900 fish, with about 1470 hatchery-origin fish and about 450 wild fish. Estimates of escapement average about 865 hatchery fish and 280 wild fish. Figure 9 in Appendix B shows the total run reconstruction estimates (including adults and jacks) in comparison to the Lyle Falls mark-recapture run size estimates (which are described in the Adult salmonid monitoring section). Estimates of escapement in 2019 are likely biased low due to small samples sizes in harvest estimates and were not used in long term averages.

### Conclusions

The results of the run reconstruction estimates are generally lower than the mark-recapture estimates, which may be due to underestimation of escapement (from redd counts) and harvest (although harvest estimates are likely more accurate than redd-count-based natural escapement estimates). Both sets of estimates, however, indicate that while hatchery spring Chinook returns are quite variable, returns of several thousand fish are possible. And for wild fish, returns of only several hundred fish, with natural spawner escapements of only about 300 or fewer fish are not uncommon. The run reconstruction estimates, like the mark-recapture estimates, indicate a wild spring Chinook return that is much lower than likely historic numbers (Bryant 1949), support the WDFW "depressed" rating for this stock, and warrant significant concern regarding the status and trend of this native population.

## Genetic analysis

### Introduction

Objectives of genetic analysis are to gain a thorough understanding of the genetic characteristics (including stock identification, diversity, and degree of introgression between various stocks) of anadromous salmonid populations in order to maintain long term genetic variability and minimize the impacts of artificial production on native populations (spring Chinook and steelhead). A thorough knowledge of baseline genetic conditions, landscape and habitat influences, effects of past and current hatchery practices, anadromous/resident interactions, and dip-in rates by out-of-basin adults is important in order to adhere to YKFP genetic guidelines, minimize negative effects, and monitor hatchery actions aimed at improving population parameters.

### Methods

Genetic samples were collected from adult steelhead and Chinook salmon at the Lyle Falls adult trap on the lower Klickitat River (RM 2.4). As fish were enumerated, netted and removed from the live trap, small fin clips or opercle punches of Chinook and steelhead were collected. Genetic samples were also collected from adult spring Chinook spawned for broodstock at the Klickitat Hatchery, beginning in 2006. In addition, genetic samples were collected from juvenile and resident fish during stream electrofishing activities and from outmigrating juveniles at the floating rotary screw traps (via a non-lethal fin clip). Samples were stored in 95% non-denatured ethanol or on gridded paper. A genetic sample number was recorded with the biodata collected for each fish.

Samples were sent to the Columbia River Intertribal Fish Commission (CRITFC) Genetics Laboratory in Hagerman, Idaho, for analysis and archival. Information resulting from tissue analysis is added to existing regional genetic databases and incorporated into reports, manuscripts, and management actions. Various types of genetic information are derived from sample analysis, including: genetic stock identification, parentage-based tagging identification (where possible), diversity metrics, introgression rates, and determination of phylogenetic relationships both within the Klickitat subbasin and between the Klickitat and other subbasins.

### Results

#### *Steelhead*

Analysis of juvenile *O. mykiss* samples from Klickitat River screw traps found that an estimated 6 to 7 genetically distinct subpopulations were present in the subbasin, approximately 4.0% of naturally-produced steelhead smolts had their most likely assignment to Skamania Hatchery stock, and that genetic integrity and variation of native Klickitat steelhead was fairly intact (Narum et al. 2006).

Analysis of *O. mykiss* samples collected via stream electrofishing from multiple tributary locations throughout the subbasin found primarily anadromous populations (with higher genetic diversity) in the lower elevation, warmer portions of the Klickitat subbasin; primarily resident populations (with lower genetic diversity) were found in higher elevation areas above higher gradient stream reaches and passage obstructions. Intermediate areas also exist with varying levels of mixing of the two life history types (Narum et al. 2008).

Further analysis of samples collected via stream electrofishing shows relatively small amounts of gene flow between the Skamania Hatchery stock and native Klickitat steelhead (similar to what was observed in screw trap samples), with certain tributaries showing a somewhat higher level of gene flow (e.g., Logging Camp, Swale, Bowman, and Dead Canyon creeks all showed a preliminary percentage Skamania ancestry of between 10 and 20%; CRITFC unpublished data). Determining whether this gene flow is recent or ongoing vs. historic is difficult as Klickitat native steelhead were used in the founding of the Skamania Hatchery stock (Crawford 1979).

Analysis of samples from returning adult steelhead has yielded estimates of relative production of different areas within the subbasin (in terms of proportions of adults sampled at Lyle Falls), with middle Klickitat tributaries (e.g. White Creek, lower Summit Creek) contributing a high proportion of adults (over 50%) and other significant contributions coming from lower subbasin tributaries such as Dead Canyon, Bowman Creek, lower Little Klickitat River, and Swale Creek (Narum et al. 2007). Results of genetic stock identification indicate on average for 2007-2012 approximately 25% of natural-origin steelhead and 30% of hatchery-origin steelhead sampled at the Lyle Falls adult trap are from outside the Klickitat subbasin (including an average of nearly 12% of fish being identified as Snake River stocks).

Analysis using the various collections of *O. mykiss* samples from the Klickitat subbasin led to identification of several candidate genetic markers associated with anadromy (Narum et al. 2011). A predictive multivariate logistic model developed from the allele frequencies of these markers was tested against Klickitat populations with previous knowledge of likely anadromy or residency. The results were generally consistent with these previous determinations, indicating the possible strength of the candidate markers. Further study is needed to determine whether these findings apply to other geographic areas (Narum et al. 2011).

Additional analysis of adult steelhead samples identified several candidate genetic markers that were significantly associated with migration timing (summer- vs. winter-run) and explained 46% of the trait variation, with an additional group of markers identified that explained up to 60% of trait variation (Hess et al. 2016). Further research is warranted to characterize the extent to which this genetic mechanism for this migration-timing trait applies across the geographical distribution of the species (Hess et al. 2016).

#### *Spring Chinook*

Analysis of spring Chinook samples from Lyle Falls adult trap and Klickitat Hatchery have resulted in the identification of an introgressive hybridized genotype in the Klickitat spring Chinook population that contains alleles normally found in the interior stream type Chinook (typically spring Chinook) and in ocean type Chinook (typically fall or summer Chinook) in the Columbia basin (Hess et al. 2011). Phylogenetically the Klickitat spring Chinook population sits in an intermediate position between (and distinct from) other interior stream type stocks and lower Columbia and ocean type stocks. The introgressed genotype appears in both wild and hatchery spring Chinook in the Klickitat. A combination of computer simulations and empirical samples were used to evaluate four hypothetical causes of this introgression: historical admixture, recent admixture (which could include hatchery intermixing), isolation by distance gene flow, and selection. Simulations excluded isolation by distance and selection as they were the least likely to result in the observed introgression patterns, leaving historical or recent admixture as likely causes. Comparisons of samples collected from Klickitat spring Chinook in the early 1980s to more recent (2006-2008) samples showed a substantial shift in genetic composition: samples from the early 1980s were predominantly interior stream type pure genotypes while more recent samples showed markedly more ocean type influence (Hess el al 2011). This shift coincided in time with the adult returns of Wells Hatchery summer (Upper Columbia ocean type) Chinook that were released in the Klickitat in the late 1970s. Hatchery records and anecdotal evidence from Klickitat Hatchery staff point to the likelihood that some of these returning summer Chinook were incorporated into broodstock collections for spring Chinook, and possible interbreeding occurred via this mechanism. These fish returned (volunteering into hatchery holding ponds via the hatchery adult fish ladder) and sexually matured at a later date than most of the spring Chinook, but enough overlap in this timing was present to provide for potential interbreeding.

Additional analysis to date has provided little evidence that this introgression has resulted in reduced fitness or altered run timing in Klickitat spring Chinook (CRITFC unpublished data). Further analysis, especially with regard to effects on run timing, is ongoing using restriction site associated DNA (RAD) sequencing.

### Conclusions

#### *Steelhead*

Genetic sampling and analysis conducted under this project has provided valuable data in monitoring hatchery/wild interactions, stock identification of fish use of the lower Klickitat River, subpopulation structure within the subbasin, and anadromous/resident relationships. The summary of results for steelhead to date suggests the following: natural-origin and hatchery-origin steelhead sampled as adults and juveniles in the Klickitat appear to remain genetically distinct suggesting low introgression/interbreeding rates (with further monitoring to determine introgression rates between the stocks underway); multiple subpopulations (at least 6 or 7) exist within different areas of the Klickitat subbasin; primarily anadromous populations residing in the mid and lower subbasin downstream of major passage obstructions; resident populations using upstream areas but intermixing with some anadromous populations; and a fairly high rate of use of the lower Klickitat River by out-of-subbasin populations.

The results from the O. mykiss candidate anadromous genetic markers study were useful in predicting anadromy/residency for Klickitat subbasin fish. Additional study in other geographic areas is needed, but these findings could be very useful in characterizing relationships and interactions between anadromous and resident populations, traits that lead to anadromous behavior (typically a combination of genetic and environmental factors are involved), and the role of resident rainbow trout in the recovery of steelhead populations. Findings from the summer/winter run timing study may help predict adult migration timing which could benefit conservation by characterizing differences associated with these adult alternative migration tactics that pertain to pre-adult life stages (e.g. juvenile migration and size-at-age), and categorizing adults on spawning grounds into migration categories.

