# Spatial distribution of Chinook Salmon (*Oncorhynchus tshawytscha*) spawning in the Elwha River, Washington State during and after dam removal (2012-2025)

Chinook Redd entrance Grand Canyon of the Elwha. Photo: Katie Furey


Authors: Mike McHenry[1], George Pess[2] and Joe Anderson[3]

1. Lower Elwha Klallam Tribe, 760 Stratton Road, Port Angeles, WA 98363

2. Pess Consulting, 10333 44th Ave. NE, Seattle, WA 98125

3. Washington Department of Fish and Wildlife, PO Box 43200, Olympia, WA 98504-3200

## Executive Summary

We assessed the spatial distribution of adult Chinook salmon spawning in reaches of the Elwha River and selected tributaries from 2012 to 2025, a period in which two hydroelectric dams were removed and migratory access restored. Chinook salmon redds were located by visual surveys conducted near the peak of spawn timing in mid-to-late September. During the project the total number of Chinook redds has varied from a low of 495 in 2021 to a high of 1,673 in 2019. In 2025 a total of 867 Chinook redds and 1,734 adults (1,360 live/374 dead) were observed during peak spawning surveys in 2025. Like previous years the majority of redds were again located in the Middle Elwha (55%), followed by the Lower Elwha (26%) and with a smaller percentage (8%) in the Upper Elwha. One redd was observed above Rica Canyon and a solitary adult was observed in the upper river in the vicinity of Canyon Camp. During 2025 Chinook surveys, a post project record of adult pink salmon was also observed (11,607).

Several patterns are apparent for the spatial distribution of Chinook salmon redds following dam removal on the Elwha River. The first has been the relatively low number of Chinook salmon spawning in the lower river below both former dam sites (average=26%). This is affected directly by the hatchery brood stock program that annually removes hundreds of spawners from the lower river by gaffing and netting. Second, the proportion of Chinook salmon redds observed in the Middle Elwha increased rapidly following dam removal and has consistently had the highest proportion of redds (average=65%). Finally, Chinook salmon are not utilizing Upper Elwha in significant numbers (average=8%) and of those that do the majority are spawning in the former Mills Reservoir area. Barriers to upstream migration include the Grand Canyon of the Elwha as well as a recently formed barrier in Rica Canyon. The lack of significant numbers of adult Chinook reaching upper river spawning areas is a concern to project managers with regards to meeting recovery objectives. Eleven years following the restoration of fish passage only 35% of the potential intrinsic Chinook habitat is being utilized. As a result, co-managers will reintroduce Chinook to the Upper Elwha using adult and fry outplants beginning in 2026. Additionally, funding is being sought to assess passage conditions and potential corrections in Rica Canyon.

## Introduction

The removal of two hydroelectric dams on the Elwha River represents the second largest intentional dam removal completed to date in the world. Located at river kilometer (Rkm) 7.9 and 22.0, the 32 m tall Elwha Dam (completed in 1913) and 64 m tall Glines Canyon Dam (completed in 1927) were identified for removal under the Elwha River Ecosystem and Fisheries Restoration Act of 1992 (PL 102-495). The goal of the Elwha Act is to restore the Elwha River ecosystem and associated anadromous fish populations. This is being accomplished through dam removal, sediment management, floodplain restoration, revegetation, and the

conservation and amplification of native salmon populations. The long-term goal is to establish self-sustaining, naturally spawning populations of Pacific salmon and steelhead, sufficiently abundant to support meaningful harvest, reducing and ultimately eliminating hatchery supplementation over time (Ward et al. 2008).

To help guide this process, the Elwha Monitoring and Adaptive Management (EMAM) plan was developed for federally listed populations of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) (Peters et al. 2014). This document and the Hatchery Genetic Management Plans (HGMP) for the WDFW and Tribal hatchery programs suggest the use of adaptive management targets to inform management actions for the recovery of the populations. The HGMP targets differ significantly from the EMAM targets, so for this document, "triggers" or "targets" refer to values in the EMAM unless stated otherwise. The EMAM provides performance indicators coupled with management triggers to guide project managers through four stages of recovery including: 1) preservation, 2) recolonization, 3) local adaptation, and 4) viable natural population. Performance indicators used in the EMAM are based upon the general Viable Salmon Population (VSP) metrics including abundance, productivity, spatial distribution and diversity (McElhany et al. 2000). For Elwha River Chinook salmon, abundance is estimated using SONAR (Denton et al. 2024). Productivity metrics are being assessed using a combination of abundance estimation by smolt outmigration monitoring (McHenry et al. 2024), adult to juvenile outmigrant productivity (Pess et al. 2024) and adult to adult cohort reconstruction (Weinheimer et al. 2021). Spatial distribution on the Elwha is being assessed using a combination of visual redd surveys (foot, snorkel, boat), radiotelemetry, and eDNA techniques (Laramie et al. 2015). For diversity, Chinook salmon monitoring efforts focus on adult migration timing (SONAR), the expression of stream-type juvenile life-histories and the presence of early timed genetic markers (GREB 1L) in the adult population (Prince et al. 2017).

Elwha River salmon populations were spatially limited to approximately 8.0 km of habitat below Elwha Dam for over a century. The removal of the Elwha and Glines Canyon dams has reconnected formerly occupied habitats. However, it is uncertain how quickly the re-establishment of self-sustaining spawning populations will occur. Prior to dam removal, it was predicted that Chinook salmon were expected to rehabit the Elwha upstream of Carlson Canyon at Rkm 56.0 over a period of 5 to 7 generations (DOI 1995). On the Cedar River, Washington, a much shorter river than the Elwha River, following the construction of fish passage facilities at Landsburg Dam, Chinook salmon spawned as high as 18 km above the facility the first year they were provided access, however most spawners were concentrated 6 km above the facility (Burton et al. 2013).

The spatial distribution of Chinook salmon also potentially affects other VSP parameters such as life history diversity (Beechie et al. 2006). In the Puget Sound region, Chinook salmon

populations in snowmelt-dominated areas, such as the Elwha River, typically contain a higher proportion of the stream-type life history (juvenile residence ≥1 year in freshwater) and have older age structure than Chinook Salmon populations in rainfall-dominated areas which produce primarily zero aged migrants (Beechie et al. 2006). Furthermore, in Puget Sound, the fraction of Chinook salmon genetic differentiation that can be attributed to life history characteristics is relatively small, compared to the Columbia Basin (Waples et al. 2008). This suggests a strong role for environmental conditions in stream versus ocean-type juvenile rearing strategies of Puget Sound Chinook salmon. Thus, to the extent that spawning in snowmelt dominated headwater reaches will promote stream-type life histories, documenting Chinook salmon reoccupying habitats above the dam sites on the Elwha could be the first indication of the re-expression of this suppressed life history. Based on species composition netting from the SONAR project, earlier timed (i.e. May and June) adult Chinook salmon were captured in 2020 and 2022 compared to previous years, although the overall run timing has not significantly changed (Denton et al. 2024).

Dam construction, beginning in 1910, blocked most of the spawning habitat in the Elwha River basin, including all the snowmelt dominated areas typically associated with stream-type life histories. Chinook salmon persisted in the lower river and was maintained by a large hatchery supplementation program initiated by the Washington Department of Fisheries beginning in the 1930's and maintained to the present (Winter & Crain 2008). This program uses brood stock directly descended from the remnant Elwha Chinook salmon population, with relatively minor contributions from other rivers over the years (Myers et al. 1998). While annual estimates of the proportion of hatchery-origin natural spawners (pHOS) were initially 94-97% during and immediately following dam removal (2014-2019), pHOS declined to 82-85% during 2020-2024 (Weinheimer et al. 2022, WDFW unpublished). Furthermore, average annual pHOS estimates 2020-2024 displayed a spatial pattern with lower values further upstream in the Mills (77%) and Glines to US-101 reaches (82%) than below US-101 (94%). All Elwha recovery documents have established a recovery goal of 100% natural origin spawners for a self-sustaining population of Elwha River Chinook salmon. "Rewilding" this hatchery-dominated population represents a significant challenge for the overall Elwha project.