#### *Spring Chinook*

Conclusions from the spring Chinook analysis are that hatchery interbreeding with Wells Hatchery summer Chinook is the most likely cause of the introgressive hybridized genotype observed in Klickitat spring Chinook. It is unknown if this introgression has effects on stock fitness or is playing a role in depressed abundance (described in Adult salmonid monitoring and Spawning ground survey sections), but it is quite possible (see discussion in Hess et al 2011). Present hatchery releases of Upper Columbia upriver bright fall Chinook stocks in the Klickitat produce returning adults that spawn largely at different times and different river reaches than spring Chinook (see Spawning ground survey section). And decades of releases of Lower Columbia tule Chinook (among other stocks) appears not to have significantly affected Klickitat spring Chinook genetic composition, as evidenced in the samples analyzed from the early 1980s. These factors point primarily to the Wells Hatchery releases. This finding highlights the need for changes to the current spring Chinook program at Klickitat Hatchery; many changes are proposed in the Klickitat Master Plan (Yakama Nation 2018) including a shift to natural-origin broodstock and continued genetic and population monitoring.

## Scale and Coded Wire Tag analysis

### Introduction

The objective of scale and coded wire tag (CWT) analysis is to determine age composition, length-at-age, and origin stock of adult salmonid stocks. Results are used by state and tribal fisheries managers for run reconstruction and forecasting.

### Methods

Scale samples were collected from adult carcasses encountered during spawner surveys, from fish captured at the Lyle Falls adult trap (RM 2.4 on the Klickitat River), and from spring Chinook collected at the Klickitat Hatchery adult holding pond during hatchery spawning activities. Scale collection follows methods outlined in Crawford et al. (2007). Scales were analyzed by YKFP/YN Fisheries Program staff; scales are pressed and read according to methods described in DeVries and Frie (1996). Coded wire tags (CWT), collected from carcasses on spawner surveys and at Klickitat Hatchery, were also used to validate and correct age determinations from scale reading when possible. CWT data is uploaded to the Regional Mark Information System (RMIS) database. Age data are presented in the "year-old" format as described in Groot and Margolis (1991), i.e., number of years old for an individual fish represents number of winters starting with the egg stage.

### Results

Readable scale samples were obtained from a total of 18 adult spring Chinook, 233 fall Chinook, and 38 coho salmon, and 3 steelhead carcasses during 2016-2020 spawner surveys. A total of 418 adult spring Chinook, 463 fall Chinook, 359 coho salmon, and 866 steelhead were sampled and yielded readable scales in the Lyle adult trap in 2016-2020. A total of 492 spring Chinook were also sampled during hatchery spawning at Klickitat Hatchery in 2016-2019; scale samples were not collected in 2020 due to Covid-19.

A brief description of the results by species is below. Table 9 through Table 17 in Appendix B presents the age breakdown by year and marks with accompanying fork and postorbital-hypural length averages and ranges for each species sampled. Due to a lack of 100% marking of fall Chinook, origin (hatchery or wild) of these fish sampled could not always be reliably determined. Hatchery spring Chinook and coho salmon, as well as Skamania Hatchery steelhead, that are released in the Klickitat River are currently 100% adipose-clip marked.

Overall during the 2016-2020 return years the majority (69.5%) of spring Chinook adults were 4-year-olds; 16.5% were 5-year-olds. Age and length data for spring Chinook carcasses recovered on spawning ground surveys are in Table 9; data for fish captured in the Lyle Falls adult trap are in Table 10; data for fish returning to the Klickitat Hatchery adult holding pond are in Table 11 (all in Appendix B).

For fall Chinook during 2016-2020, 4-year-old fish made up the largest portion of the returns at 66.5%; 5-year-olds made up 18.1% and 3-year-old jacks made up 14.1% of the returns. Age and length data for fall Chinook carcasses recovered on spawning ground surveys are in Table 12; data for fish captured in the Lyle Falls adult trap are in Table 13 (Appendix B).

For coho in 2016-2020 the vast majority of returning fish (99.5%) were 3-year-olds. Age and length data for carcasses recovered on spawning ground surveys are in Table 14; data for fish captured in the Lyle Falls adult trap in Table 15 (Appendix B).

For steelhead in 2016-2020, 3-year-olds represented 35.6% of the adult returns, 57.4% were 4-year-olds, and 4.8% were 5-year-olds. Total age and length data for carcasses recovered on spawning ground surveys are in Table 16; data for fish captured in the Lyle Falls adult trap are in Table 17 (Appendix B).

### Conclusions

For spring and fall Chinook, 4-year-olds continue to be the most common age of returning adults; 5-year-olds comprise a small percentage of the spring Chinook return and a slightly larger percentage of the fall Chinook return. For coho, 3-year-olds continue to dominate the returning adult population. For steelhead, 4-year-olds comprised the highest percentage of returning adults during this reporting period, with 3-year-olds making up slightly less of the population and 5-year-olds a small percentage.

## Hatchery spring Chinook and steelhead PIT tagging

### Introduction

Objectives of using Passive Integrated Transponder (PIT) tagging as a means of monitoring spring Chinook salmon and steelhead travel and/or holdover time between the Klickitat River and Bonneville Dam detection sites, estimating smolt survival rates, and estimating smolt-to-adult return rates for these hatchery populations. Monitoring smolt survival and smolt-to-adult rates under current hatchery production practices will provide effectiveness monitoring information for comparisons of these parameters under planned future hatchery actions, as well as for comparisons to wild populations.

### Methods

Spring Chinook salmon juveniles from the Klickitat Hatchery were injected with PIT tags in early summer of each year and released from the hatchery into the Klickitat River in early spring of the following year. PIT tagging of the spring Chinook production population at Klickitat Hatchery began in 2006. During this reporting period, approximately 10,000-20,000 fish were tagged each year; estimated numbers of fish released per year are shown in Table 1. Fewer fish were tagged in 2016 due to high bacterial kidney disease at the hatchery. The number of fish released is derived from monitoring the hatchery pond for tagged-fish mortalities and subtracting these fish from the total number of fish tagged. Steelhead juveniles at Skamania Hatchery were also tagged in the early fall each year beginning in 2009; these fish are transported via truck and released in the Klickitat River the following spring. Approximately 10,000 hatchery steelhead are tagged per year; numbers of fish released per year are shown in Table 2. The estimates of fish released also come from numbers of fish tagged minus mortalities tallied by hatchery staff. Tag data was entered into the regional PIT Tag Information System (PTAGIS) database for monitoring at mainstem Columbia River detection sites. No spring Chinook or steelhead were PIT tagged in 2020 due to COVID-19. Returning adult fish are detected at Bonneville Dam adult fish ladders to provide smolt-to-adult return rate (SAR) information. SAR estimates are generated by dividing Bonneville Dam detections of adults by estimated release numbers.

### Results

A summary of tagging and returning fish detections is given below for spring Chinook (Table 1) and for steelhead (Table 2). The average spring Chinook SAR estimate (using projected returns of 5- and 6-year-old fish for the more recent brood years based on average age compositions) for brood years 2005 through 2015 fish is fairly low, at approximately 0.4%. This includes some very low estimates from brood years 2014 and 2015, brood years which experienced very low returns in 2018-2020.

For steelhead, the estimated SAR is approximately 2.6% for brood years 2009-2016. More recent years have projected numbers in older age classes based on average age compositions.

**Table 1. Klickitat Hatchery spring Chinook PIT-tagged releases and returns to Bonneville Dam to date.**

| Brood Year | Tagging Year | Release Year | Total Jack/Adult Returns[3] (Age 3-6) | Total Adult Returns[3] (Age 4-6) | Number of Tagged Fish Released[2] | SAR[3] (incl. jacks) |
|---|---|---|---|---|---|---|
| 2004 | 2005 | 2005 | 0 | 0 | 9830 | 0%[4] |
| 2005 | 2006 | 2007 | 17 | 14 | 4917 | 0.35% |
| 2006 | 2007 | 2008 | 24 | 19 | 4635 | 0.52% |
| 2007 | 2008 | 2009 | 35 | 34 | 6848 | 0.51% |
| 2008 | 2009 | 2010 | 259 | 154 | 34643 | 0.75% |
| 2009 | 2010 | 2011 | 96 | 69 | 23849 | 0.40% |
| 2010 | 2011 | 2012 | 117 | 86 | 20954 | 0.56% |
| 2011 | 2012 | 2013 | 118 | 97 | 18936 | 0.62% |
| 2012 | 2013 | 2014 | 51 | 42 | 19208 | 0.27% |
| 2013 | 2014 | 2015 | 113 | 91 | 19912 | 0.57% |
| 2014 | 2015 | 2016 | 3 | 2 | 19742 | 0.02% |
| 2015 | 2016 | 2017 | 1 | 1 | 9591 | *0.01%* |
| 2016 | 2017 | 2018 | | | 20011 | |
| | | | | | *Average* | *0.41%* |

[1]Based on detections at Bonneville adult ladders
[2]Based on known tagged fish minus known pre-release mortalities and sheds at Klickitat Hatchery
[3]Italicized numbers are projections based on partial brood year returns and average age composition
[4]2005 release was thinning group with lower survival expected, not included in average

**Table 2. Klickitat River Skamania Hatchery steelhead PIT-tagged releases and returns to Bonneville Dam to date.**

| Tagging Year | Release Year | Total Adult Returns[3] (Age 2-6) | Number of Tagged Fish Released[2] | SAR[3] |
|---|---|---|---|---|
| 2009 | 2010 | 325 | 9937 | 3.27% |
| 2010 | 2011 | 150 | 9737 | 1.54% |
| 2011 | 2012 | 437 | 9960 | 4.39% |
| 2012 | 2013 | 333 | 9945 | 3.35% |
| 2013 | 2014 | 413 | 9996 | 4.13% |
| 2014 | 2015 | 95 | 9972 | 0.95% |
| 2015 | 2016 | *194* | 9964 | *1.95%* |
| 2016 | 2017 | *95* | 9566 | *0.99%* |
| | | | *Average* | *2.57%* |

[1]Based on detections at Bonneville adult ladders

[2]Based on known tagged fish minus known pre-release mortalities at Skamania Hatchery

[3]Italicized numbers are projections based on partial brood year returns and average age composition

### Conclusions

To date, SAR estimates for Klickitat Hatchery spring Chinook have been fairly low (approximately 0.4%), at levels similar to or lower than other hatchery spring Chinook stocks in the Middle Columbia region (CSS 2020) and also low considering that these fish have only one mainstem Columbia dam (Bonneville Dam) to pass as outmigrating smolts and returning adults. Recent return years (2018-2020) experienced low returns and very low SAR rates, also similar to other regional populations. Preliminary SAR estimates for Skamania Hatchery steelhead released in the Klickitat River are higher, at approximately 2.6%. This appears to be similar to or slightly below other steelhead populations in the Middle Columbia region (CSS 2020).

Future analysis will include additional methods of SAR and other survival rate estimation such as those described in Buchanan and Skalski (2007). Continued PIT tagging and monitoring will also allow for analysis of changes in SAR following changes to hatchery production programs and comparisons to wild populations.

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# VI. Appendix A: Use of Data & Products

Data generated from this project is available at several web sites and publicly-accessible databases, as outlined below. Use of these data is conditional upon a sufficient understanding of data limitations and knowledge of valid inferences that can be made from various data analyses. Contact lead project biologist Joseph Zendt (jzendt@ykfp.org) or data systems manager Michael Babcock (mbabcock@ykfp.org) with questions regarding data collection, use, and limitations.

Fish population and tagging monitoring data:
http://www.ykfp.org/klickitat/Data.htm
https://dashboard.yakamafish-star.net/
https://cax.streamnet.org/
http://www.ptagis.org/
http://www.rmpc.org/

Habitat data:
http://www.ykfp.org/klickitat/Data.htm

Past reports and publications:
http://www.ykfp.org/klickitat/Reports&Pubs.htm

# VII. Appendix B: Detailed Results

**Table 3. Mark-recapture estimates of spring Chinook run size at Lyle Falls on the lower Klickitat River for 2005-2018.**

| Year | Pop. Estimate (total) | L 95% CL | U 95% CL | - 95% CI | + 95% CI | % Wild[3] | Hatchery | Wild | % Jacks[4] | Adult total |
|---|---|---|---|---|---|---|---|---|---|---|
| 2005 *1/* | 2011 | 1475 | 2842 | 536 | 831 | | | | | |
| 2006 *1/* | 2100 | 1884 | 2391 | 216 | 291 | | | | | |
| 2007 *2/* | 1882 | 1585 | 2257 | 297 | 375 | 20.9% | 1489 | 393 | 17.7% | 1549 |
| 2008 | 1712 | 1330 | 2256 | 382 | 544 | 26.2% | 1263 | 449 | 35.9% | 1097 |
| 2009 | 6204 | 5526 | 6997 | 678 | 793 | 10.0% | 5584 | 620 | 22.2% | 4827 |
| 2010 | 4535 | 3599 | 5825 | 936 | 1290 | 11.2% | 4027 | 508 | 9.8% | 4091 |
| 2011 | 4536 | 3794 | 5483 | 742 | 947 | 15.1% | 3851 | 685 | 21.0% | 3583 |
| 2012 | 4452 | 3740 | 5357 | 712 | 905 | 13.0% | 3873 | 579 | 21.4% | 3499 |
| 2013 | 6421 | 5339 | 7817 | 1082 | 1396 | 7.2% | 5959 | 462 | 38.8% | 3930 |
| 2014 | 5060 | 4399 | 5861 | 661 | 801 | 6.1% | 4751 | 309 | 20.0% | 4048 |
| 2015 | 5865 | 4928 | 7056 | 937 | 1191 | 11.3% | 5202 | 663 | 5.7% | 5531 |
| 2016 | 4052 | 3304 | 5043 | 748 | 991 | 10.9% | 3610 | 442 | 24.6% | 3055 |
| 2017 | 4703 | 3947 | 5664 | 756 | 961 | 16.3% | 3936 | 767 | 9.8% | 4242 |
| 2018 | 1316 | 1002 | 1777 | 314 | 461 | 13.6% | 1137 | 179 | 13.0% | 1145 |
| Avg. | 3918 | | | | | | 3724 | 505 | 20% | 3383 |
| Geomean | 3472 | | | | | | 3271 | 473 | | 3008 |

*1/* Estimates from Gray 2007
*2/* 2007 is first year all returning adult age classes were 100% ad marked
3/ Percentage of wild (adipose-present) fish as counted at Lyle Falls adult trap
4/ Percentage of jacks as counted at Lyle Falls adult trap

Note: Hatchery/wild numbers estimated from proportions observed at Lyle adult trap. Estimates include jacks and adults (except Adult total column).

**Table 4. Mark-recapture estimates of steelhead run size at Lyle Falls on the lower Klickitat River for run years 2005-06 through 2019-20.**

| | Hatchery | | | | | | Wild (Summer and Winter) | | | | | | Wild (Summer) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Pop. Estimate | SE | L 95% CL | U 95% CL | - 95% CI | + 95% CI | Pop. Estimate | SE | L 95% CL | U 95% CL | - 95% CI | + 95% CI | Pop. Estimate | SE | L 95% CL | U 95% CL | - 95% CI | + 95% CI | Wild (Winter)[1] |
| 2005-06 [2] | 1,833 | 148 | 1,572 | 2,160 | 261 | 327 | 1,577 | 102 | 1,395 | 1,801 | 182 | 224 | 1,252 | 102 | 1,070 | 1,476 | 182 | 224 | 325 |
| 2006-07 [2,3] | 1,854 | 349 | 1,394 | 3,231 | 460 | 1,377 | 1,669 | 261 | 1,324 | 2,687 | 345 | 1,018 | 1,325 | 261 | 980 | 2,343 | 345 | 1,018 | 344 |
| 2007-08 [4] | | | | | | | | | | | | | | | | | | | 90 |
| 2008-09 [4] | | | | | | | | | | | | | | | | | | | 82 |
| 2009-10 [5] | 3,578 | 390 | 2,913 | 4,470 | 665 | 892 | 1,290 | 116 | 1,090 | 1,551 | 200 | 261 | 1,137 | 116 | 937 | 1,398 | 200 | 261 | 153 |
| 2010-11 [3,5] | 5,154 | 834 | 3,813 | 7,209 | 1,341 | 2,055 | 1,111 | 137 | 885 | 1,438 | 226 | 327 | 979 | 137 | 753 | 1,306 | 226 | 327 | 132 |
| 2011-12 | 2,443 | 715 | 1,448 | 4,630 | 995 | 2,187 | 2,483 | 709 | 1,497 | 4,649 | 986 | 2,166 | 2,399 | 709 | 1,413 | 4,565 | 986 | 2,166 | 84 |
| 2012-13 | 2,663 | 929 | 1,146 | 5,818 | 1,517 | 3,155 | 1,063 | 348 | 604 | 2,230 | 459 | 1,167 | 999 | 348 | 540 | 2,166 | 459 | 1,167 | 64 |
| 2013-14 [3] | 1,255 | 248 | 873 | 1,904 | 382 | 649 | 1,222 | 230 | 868 | 1,822 | 354 | 600 | 1,146 | 230 | 792 | 1,746 | 354 | 600 | 76 |
| 2014-15 | 3,500 | 1,035 | 2,066 | 6,687 | 1,434 | 3,187 | 2,956 | 840 | 1,791 | 5,534 | 1,165 | 2,578 | 2,815 | 840 | 1,650 | 5,393 | 1,165 | 2,578 | 141 |
| 2015-16 | 3,817 | 1,142 | 2,235 | 7,333 | 1,582 | 3,516 | 3,270 | 957 | 1,943 | 6,212 | 1,327 | 2,942 | 3,202 | 957 | 1,875 | 6,144 | 1,327 | 2,942 | 68 |
| 2016-17 [3] | 2,190 | 353 | 1,622 | 3,058 | 568 | 868 | 544 | 56 | 448 | 672 | 96 | 128 | 512 | 56 | 416 | 640 | 96 | 128 | 32 |
| 2017-18 | 2,670 | 683 | 1,682 | 4,631 | 988 | 1,961 | 1,785 | 439 | 1,148 | 3,035 | 637 | 1,250 | 1,725 | 439 | 1,088 | 2,975 | 637 | 1,250 | 60 |
| 2018-19 | 2,119 | 420 | 1,472 | 3,217 | 647 | 1,098 | 1,025 | 187 | 734 | 1,508 | 291 | 483 | 973 | 187 | 682 | 1,456 | 291 | 483 | 52 |
| 2019-20 | 1,051 | 132 | 831 | 1,359 | 220 | 308 | 1,009 | 118 | 810 | 1,285 | 199 | 276 | 948 | 118 | 749 | 1,224 | 199 | 276 | 61 |
| Avg: | 2,625 | 568 | 1,774 | 4,285 | | | 1,616 | 346 | 1,118 | 2,648 | | | 1,493 | 346 | 996 | 2,526 | | | 118 |
| **Geomean:** | **2,403** | | **1,623** | **3,805** | | | **1,443** | | **1,031** | **2,196** | | | **1,321** | | **916** | **2,063** | | | **94** |

[1]Count of fish captured in Lyle adult trap Dec 1 - Apr 30 (assumes no winter steelhead ascend falls, which likely biases estimate low). No recaptures of winter fish due to no winter sport fishery.
[2]From Gray 2007
[3]Winter steelhead counts estimated from previous winters' proportion of total, due to winter trap shutdowns.
[4]No estimate; angler recapture data not collected.
[5]Estimate of hatchery fish may be biased high by a high dip-in rate by out-of-basin fish