Dam removal was initiated in the fall of 2011 and by the spring of 2012, Elwha Dam had been removed[1]. Glines Canyon Dam was removed by August 26th, 2014, and the first Chinook salmon above the Glines Canyon Dam site was reported approximately 10 days later September 9th, 2014. Several weeks later, large boulders fell from the canyon walls and created vertical drops of 3-4 m through the entrance to Glines Canyon. It was feared, and later confirmed, that these

[1] During extreme low flows of 2015 it was discovered that the base of Elwha Dam along with a caisson constructed after the initial dam failed in 1912 had not been removed. Project managers are currently assessing options for potentially removing the caisson in the future.

boulders created blockages to upstream migrating salmon. In the fall of 2015 and 2016, selective blasting was conducted to reduce vertical drops and increase effective stream width through the rock fall. Those treatments have been mostly successful, and all salmon species have been documented passing through Glines Canyon. Between 2016-2019 moderate numbers of Chinook were observed in the Geyser Valley upstream of Rica Canyon. However, the upstream progression of Chinook in the upper Elwha was halted beginning in 2020 and very few redds or adults have been observed in Geyser Valley or the upper Elwha since. A low flow habitat survey of Rica Canyon conducted by ONP biologists revealed the presence of a series of two hydraulic jumps that limits the upstream extent of observed redds and adults (Connor 2022).

In order to collect information on the spatial extent of Chinook salmon spawning, biologists from the Washington Department of Fish and Wildlife (WDFW), Lower Elwha Klallam Tribe (LEKT), Olympic National Park (ONP), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), and United States Geological Survey (USGS) initiated a one-day, peak spawning survey event in 2012. This survey event was repeated in 2013 and focused on the areas downstream of Glines Canyon Dam. In 2014-25 additional surveys, primarily snorkel based, were conducted in Geyser Valley and upstream of the Grand Canyon of the Elwha to ascertain Chinook salmon passage at Glines Canyon and to document the reutilization of habitat by Chinook salmon. This report summarizes those survey efforts as our objectives were to; 1) map the spatial distribution of Chinook salmon redds, 2) calculate the density of Chinook salmon redds by river kilometer (Rkm), and to compare the relative distribution of spawning Chinook salmon within and between years.

**Methods**

One-day to five-day spawning ground surveys of the mainstem Elwha River, larger floodplain channels, and several major tributaries were conducted in mid-September from 2012 to 2025 in the Elwha watershed. Survey timing was based on the estimated contemporary date of peak spawning activity for Elwha River Chinook salmon, approximately September 15 - September 25 (WDFW Unpublished Data). For purposes of the survey, the Elwha River was divided into three broad sections. The Lower Elwha (LE) was defined as the area downstream of Elwha Dam (Rkm 0.0-6.6). The Middle Elwha (ME) includes the reach immediately above the former Elwha Dam, including the former Aldwell Reservoir, upstream to the former Glines Canyon Dam (Rkm 6.6-19.6). Lastly the Upper Elwha (UE) is defined as the reach above Glines Canyon Dam, including the former Mills Reservoir, Cat and Boulder creeks, upstream to Chicago Camp (Rkm 19.6-63.4)[2]. The Lower Elwha[3] and Middle Elwha were surveyed in all years. Supplemental surveys

[2] The actual upper end of survey has varied by years. Please consult Figures 3-15 to determine that end by year.
[3] Lower Elwha surveys were unsuccessful in 2012 and partially successful in 2013 due to elevated turbidity.

were conducted in the UE beginning in 2014, and the UE was surveyed more consistently beginning in 2016. The upper extent of the UE surveys varied among years due to logistical constraints, see footnotes in Tables 9-18 for details. We did not generally survey any of the major canyon areas of the Elwha River during peak surveys except for Rica Canyon in 2014 (lower 1.6 km), 2015 and 2022 (entirety), Carlson Canyon in 2020, and the lower 1.6 km of the Grand Canyon in 2022 and 2025. Additionally, no Chinook surveys have occurred to date in larger tributaries upstream of the Grand Canyon.

Each survey reach was originally partitioned using local geographic features or place names that have an associated River Kilometer (Rkm) (Table 1). These reaches were consolidated in 2015-2025 to simplify data collection (Tables 2 & 3). Individual reach surveys were assigned to two person crews consisting of biologists and biological technicians from the Lower Elwha Klallam Tribe (LEKT), Olympic National Park (ONP) and Washington Department of Fish and Wildlife (WDFW). Additional support was also provided by staff from the United States Fish and Wildlife Service (USFWS), National Oceanographic and Atmospheric Administration (NOAA), Trout Unlimited (TU), and the United States Geological Survey (USGS) in some years. Within each survey reach, two person crews conducted standard spawning ground surveys by walking from the upper end of the reach downstream to its terminus (Gallagher et al. 2007), typically with one surveyor on each side of the river. In some years observers also conducted snorkel surveys to collect observations of live Chinook salmon and associated nests (redds).

The surveyors recorded the number of Chinook salmon redds, and live and dead Chinook salmon observed within each survey reach. Opportunistic determination of the sex of live and dead Chinook salmon, jacks (precocious males), visual marks (floy tags or fin clips), as well as presence of pink, chum and sockeye salmon and steelhead was also documented. Redds were identified as disturbed areas in the stream bed where the substrate was overturned (Gallagher et al. 2007). Each redd was geo-located (latitude and longitude) using a Garmin GPS (chiefly models GPSmap 60CSx and 64s).

Flow levels, turbidity, and suspended sediment concentration levels varied each year (Table 4). Both flow and turbidity levels were highest in 2012, which limited surveys in the Lower Elwha (Table 5). In 2013, conditions improved to allow for surveys below the former Elwha Dam, and 2014 conditions allowed for a full survey from the mouth to just above former Glines Canyon dam (Table 6). Since 2014, turbidity has not influenced surveys in any reach. While it is generally true that visual survey techniques are not effective during high flows on the Elwha River because of elevated suspended sediment levels, we have identified a low-discharge, low turbidity window that corresponds to the period of peak spawning for Chinook salmon. This was particularly true in the lower Elwha during 2012 and 2013 when turbidity levels were

elevated enough through the low flow window to preclude surveys. However, over time, survey conditions have greatly improved, enhancing precision of the peak count method.

Occupancy estimates based upon Chinook salmon redd location have been quantified since 2012. The Elwha River broke into 0.1-kilometer sections, not including tributaries. Each 1/10 of a kilometer was then identified as to whether a Chinook salmon redd was in that area. The total number of occupied areas was divided by the total number of areas that could be occupied within each section of river (below the former dams, between the former dams, and above the former dams) to give a percent occupancy. We assumed the canyon areas would not be occupied for Chinook salmon spawning and those were excluded from the occupancy metric.

**Results**

The total number of observed Chinook salmon redds observed since dam removal has varied from a low of 495 in 2021 to a high of 1,673 in 2019 (Figure 2). In 2025, 867 redds were counted in the Elwha River, the 8$^{h}$ highest count since dam removal. In all years, most Chinook salmon redds were in the Middle Elwha River (ME) above the former Elwha Dam (Rkm 7.5) and just below the former Glines Canyon Dam (Rkm 21.7) (Figure 2). Abundance estimates derived from SONAR indicated that Chinook salmon abundance has ranged from a low of 2,628 (2016) to a high of over 7,600 (2019) (Figure 12) (Denton et al. 2024) over the life of the project. The 2025 preliminary abundance estimate for Chinook salmon, based on SONAR, is not currently available.