**Table 5. Klickitat spring Chinook (Adult age 4, 5, and 6) returns, harvest, and escapement (from run reconstruction estimation). 2019 data is likely biased low and not included in summary statistics.**

| Return | Returns | | | Harvest | | | | | Escapement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sport | | Tribal | | | | |
| Year | Total | Hatchery | Wild | Total | Hatchery | Wild | Hatchery | Wild | Total | Hatchery | Wild |
| 1977 | 533 | 380 | 153 | 95 | 6 | 3 | 61 | 25 | 438 | 312 | 126 |
| 1978 | 1,528 | 1,160 | 368 | 906 | 202 | 64 | 486 | 154 | 622 | 472 | 150 |
| 1979 | 851 | 773 | 78 | 89 | 81 | 8 | 0 | 0 | 762 | 692 | 70 |
| 1980 | 1,685 | 1,619 | 66 | 67 | 6 | 0 | 59 | 2 | 1,618 | 1,555 | 63 |
| 1981 | 2,528 | 2,211 | 317 | 574 | 133 | 19 | 369 | 53 | 1,954 | 1,709 | 245 |
| 1982 | 3,238 | 2,988 | 250 | 1,775 | 399 | 33 | 1,239 | 104 | 1,463 | 1,350 | 113 |
| 1983 | 2,417 | 2,190 | 227 | 1,745 | 256 | 27 | 1,325 | 137 | 672 | 609 | 63 |
| 1984 | 1,323 | 1,086 | 237 | 754 | 268 | 59 | 350 | 77 | 569 | 467 | 102 |
| 1985 | 848 | 340 | 508 | 716 | 73 | 108 | 215 | 320 | 132 | 53 | 79 |
| 1986 | 1,112 | 860 | 252 | 485 | 19 | 5 | 357 | 104 | 627 | 485 | 142 |
| 1987 | 1,682 | 1,235 | 447 | 507 | 118 | 42 | 255 | 92 | 1,175 | 863 | 312 |
| 1988 | 3,929 | 2,239 | 1,690 | 1,353 | 141 | 107 | 630 | 475 | 2,576 | 1,468 | 1,108 |
| 1989 | 5,254 | 4,807 | 447 | 1,783 | 760 | 71 | 871 | 81 | 3,471 | 3,176 | 295 |
| 1990 | 2,583 | 1,858 | 725 | 1,785 | 256 | 100 | 1,028 | 401 | 798 | 574 | 224 |
| 1991 | 1,477 | 1,018 | 459 | 702 | 96 | 43 | 388 | 175 | 775 | 534 | 241 |
| 1992 | 1,540 | 1,026 | 514 | 587 | 82 | 41 | 309 | 155 | 953 | 635 | 318 |
| 1993 | 3,702 | 2,985 | 717 | 1,483 | 228 | 55 | 967 | 233 | 2,219 | 1,789 | 430 |
| 1994 | 958 | 831 | 127 | 233 | 44 | 7 | 158 | 24 | 725 | 629 | 96 |
| 1995 | 696 | 606 | 90 | 140 | 0 | 0 | 122 | 18 | 556 | 484 | 72 |
| 1996 | 1,156 | 782 | 374 | 308 | 97 | 46 | 112 | 53 | 848 | 574 | 274 |
| 1997 | 1,861 | 1,083 | 778 | 437 | 157 | 113 | 97 | 70 | 1,424 | 829 | 595 |
| 1998 | 702 | 397 | 305 | 149 | 8 | 6 | 76 | 59 | 553 | 313 | 240 |
| 1999 | 728 | 578 | 150 | 151 | 60 | 16 | 60 | 15 | 577 | 458 | 119 |
| 2000 | 2,708 | 1,601 | 1,107 | 1,446 | 233 | 162 | 621 | 430 | 1,262 | 746 | 516 |
| 2001 | 1,162 | 614 | 548 | 500 | 85 | 75 | 180 | 160 | 662 | 350 | 312 |
| 2002 | 2,549 | 1,250 | 1,299 | 787 | 183 | 190 | 203 | 211 | 1,762 | 864 | 898 |
| 2003 | 3,976 | 1,936 | 2,040 | 1,750 | 374 | 393 | 479 | 504 | 2,226 | 1,084 | 1,142 |
| 2004 | 3,039 | 1,710 | 1,329 | 1,171 | 338 | 262 | 321 | 250 | 1,868 | 1,051 | 817 |
| 2005 | 1,428 | 1,140 | 288 | 809 | 322 | 81 | 324 | 82 | 619 | 494 | 125 |
| 2006 | 1,593 | 1,175 | 418 | 671 | 216 | 0 | 336 | 119 | 922 | 623 | 298 |
| 2007 | 1,078 | 852 | 225 | 337 | 73 | 0 | 209 | 55 | 741 | 571 | 170 |
| 2008 | 1,115 | 823 | 292 | 593 | 121 | 0 | 348 | 124 | 522 | 354 | 169 |
| 2009 | 1,607 | 1,446 | 161 | 513 | 390 | 0 | 123 | 0 | 1,094 | 933 | 161 |
| 2010 | 1,784 | 1,584 | 200 | 641 | 242 | 0 | 371 | 28 | 1,143 | 971 | 172 |
| 2011 | 1,699 | 1,442 | 257 | 559 | 475 | 0 | 79 | 5 | 1,140 | 888 | 252 |
| 2012 | 2,298 | 1,999 | 299 | 1,148 | 698 | 0 | 411 | 39 | 1,150 | 890 | 260 |
| 2013 | 1,623 | 1,506 | 117 | 484 | 359 | 0 | 122 | 3 | 1,139 | 1,025 | 114 |
| 2014 | 2,724 | 2,558 | 166 | 1,358 | 327 | 0 | 923 | 108 | 1,366 | 1,308 | 58 |
| 2015 | 3,122 | 2,778 | 343 | 1,411 | 662 | 0 | 722 | 27 | 1,711 | 1,394 | 316 |
| 2016 | 2,128 | 1,894 | 234 | 1,113 | 493 | 0 | 508 | 112 | 1,015 | 893 | 122 |
| 2017 | 2,173 | 1,825 | 348 | 602 | 392 | 0 | 170 | 40 | 1,571 | 1,263 | 308 |
| 2018 | 723 | 622 | 101 | 161 | 141 | 0 | 20 | 0 | 562 | 461 | 101 |
| 2019 | 396 | 325 | 71 | 102 | 32 | 0 | 20 | 50 | 294 | 273 | 21 |
| 2020 | 1,517 | 1,441 | 76 | 431 | 390 | 0 | 41 | 0 | 1,086 | 1,010 | 76 |
| Min | 396 | 340 | 66 | 67 | 0 | 0 | 0 | 0 | 132 | 53 | 58 |
| Max | 5254 | 4807 | 2040 | 1785 | 760 | 393 | 1325 | 504 | 3471 | 3176 | 1142 |
| Avg | 1,916 | 1,471 | 445 | 775 | 233 | 50 | 373 | 119 | 1,141 | 865 | 276 |