In 2012, 217 Chinook salmon redds were located, of which 203 (93.5%) were identified upstream of the former Elwha Dam[4] (Figure 3, Table 5). Fifty-two percent of the redds were located either in the mainstem ME or in the former Aldwell Reservoir area (Table 5). Forty-five percent of the Chinook salmon redds were found in Indian Creek and Little River, two Middle Elwha tributaries unaffected by dam removal turbidity effects (Figure 3). The spatial distribution of Chinook salmon redds in 2012 were clumped in three general areas Rkm 9.8 to 12.2 (Gooseneck to Highway 101 bridge), Rkm 16.5 to 18.0 (Fisherman's Bend to Elwha Ranger Station), and the two large ME tributaries (Indian Creek and Little River) (Figure 3).

In 2013, additional survey reaches were added in the Lower Elwha River (LE) due to better visibility (Figure 4, Table 6). A total of 765 Chinook redds were identified, 79% (602 out of 765) of which were observed above the former Elwha Dam location (Table 6). The distribution of mainstem and tributaries changed in 2013, with most Chinook salmon redds (85%) were in the mainstem and 10% being identified in Little River, Indian Creek, and Hughes Creek collectively (Figure 4, Table 6). Nearly one quarter of the Chinook salmon redds, 27%, were 1.1 km below

[4] Low visibility from dam removal limited redd surveys in the lower river in 2012-2013.

Glines Canyon Dam in 2013. Fifty-eight percent of the Chinook salmon redds were located within 5.0 km of the Glines Canyon Dam site (Table 6). Glines Canyon Dam was still being removed in 2013 and was not passable to anadromous fish. In addition to Chinook salmon, surveyors reported one pink salmon and three sockeye upstream of Elwha Dam. Below the former Elwha Dam site, Chinook salmon spawning activity was only documented upstream of Rkm 3.9 due to deteriorating visibility in the reaches further downstream. The reach from the Highway 112 Bridge to the weir at Rkm 5.5 had the second highest density of Chinook salmon redds recorded in the survey (Figure 4, Table 6).

In 2014, visibility was excellent and survey reaches from the previous year were used to conduct a river wide survey. A total of 1,310 Chinook salmon redds were located and identified, of which 62% (811 out of 1,310) were in the middle Elwha, upstream of the Elwha Dam and below the former Glines Canyon Dam). The distribution of mainstem vs. tributaries changed again in 2014 relative to the two previous years: 95% of the Chinook salmon redds were in the mainstem, while only 7% were identified in Little River, Indian Creek, and Hughes Creek (Figure 5, Table 7). Only one redd was observed in Little River. The low number was likely a result of low attraction flows, as the mouth of Little River joined the Elwha River across a broad gravel bar that had flow only several centimeters deep. Over one quarter of the Chinook salmon redds in the middle Elwha (30%) of 812) were in the 1.1 km immediately below Glines Canyon Dam in 2014, while over 60% (61%) of the Chinook salmon redds were located within 5.0 km downstream of the Glines Canyon Dam site (Figure 5, Table 7).

Glines Canyon Dam was still being removed in 2014, a process that was not complete until August 26th. However, it should be noted that small numbers of Chinook salmon were observed above Glines Canyon in 2014. During the first week of September, Mel Elofson, a member and employee of the Lower Elwha Klallam Tribe, reported seeing a Chinook salmon just above the Glines Canyon site. On September 9, ONP staff snorkeled from Rica Canyon downstream to the Glines Canyon Dam and visually identified 3 adult Chinook salmon. A subsequent survey on September 22 identified a single Chinook salmon redd and 4 adult Chinook. On September 15 and 30, two additional Chinook salmon snorkel/redd surveys were conducted in Geyser Valley, and no Chinook salmon or Chinook salmon redds were located. On October 7, one additional survey was conducted from Rica Canyon to Glines Canyon and 1 adult Chinook was observed. It should be noted that a citizen reported to ONP staff observing a Chinook salmon near Elkhorn Ranger Station (Rkm 40.4).

In 2014, below the former Elwha dam site, Chinook salmon spawning activity was continuous and documented in all reaches (Table 7). This contrasted with 2012 and 2013, when at least four reaches had been surveyed without any redd observations. Over 38% of all Chinook salmon redds observed in 2014 were found below the former Elwha dam site, making it the

highest number and percentage of Chinook salmon redds below the dam since dam removal (Figure 5, Table 7).

In 2015, visibility was again excellent, and surveys from the previous year were used to conduct a river wide survey (Figure 6, Table 8). We counted 366 live and 387 dead Chinook adults of which 82% and 94% were located upstream of the former Elwha Dam site. A total of 937 Chinook salmon redds were located and identified, of which 77% (719 out of 937) were in the middle Elwha (Figure 6, Table 8). The trend toward mainstem spawning preference continued, with 90% of the Chinook salmon redds located in the mainstem habitats, while only 12% were identified in Little River, Indian Creek, and Hughes Creek (Figure 6, Table 8). The 1.1 km reach immediately below Glines Canyon remained among the highest density reaches in the middle Elwha, though at a lower density than previous years (Figure 6, Table 8). No Chinook redds were documented above Glines Canyon, and only one adult Chinook was observed during a late August snorkel survey.

We also made observations of pink salmon adults during the 2015 survey. A total of 80 live and 27 dead pink salmon adults were observed during the survey. Of these the majority (68%) were located above the former Elwha Dam site. Furthermore 77% of the pink salmon adults were observed in Little River, Indian and Hughes Creek. This was the first documented return of pink salmon adults to the middle river tributaries and was likely the first significant return of pink salmon above the former Elwha Dam site.

In 2016, despite an apparent reduction in total escapement, the spatial extent of Chinook salmon spawning was the greatest observed since survey efforts began in 2012 (Figure 7, Table 9). Of the 614 redds, 95% were in mainstem habitats. Over 90% of the total redds observed were located above Elwha Dam and the first significant numbers (58) of redds were observed above Glines Canyon. Chinook redds were also observed in lower Boulder Creek (8) and in Cat Creek (2) for the first time. A single Chinook salmon redd was observed in the upper Elwha River just below the confluence with Godkin Creek (Rkm 57.8) during upriver surveys (to Rkm 61.6) by ONP personnel (Figure 7). While no Chinook adults were observed above the Grand Canyon during the mid-September surveys, one live Chinook was observed above Grand Canyon during a late August snorkel survey, and 1 live and 3 carcasses were observed during a late September carcass survey in Geyser Valley. We also did not observe a high density of redds immediately below Glines Canyon as in past years. This would suggest that passage conditions for Chinook salmon were improved in 2016 compared to 2015.

In 2017, the spatial distribution of Chinook salmon redds was like that observed in 2016 (Figure 8, Table 10). The total number of redds located was 767, a 20% increase over 2016. Of the total redds, 94% were in mainstem habitats. A total of 523 (68%) redds were observed in the ME, and 192 (25%) redds were observed in the LE. In the UE, we observed 52 (7%) total redds

and of these, 92% were in the former Mills Reservoir including the lower portions of Cat and Boulder Creeks. Only two redds were observed above the Grand Canyon of the Elwha, both in the vicinity of the confluence of Lost Creek, at Rkm 43.0. Surveyors also observed two live Chinook salmon, and possibly one more, in this reach. Two redds were observed in Geyser Valley along with 8 live Chinook and 1 carcass. We also made observations of pink salmon adults during the 2017 season. Thirty-eight live pink salmon were reported during the surveys, and all were in the middle Elwha. Ninety-two percent of the pink salmon were observed in Little River and Indian Creek.

In 2018, the second highest number of Chinook redds were observed since the beginning of the project (Figure 9, Table 11). The peak count of 1,601 redds was over two times greater than the average count since 2012. Of the total redds 84% were in mainstem habitats. Proportionally, the greatest number of redds were observed in the ME (57%), followed by the LE (30%), and the UE (13%). The 211 redds observed in the UE was the greatest observed since fish passage was reestablished in 2016. It should be noted that a total of 1,000 adult Chinook salmon were relocated from lower river hatcheries to a release point at the entrance of Glines Canyon. The distribution of Chinook redds in the UE was heavily skewed to the former Mills Reservoir and only 11 and 5 redds were observed in the Geyser Valley and above Grand Canyon, respectively. The most upstream redd was located above the confluence with Hayes River at Rkm 49.5, and the highest observed adult (a female) was observed on that redd. Six adults total were observed above the Grand Canyon. Surveyors also reported 5 sockeye salmon adults with confirmed spawning (3 redds) in the former Mills Reservoir. Due to a surplus of hatchery Chinook salmon, a total of 1,000 adults (887 males/113 females) were relocated to a release point below the former Glines Powerhouse (Rkm 19.2). Those fish were visibly marked using colored Spaghetti tags. Relocated fish were observed on spawning ground surveys both upstream and downstream of their release point. Of the 358 adult Chinook observed upstream of Glines Canyon, 44 (12%) were confirmed to have tags.

In 2019, the highest total number (1,673) of Chinook redds were observed since the beginning of the project (Figure 10, Table 12), slightly eclipsing the total for 2018 (1,601). Of the total redds observed 78% were observed in mainstem habitats. Proportionally, the greatest number of redds were observed in the ME (66%), followed by the LE (28%), and the UE (6%). The 104 redds observed in the UE was less than half what was observed in 2018. Like 2018, 576 adult Chinook (181 males/395 females/6 jacks) were relocated from lower river hatcheries to a release point just above the ONP entrance. The distribution of Chinook redds in the UE was heavily skewed to the former Mills reservoir and its tributaries, Cat and Boulder Creeks. Only two Chinook adults and one redd were observed upstream of the Grand Canyon during snorkel surveys in early September. Of the fish observed upstream of Glines Canyon, only two with colored Spaghetti tags were observed in the former Mills area, indicating they were part of the

group moved upstream from the lower river hatcheries. Some relocated fish were observed on subsequent spawning ground surveys both upstream and downstream of their release point, however there were not enough tag recoveries to determine the effect of that action. A small number of pink salmon redds (24) was observed, with the majority in Indian Creek and former Aldwell reservoir. One pair of pink salmon was observed above Glines Canyon, near the outlet of Rica Canyon, and a peak count of 26 pink salmon were observed in mainstem river snorkel surveys between Glines Canyon and Fisherman's Bend. A total of 95 pink salmon were observed during the riverscape survey. This was the first year that pink salmon have been observed above the former Glines Canyon Dam site.

In 2020, the number of Chinook redds observed was the third lowest since the inception of the project (Figure 11, Table 13). A total of 625 redds were counted with the majority (52.6%) in the middle Elwha, followed by the lower Elwha (30.4%) and upper Elwha (16.9%). Of the total redds observed, 83% were in mainstem habitats. We observed three discrete areas of high Chinook redd density including the reach from the Highway 112 Bridge downstream to the Elwha River Road Bridge, Indian Creek, and the former Mills Reservoir surface. Although the total number of redds was low, the percentage that spawned above the former Glines Canyon site was the highest to date (16.9%). Those Chinook that ascended above Glines Canyon spawned on the former Mills Reservoir surface as well in Cat and Boulder Creeks. No adult Chinook or redds were observed upstream of Rica Canyon in 2020.

In 2021, the number of Chinook redds observed was the lowest since the inception of the project (Figure 12, Table 14). A total of 495 redds were counted with the majority (65.9%) in the ME, followed by the LE (17.9%) and Upper Elwha River (UE) (16.2%). Of the total redds observed, 67% were in mainstem habitats. No adult Chinook salmon or redds were observed upstream of Rica Canyon for the second consecutive year. However, the proportion of redds in the UE increased for the second consecutive year. Three areas of relatively high Chinook salmon redd density were observed in 2021: Fisherman's Bend area in the middle Elwha, and Indian and Boulder Creeks (Figure 13), the latter of which had the highest redd density of all reaches surveyed. A total of 1,246 pink salmon were also counted, the largest number observed in the Elwha since the early 1960's. Pink salmon were observed in the majority of reaches from the lower river extending to the entrance to Rica Canyon at Cat Creek. The highest abundance of pink salmon was in Little River in 2021 (198 total).

In 2022, the number of Chinook redds observed was 987, a 50% increase over the low number observed in 2021 (Figure 13, Table 15). Of the total redds observed, 90% were in the mainstem. Once again, the majority were observed in the ME (63.2%) followed by the LE (28.1%) and UE (8.6%). Areas of highest redd density included downstream of Glines powerhouse, the Elwha Ranger Station Reach, the former Aldwell reservoir, and Indian Creek.

No adult Chinook salmon or redds were observed upstream of Rica Canyon for third consecutive year. A habitat survey conducted within Rica Canyon identified a potential low flow barrier in the upper portions of Rica Canyon and no Chinook salmon were observed upstream of that point in 2022 (Connor 2022), although Chinook were observed immediately below the presumed barrier.

In 2023, the total number of redds observed was 806 (Figure 14, Table 16). The majority of redds were, again, located in the ME (59%), followed by the LE (23.1%) and the UE (17.9%). Areas of highest redd density were the former Mills reservoir, downstream of the Glines powerhouse, below Altaire, and Indian Creek. Three large (approx. 1.2 m in length or larger) adult Chinook salmon were observed above Rica Canyon (2 males in Geyser Valley, Rkm 31, and 1 female near Hayes River, Rkm 50); a single redd was in the vicinity of Mary's Fall Camp (Rkm 36.2). A project record of 3,165 pink salmon were observed during the surveys with a notable 1,032 observed in Little River. Pink salmon were widely observed in the mainstem from the lower River to the entrance of Rica Canyon.

In 2024, the total number of redds observed was 976 (Figure 15, Table 17). This is the 5$^{th}$ highest number observed over the period of the project. The majority of redds were, once again, in the ME (55%), followed by the LE (37%) and the UE (8%). A single redd was observed upstream of Rica Canyon in 2025 in the lower Grand Canyon and a lone adult observed in the upper watershed near Canyon Camp. The areas of highest redd density were generally in the ME.

In 2025, the total number of redds observed was 867 (Figure 16, Table 18). This is the 7$^{th}$ highest number observed over the period of the project. The majority of redds were, once again, in the ME (55%), followed by the LE (37%) and the UE (8%). A single redd was observed upstream of Rica Canyon in 2025 in the lower Grand Canyon and a lone adult observed in the upper watershed near Canyon Camp. The areas of highest redd density were observed in two mainstem reaches: 1) Elwha Dam to Highway 112 Bridge, and 2) Elwha Ranger Station to Hughes Creek. A new project record of 11,607 adult pink salmon were observed during the survey.

At present, redd density levels above Rkm 30.0 are still quite low in comparison to the rest of the Elwha River. Examination of redd occupancy (presence of at least one redd in each tenth of a Rkm), excluding the canyon areas where few surveys have been conducted, reveals that 2018 and 2019 had the highest level of occupancy between and above the former dam locations (Figure 18). However, only one Chinook salmon redd was observed above Rica Canyon in 2025. Only two redds have been observed above Rica Canyon since 2020 (2023 and 2025). A total of 11 Chinook salmon redds have been observed in the upper Elwha since access was restored in 2014. Chinook salmon redd occupancy exhibited three clear patterns across the time series.