**Table 6. Results of spring Chinook spawning ground surveys (redd counts) in the Klickitat subbasin for 1989-2020.**

| REACH | MILES | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015[1] | 2016 | 2017 | 2018 | 2019[2] | 2020[2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Redd Counts | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Diamond Fork | 8.5 | ns | 0 | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | 0 | 0 | 0 | 0 | 0 | ns | 0 | ns | ns | ns | 0 | ns | 0 | ns | ns | 0 | 0 |
| McCormick Mdws - Castile Falls | 18.0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 64 | 2 | 243 | 165 | 122 | 4 | 6 | 36 | 0 | 4 | 1 | 0 | 5 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 |
| Castile Falls #10 - Falls #1 | 0.8 | ns | ns | ns | ns | ns | ns | ns | ns | 3 | 3 | 2 | 0 | 7 | 0 | 4 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| Castile Falls - Signal Peak Br. | 3.3 | 20 | 17 | 28 | 34 | 33 | 18 | 17 | 24 | 87 | 56 | 40 | 39 | 33 | 50 | 41 | 18 | 11 | 14 | 18 | 15 | 21 | 13 | 31 | 20 | 35 | 18 | 22 | 15 | 27 | 26 | 2 | 17 |
| Signal Peak Br. - Big Muddy Cr. | 6.9 | 33 | 42 | 61 | 63 | 84 | 20 | 25 | 51 | 118 | 53 | 38 | 29 | 78 | 75 | 71 | 38 | 9 | 39 | 34 | 34 | 26 | 44 | 38 | 57 | 44 | 29 | 41 | 69 | 58 | 35 | 11 | 16 |
| Big Muddy Cr. - Old USGS gage | 3.3 | ns | ns | 0 | 5 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 | 5 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 0 |
| Old USGS gage - Klickitat Hatchery | 8.2 | ns | ns | ns | ns | ns | ns | ns | 14 | 2 | 0 | 0 | 27 | 1 | 16 | 34 | 10 | 15 | 4 | 8 | 5 | 3 | 18 | 28 | 35 | 26 | 10 | 28 | 35 | 12 | 1 | 0 | 0 |
| Klickitat Hatchery - Summit Cr. | 5.5 | ns | ns | 2 | ns | ns | ns | ns | 8 | 14 | 1 | 2 | 4 | 1 | 0 | 17 | 3 | 7 | 15 | 5 | 9 | 9 | 14 | 45 | 19 | 7 | 14 | 78 | 28 | 9 | 8 | 2 | 8 |
| Summit Creek - Leidl | 5.6 | ns | ns | 2 | ns | ns | ns | ns | 8 | 3 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 3 | 3 | 0 | 11 | 2 | 3 | 4 | 1 | 7 | 7 | 1 | 10 | 4 | 5 | 2 | 2 |
| Leidl - Stinson Flats | 3.2 | ns | ns | ns | ns | ns | ns | ns | 5 | 4 | ns | ns | ns | ns | ns | ns | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 1 | 2 | 0 | 14 | 4 | 0 | 1 |
| Stinson Flats - Soda Springs/Beeks Canyon | 4 | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | 3 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 2 | 4 | 1 | 2 | 0 | 1 | 5 | 0 | 5 |
| Soda Springs/Beeks - Twin Bridges | 6.4 | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | 0 | 6 | 7 | 3 | 2 | 4 | 2 | 0 | 1 | 0 | 4 |
| Twin Bridges - Pitt Bridge | 8 | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | 0 | 0 | ns | ns | ns | 0 | 0 |
| Pitt - Turkey Farm | 5 | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Turkey Farm - Lyle Falls | 2 | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| **Totals** | **88.7** | **53** | **59** | **93** | **102** | **132** | **39** | **42** | **110** | **231** | **113** | **83** | **167** | **123** | **389** | **332** | **195** | **50** | **82** | **104** | **76** | **70** | **97** | **157** | **154** | **130** | **86** | **185** | **161** | **125** | **85** | **17** | **53** |
| **Totals (minus releases above Castile)** | | **53** | **59** | **93** | **102** | **132** | **39** | **42** | **110** | **231** | **113** | **83** | **103** | **123** | **146** | **167** | **73** | **50** | **82** | **104** | **76** | **70** | **97** | **157** | **154** | **130** | **86** | **185** | **161** | **125** | **85** | **17** | **53** |
| **Totals above Castile (minus releases)** | | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **2** | **0** | **0** | **0** | **4** | **6** | **36** | **0** | **4** | **1** | **0** | **5** | **0** | **0** | **3** | **2** | **0** | **0** | **0** | **0** |
| **Totals in Wild index reach** | | 53 | 59 | 89 | 97 | 117 | 38 | 42 | 75 | 205 | 109 | 78 | 68 | 111 | 125 | 112 | 56 | 20 | 53 | 52 | 49 | 47 | 57 | 69 | 77 | 79 | 47 | ns | 84 | 85 | 61 | ns | 33 |
| **Percent of Total in Wild index reach** | | 100% | 100% | 96% | 95% | 89% | 97% | 100% | 68% | 89% | 96% | 94% | 66% | 90% | 86% | 67% | 77% | 40% | 65% | 50% | 64% | 67% | 59% | 44% | 50% | 61% | 55% | | 52% | 68% | 72% | | |
| **Totals in Hatchery reach** | | | | | | | | | | 16 | 1 | 2 | 31 | 2 | 16 | 51 | 13 | 22 | 19 | 13 | 14 | 12 | 32 | 73 | 54 | 33 | 24 | 106 | 63 | 21 | 9 | ns | 8 |
| **Percent of Total in Hatchery reach** | | | | | | | | | | 7% | 1% | 2% | 30% | 2% | 11% | 31% | 18% | 44% | 23% | 13% | 18% | 17% | 33% | 46% | 35% | 25% | 28% | | 39% | 17% | 11% | | |

ns = not surveyed

[1] In 2015, Cougar Creek fire-related road closures prevented surveys from Signal Peak Bridge to Old USGS gage site. 2015 redd counts for those reaches are estimated based on linear regression with total wild fish run size at Lyle Falls in 2015 and recent years' proportions of total redd counts observed in those reaches.

[2] In 2019 and 2020, extended river trubidity (both years) and wildfire smoke (2020) limited surveys and reaches below Signal Peak Bridge were surveyed only 1-2 times likely leading to low redd counts

**Note:** In 2000, 2002, 2003, and 2004 surplus spring Chinook adults from Klickitat Hatchery were transported and released above Castile Falls. High redd counts above Castile Falls in those years are almost exclusively a result of those releases. For this reason the "Totals (minus releases above Castile)" row provides for a more consistent across-year comparison of natural spawner escapement in the Klickitat subbasin. The "Totals above Castile (minus releases)" row provides an across-year comparison of natural spawner escapement and passage above Castile Falls, assuming virtually no natural passage in 2000, 2002, 2003, and 2004. The "Wild Index Reach" is Castile Falls to Big Muddy Cr. The "Hatchery Reach" is old USGS gage to Summit Cr.

**Table 7. Klickitat subbasin spring Chinook spawner survey carcass observations for 2007-2018. 2007 is the first year in which all returning hatchery-origin adults were 100% ad-clipped. 2015, 2019, and 2020 data are not used due to limited surveys and carcass recoveries.**

| | Carcasses observed | | |
|---|---|---|---|
| Year | Ad-clipped | Unclipped | % Ad-clipped |
| 2007 | 6 | 10 | 38% |
| 2008 | 2 | 4 | 33% |
| 2009 | 1 | 8 | 11% |
| 2010 | 4 | 3 | 57% |
| 2011 | 11 | 7 | 61% |
| 2012 | 4 | 3 | 57% |
| 2013 | 1 | 5 | 17% |
| 2014 | 5 | 3 | 63% |
| 2016 | 2 | 2 | 50% |
| 2017 | 1 | 4 | 20% |
| 2018 | 1 | 7 | 13% |
| | | Avg. | 38% |

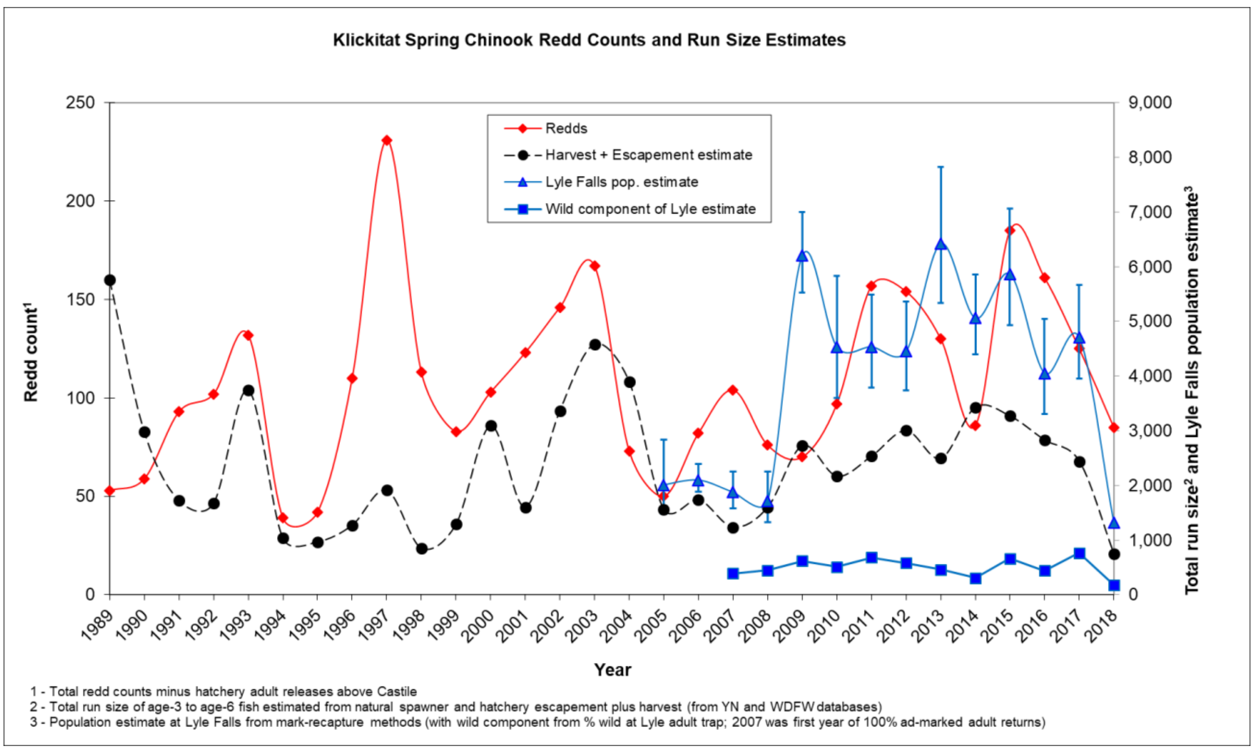


**Figure 9. Results of spring Chinook redd counts and run size estimates in the Klickitat subbasin for 1989-2018. Error bars on Lyle Falls mark-recapture population estimates represent 95% confidence intervals.**