First, redd occupancy in the upper Elwha was substantially lower than the lower and middle Elwha in all years. Second, the middle Elwha had the highest redd occupancy in all years except 2013 and 2019. Third, redd occupancy across all reaches was higher in high abundance years, notably 2018 and 2019.

The early stages of pink salmon recovery were also documented in this survey. Pink salmon (107) were first documented above Elwha Dam in 2017. In 2017, 38 pink salmon were observed in Little River and Indian Creek. In 2019, pink salmon were observed upstream of Glines Canyon and the population continues to expand with 1,246, 3,165, and 11,607 observed in 2021, 2023, and 2025, respectively.

**Discussion**

We conducted annual peak spawning ground surveys for Elwha River Chinook salmon during dam decommissioning (2012-2014) and the early stages of recolonization (2015-2025). These surveys were designed to provide information on the spatial distribution of Chinook salmon spawning nest locations as access to historic habitats was restored. The surveys were not intended to enumerate the total number of Chinook salmon returning to the Elwha River and that effort is being measured using SONAR (Figure 20).

In 2012, the proportion of Chinook salmon redds in the ME was evenly distributed between the mainstem and tributary habitat. The two major ME tributaries, Indian Creek and Little River, which enter on opposite sides of the Elwha River at Rkm 11.5, are the first clear water refugia above the former Elwha dam site and newly exposed former Aldwell Reservoir (Figure 3). Two other areas of concentrated Chinook salmon spawning activity were Rkm 16.9 to 17.5 (Elwha Ranger Station/Hughes Creek) and Rkm 6.6 to 11.2 (former Aldwell reservoir) (Figure 3). Within the ME is one of several anastomosing (forested island) reaches, a habitat type where higher occurrence of Chinook salmon spawning activity has been documented in other studies due to local hydraulic conditions that promote upwelling (Vronskiy 1972, Vronskiy et al. 1991, Geist 2000, Beechie and Imaki 2014). However, it should also be noted that the Aldwell reach was immediately upstream of Elwha Dam and therefore the closest spawning habitat for returning adults, which may select spawning sites according to distance upstream from former barriers (Kiffney et al. 2008, Pess et al. 2012). The reach also had two large tributaries that provided refuge from elevated turbidity caused by dam removal.

The distribution of Chinook salmon redds was more extensive beginning in 2013 (Figure 4), as redds were observed in each survey reach above the former Elwha dam site, and the density in each reach was similar or higher than observed in 2012 (Tables 4 & 6). Unlike 2012, most Chinook salmon redds were in the mainstem ME rather than the tributaries. This difference in distribution was hypothesized to occur for three primary reasons. First, turbidity levels in the LE

were lower at the time of the survey in 2013 than 2012 (Table 4). Second, connectivity between Little River, Indian Creek, and the mainstem was reduced in 2013 due to the development of mainstem gravel bars at the confluence of each tributary. Lastly and most importantly, between September 2012 and September 2013, there was a large increase in the amount of sediment released from the former Mills reservoir (Warrick et al. 2015), a process that increased the quantity and quality of Chinook salmon spawning habitat in the mainstem ME.

In 2012, the mainstem ME did not markedly change in terms of sediment load and channel characteristics because most of the sediment released by October of 2012 came from the former Elwha dam site (Warrick et al. 2015). Thus, the major changes in 2012 occurred below the former Elwha dam (East et al. 2015). However, between October 2012 and September 2013 large scale geomorphic changes occurred in the ME due to the substantial increase in sediment flux from the former Lake Mills delta, which was fully prograded to Glines Canyon and released ~ 8.9 million tons of sediment (Warrick et al. 2015). During that period, the entire river aggraded due to an order of magnitude increase in bedload material (Warrick et al. 2015). The bedload increase resulted in an increased riffle crest and channel thalweg elevation and bar formation. Substrate size in the ME also decreased 16-fold due to the influx of sand and gravel, and the density of mainstem channels increased (East et al. 2015). Prior to dam removal, the middle Elwha was characterized by cobble and boulder sized substrates greater than 64 mm (East et al. 2015), and so the reduction in substrate size may have improved Chinook salmon spawning habitat quality. Much of this change occurred within the first 5 km downstream of the former Glines Canyon dam site (Figure 5), an area of high spawning density in 2013 and 2014 (Tables 6 and 7) (Figure 2).

In the fall of 2014, Glines Canyon Dam was in the final stages of removal during the bulk of the Chinook salmon migration, a process that was not complete until August 26th. The first Chinook salmon were observed in the former Mills Reservoir only 10 days after dam removal was completed and 3 redds were observed. Chinook migration above Glines Canyon was inhibited in 2015 because of a rock fall shortly following dam removal in 2014. This blockage was subsequently blasted in the fall of 2015, but too late to allow upstream migration in the 2015 spawning year. Additional blasting was conducted in 2016 and those efforts appear to have been successful at improving passage conditions (at least for Chinook). One of the Elwha project goals was to provide fish passage for all species of salmonids (DOI 1995) and migration through the former Glines Canyon dam site was a concern in the early years of the project. It has now been documented that all species of Pacific salmon have been documented upstream of the former Glines Canyon dam site. Additionally, in 2016, the spatial distribution of redds advanced upstream as the first significant number of redds was observed above Glines Canyon.

The 2016-2025 Chinook salmon spawner surveys were the most spatially extensive Chinook survey efforts to date. The distribution of Chinook salmon redds observed in this period is likely due to the combination of relatively high abundance of spawners and an increase in the quantity and quality of accessible spawning habitat. Visual observations made by spawning ground surveyors indicated that the mainstem spawning habitat is now dominated by well sorted gravel deposits with minimal fine sediment. In contrast, many of the mainstem side-channels have persistent deposits of fine sediment on their channel beds (Pess et al. 2015; Peters et al. 2015).

Monitoring the spatial distribution of Chinook salmon provides insights into the reoccupancy of Chinook salmon in the Elwha River following removal of two hydroelectric dams. Immediately following dam removal, Chinook salmon volitionally migrated to habitats upstream of Elwha Dam, including Little River and Indian Creek. That upstream migration was mostly restricted through Glines Canyon until 2015, when supplemental fish passage work was conducted. In 2016-2019, the first significant numbers of Chinook ascended Glines Canyon and spawned in the upper watershed, primarily in the former Mills Reservoir. However, since 2020 few adults have been observed above Rica Canyon (Figures 19 & 21).

Between 2014-2017, environmental DNA monitoring conducted in the upper Elwha found that Chinook salmon presence was detected in decreasing frequency as one progressed upstream (Duda et al. 2020). The authors reported the presence of Chinook salmon in all four years at Mills, three of four years at Geyser Valley, two of four years at Elkhorn and one of four years at Hayes. No detections were reported at Camp Wilder (Rkm 55.1). These observations are consistent with redd and snorkel surveys in upper watershed and suggest very low numbers of Chinook above the Grand Canyon.

The lack of Chinook salmon to the headwaters may be the result of several factors. First, low densities of Chinook salmon may result in redd selection occurring in the first suitable habitat encountered by migrating females. In this case, the middle Elwha and newly exposed Mills Reservoir surface provided abundant, suitable spawning sites for early migrants immediately following dam removal. Burton et al. (2013) described this pattern for Chinook migrants immediately following installation of fish passage facilities on the Cedar River, Washington. Second, the Elwha Chinook salmon population, which is currently dominated by Hatchery Origin Recruits (HOR) which may have a high fidelity to the lower river where the WDFW hatchery (Rkm 4) is located. On the Chiwawa River, a higher proportion of hatchery female spring Chinook salmon spawned in the lower reaches of the river near acclimation release sites, while greater numbers of natural origin Chinook utilized upstream habitats (Hughes and Murdoch 2017). Under this scenario, an increasing proportion of natural-origin adult returns in future years may lead to a shift towards a more upstream spawning distribution.