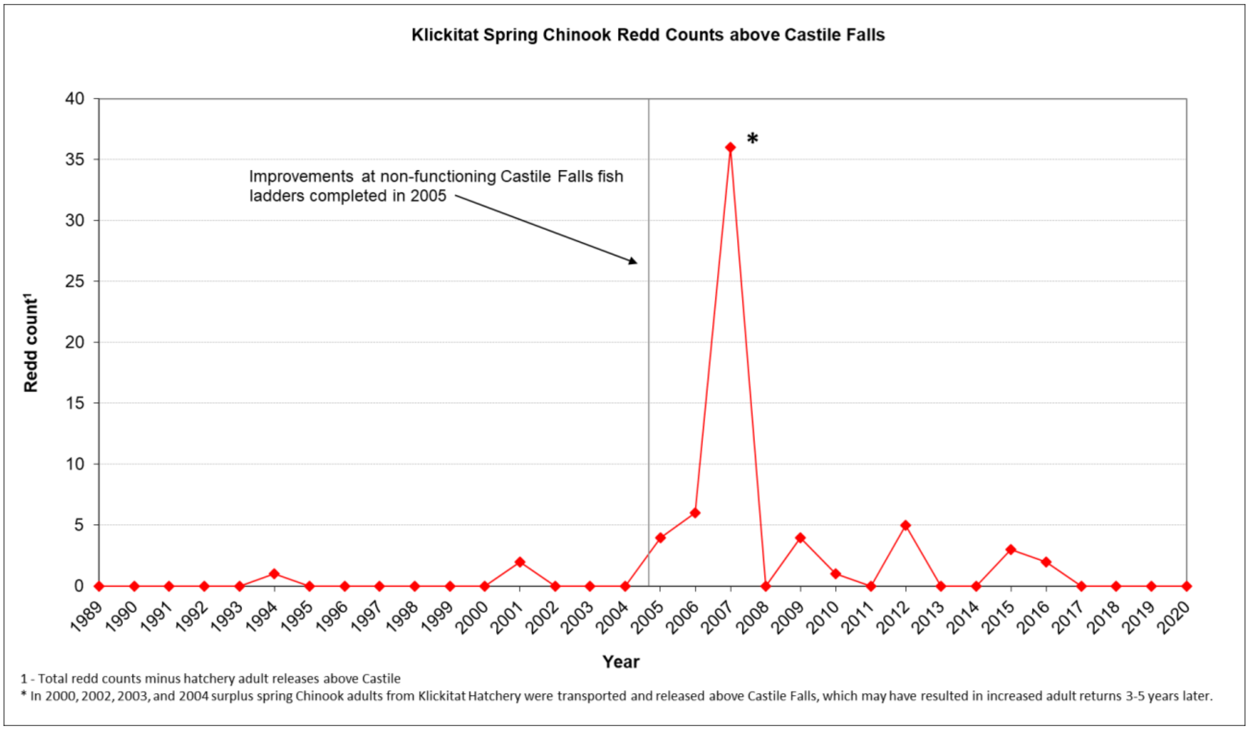


**Figure 10. Results of spring Chinook redd counts above Castile Falls (RM 64) in the upper Klickitat River for 1989-2020.**

**Table 8. Results of fall Chinook spawning ground surveys (redd counts) in the Klickitat subbasin for 1995-2020.**

| | | Redd Counts | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REACH | MILES | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| Old USGS gage - Klickitat Hatchery | 8.2 | ns | 1 | 12 | 6 | 0 | 0 | 0 | 3 | ns | 4 | 1 | ns | 5 | 0 | ns | 0 | 1 | 12 | 0 | 11 | ns | 6 | 0 | 0 | ns | 0 |
| Klickitat Hatchery - Summit Cr. | 5.5 | 194 | 300 | 248 | 475 | 263 | 468 | 35 | 75 | 18 | 65 | 88 | 72 | 112 | 92 | 313 | 423 | 336 | 58 | 416 | 537 | 132 | 234 | 14 | 47 | 74 | 105 |
| Summit Creek - Leidl | 5.6 | | 303 | 310 | 434 | 239 | 492 | 49 | 258 | 159 | 94 | 199 | 1 | 23 | 16 | 108 | 291 | 232 | 143 | 498 | 273 | 87 | 234 | 30 | 39 | 42 | 121 |
| Leidl - Stinson Flats | 3.2 | 120 | 104 | 144 | 183 | 160 | 207 | 138 | 97 | 190 | 52 | 55 | 2 | 39 | 21 | 101 | 132 | 157 | 65 | 404 | 164 | 269 | 144 | 13 | 8 | 20 | 150 |
| Stinson Flats - Soda Springs/Beeks Canyon | 7.5 | | 159 | 68 | 180 | 66 | 86 | 53 | 160 | 26 | 84 | 68 | 23 | 24 | 2 | 60 | 119 | 134 | 6 | 445 | 689 | 282 | 205 | 56 | 24 | 48 | 257 |
| Soda Springs/Beeks - Twin Bridges | 6.4 | 140 | 146 | 90 | 413 | 82 | 227 | 112 | 420 | 43 | 368 | 77 | 21 | 32 | 12 | 152 | 152 | 322 | 71 | 1324 | 1536 | 532 | 266 | 82 | 33 | 62 | 329 |
| Twin Bridges - Pitt Bridge | 8 | 27 | 100 | 46 | 1 | 19 | 138 | 1 | 163 | 34 | 68 | 13 | 0 | 15 | 0 | 12 | 65 | 309 | 51 | 512 | 508 | 246 | 201 | 24 | 34 | 35 | 194 |
| Pitt - Turkey Farm | 5 | 15 | 18 | 11 | 8 | 6 | 31 | 7 | 38 | 0 | 18 | 4 | 0 | 0 | 0 | 8 | 46 | 64 | 26 | 50 | 89 | 37 | 62 | 13 | 9 | 12 | 87 |
| Turkey Farm - Lyle Falls | 2 | ns | 2 | ns | ns | ns | ns | ns | 11 | 4 | 10 | 0 | 0 | 2 | ns | 0 | 10 | 25 | 4 | 8 | 11 | 8 | 5 | 4 | 7 | 6 | 13 |
| Below Lyle Falls | 0.3 | ns | ns | ns | ns | ns | ns | 13 | ns | ns | 14 | 0 | ns | 1 | 4 | ns | 41 | 19 | ns | ns | ns | ns | 14 | ns | 20 | ns | ns |
| **Totals** | **51.7** | **496** | **1133** | **929** | **1700** | **835** | **1649** | **408** | **1225** | **474** | **777** | **505** | **119** | **253** | **147** | **754** | **1279** | **1599** | **436** | **3657** | **3818** | **1593** | **1371** | **236** | **221** | **299** | **1256** |

ns = not surveyed

**Recent 10-year average: 1449**

**Note:** High flows and/or turbidity in some years (especially 2003, 2006, 2008, 2009, 2012, and 2015) limit survey coverage and visibility and may bias redd counts low. High flows and suspended sediment in October 2003 and November 2006 also caused significant pre-spawn mortality of fall Chinook. Some survey reaches were combined in 1995 data.

**Table 9. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for spring Chinook recovered on spawning ground surveys in the Klickitat River in 2016-2020.**

| | | | Fork Length | | | POH Length | | |
|---|---|---|---|---|---|---|---|---|
| Spring Chinook | | Count | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 4 | 1 | 712 | 712 | 712 | 590 | 590 | 590 | 100.0% |
| | Total | 1 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 4 | 2 | 892 | 885 | 898 | 708 | 701 | 715 | 100.0% |
| | Total | 2 | | | | | | | 100.0% |
| 2017 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 4 | 1 | 765 | 765 | 765 | 632 | 632 | 632 | 100.0% |
| | Total | 1 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 4 | 2 | 794 | 763 | 825 | 635 | 605 | 665 | 40.0% |
| | 5 | 3 | 913 | 875 | 960 | 736 | 705 | 753 | 60.0% |
| | Total | 5 | | | | | | | 100.0% |
| 2018 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 4 | 1 | 665 | 665 | 665 | 520 | 520 | 520 | 100.0% |
| | Total | 1 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 4 | 6 | 806 | 722 | 907 | 635 | 543 | 712 | 100.0% |
| | Total | 6 | | | | | | | 100.0% |
| 2019 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 1 | 524 | 524 | 524 | 422 | 422 | 422 | 100.0% |
| | Total | 1 | | | | | | | 100.0% |
| 2020 | | | | | | | | | |
| | Unmarked | | | | | | | | |
| | 4 | 1 | 780 | 780 | 780 | 570 | 570 | 570 | 100.0% |
| | Total | 1 | | | | | | | 100.0% |

**Table 10. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for spring Chinook captured in the Lyle Falls adult trap in 2016-2020.**

| | | | Fork Length | | | POH Length | | | |
|---|---|---|---|---|---|---|---|---|---|
| Spring Chinook | | Count | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 19 | 554 | 495 | 665 | 464 | 407 | 555 | 16.1% |
| | 4 | 72 | 723 | 605 | 820 | 612 | 503 | 715 | 61.0% |
| | 5 | 27 | 850 | 752 | 984 | 721 | 633 | 813 | 22.9% |
| | Total | 118 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 2 | 524 | 515 | 533 | 446 | 430 | 462 | 15.4% |
| | 4 | 5 | 701 | 640 | 752 | 597 | 538 | 641 | 38.5% |
| | 5 | 6 | 920 | 874 | 996 | 773 | 723 | 830 | 46.2% |
| | Total | 13 | | | | | | | 100.0% |
| 2017 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 10 | 543 | 434 | 695 | 445 | 365 | 582 | 10.0% |
| | 4 | 79 | 739 | 532 | 862 | 615 | 441 | 712 | 79.0% |
| | 5 | 11 | 826 | 763 | 886 | 687 | 595 | 751 | 11.0% |
| | Total | 100 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 1 | 572 | 572 | 572 | 473 | 473 | 473 | 5.9% |
| | 4 | 10 | 742 | 682 | 834 | 635 | 542 | 741 | 58.8% |
| | 5 | 6 | 911 | 842 | 1005 | 756 | 680 | 850 | 35.3% |
| | Total | 17 | | | | | | | 100.0% |
| 2018 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 1 | 520 | 520 | 520 | 416 | 416 | 416 | 1.6% |
| | 4 | 50 | 721 | 570 | 812 | 592 | 450 | 681 | 80.6% |
| | 5 | 11 | 828 | 742 | 896 | 684 | 610 | 763 | 17.7% |
| | Total | 62 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 1 | 461 | 461 | 461 | 365 | 365 | 365 | 11.1% |
| | 4 | 2 | 731 | 698 | 764 | 605 | 590 | 620 | 22.2% |
| | 5 | 6 | 874 | 752 | 920 | 700 | 608 | 741 | 66.7% |
| | Total | 9 | | | | | | | 100.0% |
| 2019 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 7 | 523 | 455 | 598 | 424 | 385 | 475 | 10.9% |
| | 4 | 38 | 730 | 530 | 893 | 600 | 420 | 739 | 59.4% |
| | 5 | 19 | 847 | 743 | 950 | 695 | 621 | 783 | 29.7% |
| | Total | 64 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 2 | 601 | 580 | 622 | 473 | 440 | 505 | 14.3% |
| | 4 | 9 | 724 | 655 | 774 | 581 | 512 | 673 | 64.3% |
| | 5 | 3 | 897 | 796 | 990 | 726 | 643 | 800 | 21.4% |
| | Total | 14 | | | | | | | 100.0% |
| 2020 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 4 | 16 | 698 | 560 | 775 | 565 | 503 | 620 | 100.0% |
| | Total | 16 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 4 | 3 | 732 | 684 | 758 | 594 | 550 | 622 | 60.0% |
| | 5 | 2 | 847 | 758 | 935 | 691 | 621 | 760 | 40.0% |
| | Total | 5 | | | | | | | 100.0% |