A third possibility is that the Grand Canyon represents a formidable migration challenge, and the traits required to ascend it have been lost or truncated from the population. The Grand Canyon of the Elwha is the longest canyon and contains over 6.4 km of hydraulic drops (chutes, falls). Rica Canyon also presents a challenge to many migrating fish species including Chinook, and while it is shorter in length (2.5 km), it also maintains significant drops and higher velocity sections. The paucity of adult salmon observations above Rica Canyon in 2020-2025 suggested a newly formed barrier and that barrier was identified in a habitat survey of Rica Canyon (Connor 2022). The barrier consists of two bedrock cascades with hydraulic drops of approximately 1 and 3 m. The cascades lack jumping pools and appear to be a low flow barrier as no Chinook salmon were identified upstream of this point, and Chinook redds were identified immediately below the drops. It is possible that this barrier is easier for fish to ascend at the higher flows associated with snowmelt run-off (e.g. May or June) compared to the summer low flow period (e.g., August or September). We note that hundreds of summer run steelhead are holding and spawning above the Grand Canyon and likely ascending the canyons during snowmelt.

We suspect that the historic run of Chinook salmon that utilized habitats above Rica Canyon and especially the Grand Canyon likely had early run timing (e.g., May or June) due to the snowmelt dominated hydrology of these habitats. The current dominant run of returning adult Chinook salmon is July through September (Denton et al. 2024), and there is a consensus understanding that the historic spring run of Elwha Chinook salmon has been extirpated (Brannon & Hershberger 1984; Brenkman et al. 2008). Given the cooler stream temperatures in the upper Elwha, juvenile growth associated with early timing may also be a major factor for the successful occupancy of upriver habitats. It is unknown if the existing summer/fall Chinook salmon hatchery dominated population, which likely differs from the historic population, can reoccupy the Elwha River above Rica Canyon on its own.

Regardless of the precise reason, or combination of reasons, Chinook salmon have not populated the upper watershed in significant numbers in the decade since passage was restored through Glines Canyon. The Elwha Act called for the removal of the Elwha Dams and full restoration of the Elwha River Ecosystem over a period of 20-30 years. However, eleven years following the restoration of passage above Glines Canyon Dam, only 35% of potential habitat is now accessible for Chinook (essentially 4 km above Glines Canyon. As a result, project co-managers have decided to actively relocate Chinook (adults and fry) to the UE beginning in 2026. The effort will be repeated for one Chinook life cycle (5 years). Additionally, funding is being sought to assess and potentially correct fish passage issues in Rica Canyon.

Actively transporting Chinook would place more fish into suitable upriver habitats, potentially accelerating the reoccupation of the watershed. This action potentially carries the risk of undermining natural processes that may be important for adaptive evolution to upstream

habitats and ultimately spatial expansion. Conversely, the level of risk could be low in areas where Chinook salmon are currently in extremely low densities, and if progeny of adults relocated to the upper watershed are not genetically fit, they will simply not survive. It should be noted that four large natural-origin Chinook salmon cohorts migrated to sea in 2019-2021 and 2023. These progeny of hatchery adults that spawned in the wild may be more likely to reoccupy upriver habitats. Ford et al. (2015) found that natural-origin offspring of naturally spawning hatchery-origin fish in the Chiwawa River, Washington tended to spawn up to 20-30 km further upstream than their mothers. However, the first two of these four abundant Elwha outmigration cohorts completed their returns by 2024 and did not result in significant upstream expansion.

Interestingly, in recent years (2020-2025) there was some evidence from the species composition surveys for the SONAR operation of more adult Chinook returning in late May or early June compared to previous years (Denton et al. 2022). This return timing appears consistent with historic early-timed or spring run Chinook salmon entry on the Elwha (Wunderlich et al. 1993). The increase in catches of Chinook salmon in May and June did not correspond to an overall shift in the run timing though, which has not changed significantly since the start of the SONAR project in 2012. We hypothesize that exposure to the natural selection regime in the upper river and reproductive isolation from hatchery-origin fish experiencing domestication selection are important to the re-expression of the early timed Chinook salmon on the Elwha River.

Spring Chinook salmon have declined dramatically coast-wide, and research indicates a strong association between genotype at single genomic region and early migration in both steelhead and Chinook salmon (Prince et al. 2017). Thompson et al. (2018) found that on both the Klamath and Rogue Rivers, the loss of genetic variation that controlled premature migration was rapid following dam construction. Extant mature (fall) Chinook salmon populations on those rivers did not contain the premature migration genotypes at high enough frequency to prevent the complete loss the genotypes due to genetic drift. This genetic link may have significant implications to the recovery of this important early timed life history. Importantly, the Elwha River Chinook salmon population retains genotypes associated with early (spring-run) migration, and preliminary data (tempered by a low sample size) suggests an association between spring run genotypes and earlier capture dates (Personal communication, Garrett McKinney, WDFW.

**Acknowledgements**

This effort has been a multi-agency cooperative effort and would have not been possible without the assistance of many dedicated professionals over the years. The following individuals have contributed to the field surveys through the years: Sam Brenkman, Pat Crain,

Mary Commins, Heidi Connor, Kathryn Sutton, James Starr, Anna Geffre, Josh Geffre, Trevor Kumec, Katie Kierczynski, Katie Furey, Kristen Kirkby, Dylan Keel, and Phil Kennedy for ONP, Brieuc Couillerot and Alex Pavlinovic (ONP Volunteers), John McMillan (Trout Unlimited), Todd Bennett, Steve Corbett, and Martin Liermann (NOAA), Jakob Bengelink, Jeff Johnson, Roger Peters (USFWS), Randy Cooper, Joshua Weinheimer, Andrew Simmons, Lucas Young, Ryan Handeland, Steven Fredrickson, Matthew Choowong, Henry Kei, Dan Gorze, Leif Rinearson, Bethany Craig, Pete Topping, Clayton Kinsel, Pete Lisi, Adam Lindquist, Ian Anderson, Brittany Phillips, Josh Younk, Michael Scheu, Jake Eastby, Jennifer Whitney, and Chris O'Connell for WDFW, Mel Elofson, Ray Moses, Gabe Youngman, Sonny Sampson, Kim Williams, Wilson Wells, Allyce Miller, Laurel Moulton, McKenzi Taylor, Vanessa Castle, Gabe Ritchie and Keith Denton for LEKT, and Jeff Duda and Trevor Eakes for USGS. Randall McCoy (LEKT) provided GIS support and spatial distribution maps produced in this report. Technical review was provided by Keith Denton.

**References**

Anderson, J., M. Mizell, M. Ackley, M. Mayer, M. Zimmerman and P. Crain. 2015. Elwha River weir project: 2013 operations and final summary report. FPT 15-03. Washington Department of Fish and Wildlife, Olympia, WA.

Beechie, T. J., E. Buhle, M. H. Ruckelshaus, A. H. Fullerton, L. Holsinger. 2006. Hydrologic regime and the conservation of salmon life history diversity. Biological Conservation, 130(4):560-572.

Beechie, T.J., and H. Imaki. 2014. Predicting natural channel patterns based on landscape and geomorphic controls in the Columbia River basin, USA. Water Resources Research 50:1-39.