**Table 11. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for spring Chinook returning to the Klickitat Hatchery adult holding pond in 2016-2019. Scale samples not collected in 2020 due to Covid-19.**

| | | | Fork Length | | | POH Length | | | |
|---|---|---|---|---|---|---|---|---|---|
| Spring Chinook | | Count | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | Age 3 | 26 | 586 | 505 | 682 | 464 | 400 | 530 | 14.9% |
| | Age 4 | 111 | 744 | 618 | 962 | 587 | 390 | 740 | 63.8% |
| | Age 5 | 37 | 870 | 719 | 1003 | 691 | 570 | 799 | 21.3% |
| | Total | 174 | | | | | | | 100.0% |
| 2017 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | Age 3 | 2 | 682 | 667 | 697 | 525 | 518 | 532 | 1.5% |
| | Age 4 | 130 | 759 | 655 | 918 | 615 | 533 | 768 | 95.6% |
| | Age 5 | 4 | 866 | 820 | 930 | 688 | 628 | 735 | 2.9% |
| | Total | 136 | | | | | | | 100.0% |
| Unmarked | | | | | | | | | |
| | Age 4 | 3 | 717 | 685 | 735 | 570 | 542 | 595 | 100.0% |
| | Total | 3 | | | | | | | 100.0% |
| 2018 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | Age 3 | 9 | 648 | 520 | 723 | 516 | 415 | 583 | 9.8% |
| | Age 4 | 73 | 744 | 581 | 900 | 587 | 468 | 745 | 79.3% |
| | Age 5 | 10 | 834 | 745 | 972 | 680 | 600 | 750 | 10.9% |
| | Total | 92 | | | | | | | 100.0% |
| Unmarked | | | | | | | | | |
| | Age 3 | 1 | 635 | 635 | 635 | 510 | 510 | 510 | 33.3% |
| | Age 4 | 2 | 727 | 662 | 792 | 593 | 550 | 635 | 66.7% |
| | Total | 3 | | | | | | | 100.0% |
| 2019 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | Age 3 | 46 | 544 | 470 | 672 | 435 | 375 | 609 | 55.4% |
| | Age 4 | 28 | 759 | 500 | 973 | 609 | 390 | 770 | 33.7% |
| | Age 5 | 8 | 882 | 810 | 915 | 714 | 635 | 793 | 9.6% |
| | Age 6 | 1 | 775 | 775 | 775 | 625 | 625 | 625 | 1.2% |
| | Total | 83 | | | | | | | 100.0% |
| Unmarked | | | | | | | | | |
| | Age 3 | 1 | 520 | 520 | 520 | 412 | 412 | 412 | 100.0% |
| | Total | 1 | | | | | | | 100.0% |

**Table 12. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for fall Chinook recovered on spawning ground surveys in the Klickitat River in 2016-2020.**

| | | | Fork Length | | | POH Length | | |
|---|---|---|---|---|---|---|---|---|
| Fall Chinook | | Count | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 8 | 645 | 612 | 679 | 511 | 474 | 551 | 14.0% |
| | 4 | 41 | 769 | 674 | 857 | 630 | 527 | 727 | 71.9% |
| | 5 | 8 | 817 | 716 | 906 | 670 | 565 | 754 | 14.0% |
| | Total | 57 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 4 | 26 | 785 | 690 | 875 | 638 | 565 | 716 | 59.1% |
| | 5 | 18 | 850 | 784 | 948 | 699 | 615 | 795 | 40.9% |
| | Total | 44 | | | | | | | 100.0% |
| 2017 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 4 | 4 | 760 | 735 | 788 | 619 | 590 | 656 | 57.1% |
| | 5 | 3 | 837 | 748 | 904 | 671 | 615 | 735 | 42.9% |
| | Total | 7 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 2 | 597 | 454 | 740 | 485 | 365 | 605 | 28.6% |
| | 4 | 4 | 769 | 740 | 795 | 640 | 600 | 680 | 57.1% |
| | 5 | 1 | 815 | 815 | 815 | 670 | 670 | 670 | 14.3% |
| | Total | 7 | | | | | | | 100.0% |
| 2018 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 2 | 1 | 420 | 420 | 420 | 334 | 334 | 334 | 8.3% |
| | 3 | 5 | 665 | 642 | 690 | 542 | 505 | 582 | 41.7% |
| | 4 | 3 | 811 | 752 | 887 | 650 | 628 | 678 | 25.0% |
| | 5 | 3 | 850 | 802 | 913 | 690 | 664 | 715 | 25.0% |
| | Total | 12 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 4 | 8 | 788 | 753 | 841 | 645 | 621 | 695 | 72.7% |
| | 5 | 3 | 872 | 820 | 947 | 700 | 660 | 749 | 27.3% |
| | Total | 11 | | | | | | | 100.0% |
| 2019 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 3 | 637 | 560 | 685 | 526 | 450 | 583 | 16.7% |
| | 4 | 14 | 763 | 643 | 882 | 629 | 545 | 715 | 77.8% |
| | 5 | 1 | 812 | 812 | 812 | 679 | 679 | 679 | 5.6% |
| | Total | 18 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 2 | 617 | 603 | 630 | 505 | 500 | 510 | 33.3% |
| | 4 | 3 | 808 | 779 | 825 | 664 | 654 | 680 | 50.0% |
| | 5 | 1 | 835 | 835 | 835 | 675 | 675 | 675 | 16.7% |
| | Total | 6 | | | | | | | 100.0% |
| 2020 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 4 | 615 | 498 | 692 | 498 | 388 | 566 | 11.8% |
| | 4 | 28 | 777 | 713 | 890 | 630 | 560 | 736 | 82.4% |
| | 5 | 2 | 880 | 875 | 884 | 723 | 713 | 733 | 5.9% |
| | Total | 34 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 1 | 597 | 597 | 597 | 468 | 468 | 468 | 2.7% |
| | 4 | 35 | 780 | 695 | 884 | 618 | 495 | 692 | 94.6% |
| | 5 | 1 | 812 | 812 | 812 | 672 | 672 | 672 | 2.7% |
| | Total | 37 | | | | | | | 100.0% |

**Table 13. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for fall Chinook captured in the Lyle Falls adult trap in 2016-2020.**

| | | | Fork Length | | | POH Length | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fall Chinook | | Count | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 3 | 663 | 650 | 685 | 544 | 507 | 572 | 13.6% |
| | 4 | 12 | 796 | 692 | 862 | 678 | 610 | 740 | 54.5% |
| | 5 | 7 | 831 | 673 | 922 | 707 | 562 | 805 | 31.8% |
| | Total | 22 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 2 | 642 | 638 | 645 | 524 | 510 | 537 | 9.1% |
| | 4 | 14 | 790 | 722 | 854 | 670 | 610 | 725 | 63.6% |
| | 5 | 6 | 852 | 815 | 890 | 723 | 685 | 765 | 27.3% |
| | Total | 22 | | | | | | | 100.0% |
| 2017 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 2 | 2 | 478 | 462 | 494 | 395 | 394 | 395 | 3.6% |
| | 3 | 3 | 608 | 551 | 642 | 505 | 449 | 545 | 5.5% |
| | 4 | 35 | 776 | 690 | 895 | 643 | 563 | 766 | 63.6% |
| | 5 | 15 | 856 | 735 | 970 | 716 | 635 | 785 | 27.3% |
| | Total | 55 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 2 | 4 | 439 | 417 | 480 | 374 | 345 | 400 | 6.0% |
| | 3 | 4 | 636 | 585 | 693 | 521 | 462 | 581 | 6.0% |
| | 4 | 41 | 776 | 625 | 890 | 640 | 490 | 738 | 61.2% |
| | 5 | 18 | 863 | 792 | 973 | 713 | 650 | 832 | 26.9% |
| | Total | 67 | | | | | | | 100.0% |
| 2018 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 11 | 623 | 573 | 691 | 498 | 452 | 552 | 15.9% |
| | 4 | 46 | 700 | 600 | 841 | 570 | 480 | 684 | 66.7% |
| | 5 | 12 | 836 | 742 | 912 | 665 | 593 | 724 | 17.4% |
| | Total | 69 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 2 | 2 | 440 | 409 | 470 | 329 | 293 | 365 | 5.1% |
| | 3 | 3 | 472 | 445 | 485 | 384 | 370 | 395 | 7.7% |
| | 4 | 28 | 744 | 645 | 836 | 599 | 507 | 665 | 71.8% |
| | 5 | 6 | 854 | 800 | 943 | 702 | 665 | 774 | 15.4% |
| | Total | 39 | | | | | | | 100.0% |
| 2019 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 20 | 641 | 450 | 681 | 520 | 370 | 560 | 21.5% |
| | 4 | 61 | 786 | 654 | 910 | 640 | 531 | 762 | 65.6% |
| | 5 | 12 | 836 | 805 | 892 | 691 | 660 | 731 | 12.9% |
| | Total | 93 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 24 | 652 | 580 | 713 | 535 | 460 | 611 | 46.2% |
| | 4 | 25 | 737 | 641 | 865 | 607 | 445 | 719 | 48.1% |
| | 5 | 3 | 848 | 786 | 932 | 697 | 639 | 771 | 5.8% |
| | Total | 52 | | | | | | | 100.0% |
| 2020 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 3 | 707 | 675 | 745 | 553 | 520 | 580 | 20.0% |
| | 4 | 10 | 806 | 730 | 892 | 644 | 590 | 700 | 66.7% |
| | 5 | 2 | 868 | 790 | 945 | 698 | 640 | 755 | 13.3% |
| | Total | 15 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 4 | 25 | 788 | 665 | 900 | 629 | 525 | 740 | 86.2% |
| | 5 | 4 | 924 | 805 | 1002 | 749 | 644 | 876 | 13.8% |
| | Total | 29 | | | | | | | 100.0% |