Brannon, E. L., and W. K. Hershberger. 1984. Elwha River fall Chinook salmon. J. M. Walton, and D. B. Houston, editors. Proceedings of the Olympic wild fish conference, Peninsula College, Fisheries Technology Program, Port Angeles, WA.

Brenkman, S.E., G.R. Pess, C.E. Torgerson, K.K. Kloehn, J.J. Duda, and S.C. Corbett. 2008. Predicting recolonization patterns and interactions between potadromous and anadromous salmonids in response to dam removal in the Elwha River, Washington State, USA. Northwest Science 82:91-106.

Burton, K.D., L.G. Lowe, H.B. Berge, H.K. Barnett, and P.L. Faulds. 2013. Dispersal patterns for recolonizing Cedar River Chinook salmon above Landsburg Dam, Washington and the source population below the dam. Transactions of the American Fisheries Society 142:703-716.

Connor, H. 2022. Rica Canyon: Anadromous Fish Passage Assessment Survey. Olympic National Park, 600 Park Avenue, Port Angeles, Washington.

Denton, K., McHenry, M., Moses, R., Ward, E., Liermann, M., Stefankiv, O., Wells, W., and G. Pess. 2024. 2024 Elwha River Chinook estimation based on DIDSON/ARIS multi-beam SONAR data. Report to Olympic National Park, Port Angeles, Washington.

Department of Interior (DOI). 1995. The Elwha Report: Restoration of the Elwha River ecosystem and native anadromous fisheries.

Duda, J.J., M.S. Hoy, D.M. Chase, G.R. Pess, S.J. Brenkman, M.L. McHenry, and C. O. Ostberg. 2020. Environmental DNA is an effective tool to track recolonizing migratory fish following large-scale dam removal. Environmental DNA 2020: 1-21.

East, A.E., Pess, G.R., Bountry, J.A., Magirl, C.S., Ritchie, A.C., Logan, J.B., Randle, T.J., Mastin, M.C.,Minear, J.T., Duda, J.J., Liermann, M.C., McHenry, M.L., Beechie, T.J., Shafroth, P.B., 2015. Large-scale dam removal on the Elwha River, Washington, USA: river channel and floodplain geomorphic change. Geomorphology 228: 765–786.

Ford, M.J., A. Murdoch, and M. Hughes. 2015. Using parentage analysis to estimate rates of straying and homing in Chinook salmon (Oncorhynchus tshawytscha). Molecular Ecology 24: 1109-1121.

Gallagher, S. P., Hahn, P. K., & Johnson, D. H. 2007. Redd counts. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland, 197-234.

Geist, D. R. (2000). Hyporheic discharge of river water into fall Chinook salmon (Oncorhynchus tshawytscha) spawning areas in the Hanford Reach, Columbia River. Canadian Journal of Fisheries and Aquatic Sciences, 57(8), 1647-1656.

Huges, M.S., and A.R. Murdoch. 2017. Spawning habitat of hatchery spring Chinook salmon and possible mechanisms contributing to lower reproductive success. Transactions of the American Fisheries Society 146:1006-1017.

Kiffney, P. M., G. R. Pess, J. H. Anderson, P. Faulds, K. Burton, S. Riley. 2008. Changes in fish communities following recolonization of the Cedar River, WA, USA by Pacific salmon after 103 years of local extirpation. River Research and Applications, 25(4):438-452.

Laramie, M.B., Pilliod, D.S., Goldberg, C.S., and Strickler, K.M., 2015, Environmental DNA sampling protocol—Filtering water to capture DNA from aquatic organisms: U.S. Geological Survey Techniques and Methods, book 2, chap. A13, 15 p., http://dx.doi.org/10.3133/tm2A13.

McElhany, P., M.H. Ruckleshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable Salmonid Population and the Recovery of Evolutionarily Significant Units. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-42.

McHenry, M.L., M. Elofson, M. Liermann, and G. Pess. 2024. 2024 Elwha River smolt enumeration project. Report to Olympic National Park, 600 Park Ave., Port Angeles, Washington.

Myers, J. M., R. G. Kope, G. J. Bryant, D. J. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. Lindley and R. S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-35, Seattle, WA.

Pess, G.R., M.L. McHenry, K. Denton, J.H. Anderson, M.C. Liermann, R.J. Peters, J.R. McMillan, S.J. Brenkman, T.R. Bennett, J.J. Duda and K.M. Hanson. 2024. Initial responses of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) to removal of two dams on the Elwha River, Washington State, USA. Frontiers in Ecology and Evolution DOI10.3389/fevo2024.1241028

Pess, G.R., M.C. Liermann, T. R. Bennett, T.J. Beechie, and M. McHenry. 2015 Longitudinal profiles in floodplain channels of the Middle and Lower Elwha River 2012 and 2014. Report to Olympic National Park. 21 pages. Seattle, WA.

Pess, G. R., R. Hilborn, K. Kloehn, T. P. Quinn. 2012. The influence of population dynamics and environmental conditions on pink salmon (*Oncorhynchus gorbuscha*) recolonization after barrier removal in the Fraser River, British Columbia, Canada. Canadian Journal of Fisheries and Aquatic Sciences, 69(5):970-982.

Pess, G. R., M. L. McHenry, T. J. Beechie and J. Davies. 2008. Biological impacts of the Elwha River dams and potential salmonid responses to dam removal. Northwest Science 82:72-90.

Peters, R.J., J.J Duda, G.R. Pess, M. Zimmerman, P. Crain, Z. Hughes, A. Wilson, M.C. Liermann, S.A. Morley, J.R. McMillan, K. Denton, D. Morrill, and K. Warheit. 2014. Guidelines for monitoring and adaptively managing restoration of Chinook Salmon (Oncorhynchus tshawytscha) and Steelhead (O. Mykiss) on the Elwha River. U.S. Fish and Wildlife Service, Olympia.

Peters, R.J., G.R. Pess, M.L. McHenry, P.D. Bakke, M. Elofson, and S. Sampson. 2015. Quantifying changes in streambed composition following the removal of the Elwha and Glines Canyon Dam on the Elwha River. U.S. Fish and Wildlife Service report. 16 pages. Lacey, WA.

Peters, R.J., M. Liermann, M.L. McHenry, P. Bakke, and G. Pess. 2017. Changes in streambed composition in salmonid spawning habitat of the Elwha River during dam removal. Journal of the American Water Resources Association 53 (4): 871-885.

Prince, D.J. et al. 2017. The evolutionary basis of premature migration in Pacific salmon highlights the utility of genomics for informing conservation. Science Advances 3: e1603198.

Ruckelshaus, M.H., Currens, K.P., Graeber, W.H., Fuerstenberg, R.R., Rawson, K., Sands, N.J., and Scott, J.B. 2006. Independent populations of Chinook salmon in Puget Sound, U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-78, Seattle, WA.

Thompson, T.Q. et al. 2018. Anthropogenic habitat alteration leads to rapid loss of adaptive variation and restoration potential in wild salmon populations. Proceedings of the National Academy of Science. www.pnas.org/cgi/doi/10.1073/pnas.1811559115.

Vronskiy, B. B. 1972. Reproductive biology of the Kamchatka River Chinook salmon [Oncorhynchus tshawytscha (Walbaum)]. Journal of Ichthyology 12:259–273.

Vronskiy, B. B., and V. N. Leman. 1991. Spawning stations, hydrological regime, and survival of progeny in nests of Chinook salmon, Oncorhynchus tshawytscha, in the Kamchatka River Basin. Voprosy Ikhtiologii 31:282–291.

Waples, R. S., G. R. Pess, T. J. Beechie. 2008. Evolutionary history of Pacific salmon in dynamic environments. Evolutionary Applications, 1(2):189-206.