**Table 14. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for coho recovered on spawning ground surveys in the Klickitat River in 2016-2020.**

| | | | Fork Length | | | POH Length | | | |
|---|---|---|---|---|---|---|---|---|---|
| Coho | | Count | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 16 | 694 | 514 | 762 | 559 | 433 | 619 | 100.0% |
| | Total | 16 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 2 | 630 | 551 | 708 | 508 | 440 | 576 | 100.0% |
| | Total | 2 | | | | | | | 100.0% |
| 2017 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 3 | 678 | 598 | 720 | 543 | 463 | 590 | 100.0% |
| | Total | 3 | | | | | | | 100.0% |
| 2018 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 2 | 633 | 630 | 635 | 494 | 485 | 503 | 100.0% |
| | Total | 2 | | | | | | | 100.0% |
| 2019 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 11 | 661 | 565 | 720 | 520 | 445 | 581 | 100.0% |
| | Total | 11 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 1 | 727 | 727 | 727 | 566 | 566 | 566 | 100.0% |
| | Total | 1 | | | | | | | 100.0% |
| 2020 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 3 | 620 | 586 | 648 | 495 | 475 | 534 | 100.0% |
| | Total | 3 | | | | | | | 100.0% |

**Table 15. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for coho captured in the Lyle Falls adult trap in 2016-2020.**

| | | | Fork Length | | | POH Length | | | |
|---|---|---|---|---|---|---|---|---|---|
| Coho | | Count | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 51 | 682 | 543 | 845 | 566 | 455 | 673 | 100.0% |
| | Total | 51 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 3 | 678 | 555 | 794 | 582 | 465 | 682 | 100.0% |
| | Total | 3 | | | | | | | 100.0% |
| 2017 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 105 | 648 | 450 | 809 | 538 | 362 | 710 | 100.0% |
| | Total | 105 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 10 | 630 | 570 | 723 | 515 | 442 | 592 | 100.0% |
| | Total | 10 | | | | | | | 100.0% |
| 2018 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 2 | 2 | 427 | 412 | 442 | 342 | 324 | 359 | 1.8% |
| | 3 | 109 | 662 | 525 | 785 | 526 | 400 | 669 | 98.2% |
| | Total | 111 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 2 | 645 | 627 | 662 | 528 | 514 | 541 | 100.0% |
| | Total | 2 | | | | | | | 100.0% |
| 2019 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 61 | 670 | 555 | 802 | 529 | 441 | 672 | 100.0% |
| | Total | 61 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 6 | 642 | 573 | 675 | 527 | 441 | 583 | 100.0% |
| | Total | 6 | | | | | | | 100.0% |
| 2020 | | | | | | | | | |
| | Ad Clipped | | | | | | | | |
| | 3 | 8 | 703 | 652 | 767 | 538 | 497 | 583 | 100.0% |
| | Total | 8 | | | | | | | 100.0% |
| | Unmarked | | | | | | | | |
| | 3 | 2 | 679 | 600 | 758 | 538 | 483 | 593 | 100.0% |
| | Total | 2 | | | | | | | 100.0% |

**Table 16. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for steelhead recovered on spawning ground surveys in the Klickitat River in 2016-2020.**

| | | Fork Length | | | POH Length | | | |
|---|---|---|---|---|---|---|---|---|
| Steelhead | Count | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | |
| Unmarked | | | | | | | | |
| 3 | 2 | 596 | 596 | 596 | 495 | 495 | 495 | 66.7% |
| 4 | 1 | | | | | | | 33.3% |
| Total | 3 | | | | | | | 100.0% |

**Table 17. Scale ages by return year and mark with mean, minimum, and maximum fork lengths and postorbital-hypural lengths for steelhead captured in the Lyle Falls adult trap in 2016-2020.**

| Steelhead | | Count | Fork Length | | | POH Length | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | Min | Max | Mean | Min | Max | % of Total |
| 2016 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | 2 | 4 | 627 | 585 | 651 | 536 | 500 | 564 | 3.1% |
| | 3 | 88 | 708 | 625 | 805 | 607 | 540 | 690 | 69.3% |
| | 4 | 32 | 752 | 660 | 892 | 640 | 560 | 745 | 25.2% |
| | 5 | 3 | 861 | 780 | 920 | 726 | 665 | 787 | 2.4% |
| | Total | 127 | | | | | | | 100.0% |
| Unmarked | | | | | | | | | |
| | 2 | 2 | 557 | 534 | 580 | 465 | 460 | 470 | 2.2% |
| | 3 | 42 | 693 | 580 | 890 | 583 | 470 | 743 | 46.2% |
| | 4 | 42 | 733 | 620 | 855 | 622 | 520 | 734 | 46.2% |
| | 5 | 5 | 757 | 662 | 830 | 639 | 560 | 695 | 5.5% |
| | Total | 91 | | | | | | | 100.0% |
| 2017 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | 2 | 5 | 601 | 564 | 643 | 503 | 455 | 547 | 6.7% |
| | 3 | 33 | 668 | 570 | 748 | 563 | 450 | 629 | 44.0% |
| | 4 | 36 | 770 | 594 | 876 | 644 | 498 | 743 | 48.0% |
| | 5 | 1 | 912 | 912 | 912 | 779 | 779 | 779 | 1.3% |
| | Total | 75 | | | | | | | 100.0% |
| Unmarked | | | | | | | | | |
| | 2 | 4 | 526 | 402 | 591 | 434 | 330 | 492 | 5.6% |
| | 3 | 38 | 645 | 557 | 738 | 534 | 453 | 652 | 53.5% |
| | 4 | 29 | 734 | 611 | 861 | 604 | 510 | 747 | 40.8% |
| | Total | 71 | | | | | | | 100.0% |
| 2018 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | 2 | 2 | 475 | 364 | 585 | 386 | 300 | 471 | 1.7% |
| | 3 | 19 | 683 | 561 | 763 | 565 | 451 | 675 | 15.8% |
| | 4 | 95 | 735 | 661 | 825 | 606 | 542 | 686 | 79.2% |
| | 5 | 4 | 818 | 740 | 884 | 660 | 590 | 720 | 3.3% |
| | Total | 120 | | | | | | | 100.0% |
| Unmarked | | | | | | | | | |
| | 2 | 1 | 334 | 334 | 334 | 273 | 273 | 273 | 0.9% |
| | 3 | 37 | 619 | 409 | 740 | 509 | 325 | 618 | 33.0% |
| | 4 | 67 | 720 | 600 | 881 | 592 | 475 | 749 | 59.8% |
| | 5 | 7 | 785 | 700 | 910 | 635 | 560 | 720 | 6.3% |
| | Total | 112 | | | | | | | 100.0% |
| 2019 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | 3 | 11 | 680 | 570 | 764 | 563 | 455 | 645 | 10.8% |
| | 4 | 87 | 704 | 634 | 803 | 579 | 510 | 670 | 85.3% |
| | 5 | 3 | 804 | 704 | 859 | 658 | 593 | 702 | 2.9% |
| | 6 | 1 | 840 | 840 | 840 | 681 | 681 | 681 | 1.0% |
| | Total | 102 | | | | | | | 100.0% |
| Unmarked | | | | | | | | | |
| | 3 | 14 | 637 | 534 | 725 | 513 | 427 | 605 | 17.1% |
| | 4 | 53 | 707 | 625 | 850 | 578 | 505 | 698 | 64.6% |
| | 5 | 15 | 759 | 643 | 861 | 624 | 524 | 760 | 18.3% |
| | Total | 82 | | | | | | | 100.0% |
| 2020 | | | | | | | | | |
| Ad Clipped | | | | | | | | | |
| | 3 | 17 | 708 | 662 | 765 | 572 | 535 | 615 | 44.7% |
| | 4 | 20 | 723 | 650 | 815 | 588 | 520 | 650 | 52.6% |
| | 5 | 1 | 749 | 749 | 749 | 598 | 598 | 598 | 2.6% |
| | Total | 38 | | | | | | | 100.0% |
| Unmarked | | | | | | | | | |
| | 3 | 8 | 695 | 570 | 756 | 561 | 455 | 615 | 16.7% |
| | 4 | 37 | 704 | 617 | 811 | 573 | 498 | 662 | 77.1% |
| | 5 | 3 | 800 | 754 | 826 | 678 | 653 | 721 | 6.3% |
| | Total | 48 | | | | | | | 100.0% |