Ward, L., P. Crain, B. Freymond, M. McHenry, D. Morrill, G. Pess, R. Peters, J.A. Shaffer, B. Winter, and B. Wunderlich. 2008. Elwha River Fish Restoration Plan: Developed pursuant to the Elwha River Ecosystem and Fisheries Restoration Act, Public Law 102-495.

Warrick, J.A., Bountry, J.A., East, A.E., Magirl, C.S., Randle, T.J., Gelfenbaum, G., Ritchie, A.C., Pess, G.R., Leung, V., Duda, J.J., 2015. Large-scale dam removal on the Elwha River, Washington, USA: source-to-sink sediment budget and synthesis. Geomorphology 246: 729-750.

Weinheimer, J., J. Anderson, R. Cooper, T. Tisdale, M. McHenry, P. Crain, S. Brenkman, and H. Connor. 2022. Age structure and hatchery fraction of Elwha River Chinook salmon: 2021 carcass survey report. FPA 22-10. Washington Department of Fish and Wildlife, Olympia.

Winter, B.D. and P. Crain. 2008. Making the case for ecosystem restoration by dam removal in the Elwha River, Washington. Northwest Science, Volume 82:1-245.

**Tables**

Table 1. Survey reaches, Rkm, and lead survey agency from 2012 to 2014. ONP = Olympic National Park, LEKT = Lower Elwha Klallam Tribe, and WDFW = Washington Department of Fish and Wildlife. Assistance in these surveys included other partners including the USGS, NOAA, and independent contractors. Surveys conducted upriver of Glines Canyon were a combination of snorkel/foot surveys.

| Survey Reach | Rkm start | Rkm end | Midpoint (Rkm) | Length (km) | Lead survey team |
|---|---|---|---|---|---|
| Rica Canyon to Dodger Point (Geyser Valley) | 25.7 | 31.8 | 28.8 | 6.1 | ONP |
| Glines Powerhouse to Rica Canyon (Mills) | 21.1 | 25.7 | 23.4 | 4.6 | ONP |
| Glines Powerhouse to Top of Altaire Canyon | 21.1 | 20.0 | 20.6 | 1.1 | ONP |
| Altaire Canyon to Altaire Bridge | 20.0 | 19.5 | 19.8 | 0.5 | ONP |
| Altaire Bridge to Griff Creek | 19.8 | 19.0 | 19.4 | 0.8 | ONP |
| Griff Creek to Rabbit Hole | 19.0 | 18.0 | 18.5 | 1.0 | ONP |
| Hughes Creek | 0.0 | 0.9 | 17.7 | 0.7 | ONP |
| Rabbit Hole to Fishermans Corner | 18.0 | 16.5 | 17.3 | 1.5 | ONP |
| Fishermans Corner to Park Boundary | 16.5 | 15.7 | 16.1 | 0.8 | ONP |
| Park Boundary to McDonald Bridge Gage | 15.7 | 13.7 | 14.7 | 2.0 | ONP |
| McDonald Bridge Gage to A-Frame | 13.7 | 12.5 | 13.1 | 1.2 | ONP |
| A-Frame to 101 Bridge | 12.5 | 12.1 | 12.3 | 0.4 | ONP |
| Little River | 0.0 | 1.9 | 12.2 | 1.9 | LEKT |
| Indian Creek | 0.0 | 1.9 | 12.1 | 1.9 | LEKT |
| 101 Bridge to Boat Launch (Aldwell) | 12.1 | 11.8 | 12.0 | 0.3 | LEKT |
| Boat launch to Oxbow (Aldwell) | 11.8 | 11.4 | 11.6 | 0.4 | LEKT |
| Oxbow Reach (Aldwell) | 11.4 | 11.1 | 11.3 | 0.3 | LEKT |
| Oxbow Reach to Goosneck | 11.1 | 9.8 | 10.5 | 1.3 | LEKT |
| Gooseneck to Elwha Dam | 9.8 | 7.5 | 8.7 | 2.3 | LEKT |
| Dam outflow to Hwy 112 bridge | 7.5 | 6.7 | 7.1 | 0.8 | WDFW |
| Hwy 112 bridge to weir | 6.7 | 5.5 | 6.1 | 1.2 | WDFW |
| Weir to new bridge | 5.5 | 4.8 | 5.2 | 0.7 | WDFW |
| New bridge to Sisson's riffle | 4.8 | 3.9 | 4.4 | 0.9 | WDFW |
| Sisson's riffle to spruce hole | 3.9 | 3.3 | 3.6 | 0.6 | WDFW |
| Sisson's riffle to Hunt's Road Channel | 3.3 | 2.8 | 3.1 | 0.5 | WDFW |
| Right bank channel (LEKT hatchery) | 2.8 | 1.2 | 2.0 | 1.6 | LEKT |
| Hunt's Road channel | 2.8 | 1.2 | 2.0 | 1.6 | LEKT |
| Elwha bluff to mouth | 1.2 | 0.0 | 0.6 | 1.2 | LEKT |

Table 2. Revised survey reaches, Rkm, and lead survey agency adopted for 2015. ONP = Olympic National Park, LEKT = Lower Elwha Klallam Tribe, and WDFW = Washington Department of Fish and Wildlife. Assistance in these surveys included other partners including the USGS, NOAA, and independent contractors. Surveys conducted upriver of Glines Canyon were a combination of snorkel/foot surveys.

| Survey Reach | Rkm start | Rkm end | Midpoint (Rkm) | Length (km) | Lead survey team |
|---|---|---|---|---|---|
| Rica Canyon to Dodger Point (Geyser Valley) | 25.7 | 31.8 | 28.8 | 6.1 | ONP |
| Glines Powerhouse to Rica Canyon (Mills) | 21.1 | 25.7 | 23.4 | 4.6 | ONP |
| Glines Powerhouse to Top of Altaire Canyon | 21.1 | 20.0 | 20.6 | 1.1 | ONP |
| Altaire Canyon to Altaire Bridge | 20.0 | 19.5 | 19.8 | 0.5 | ONP |
| Altaire Bridge to Griff Creek | 19.8 | 19.0 | 19.4 | 0.8 | ONP |
| Griff Creek to Rabbit Hole | 19.0 | 18.0 | 18.5 | 1.0 | ONP |
| Hughes Creek | 0.0 | 0.9 | 17.7 | 0.9 | ONP |
| Rabbit Hole to Fishermans Corner | 18.0 | 16.5 | 17.3 | 1.5 | ONP |
| Fishermans Corner to Park Boundary | 16.5 | 15.7 | 16.1 | 0.8 | ONP |
| Park Boundary to McDonald Bridge Gage | 15.7 | 13.7 | 14.7 | 2.0 | ONP |
| McDonald Bridge Gage to A-Frame | 13.7 | 12.5 | 13.1 | 1.2 | ONP |
| A-Frame to 101 Bridge | 12.5 | 12.1 | 12.3 | 0.4 | ONP |
| Little River | 0.0 | 1.9 | 12.2 | 1.9 | LEKT |
| Indian Creek | 0.0 | 1.9 | 12.1 | 1.9 | LEKT |
| Aldwell South (101 Bridge to Gooseneck) | 12.1 | 9.8 | 11.0 | 2.3 | LEKT |
| Aldwell North (Gooseneck to Elwha Dam) | 9.8 | 7.5 | 8.7 | 2.3 | LEKT |
| Dam outflow to Hwy 112 bridge | 7.5 | 6.7 | 7.1 | 0.8 | WDFW |
| Hwy 112 bridge to County bridge | 6.7 | 5.8 | 6.1 | 1.9 | WDFW |
| County bridge to Spruce Hole | 4.8 | 2.8 | 3.8 | 2.0 | WDFW |
| East Channel (LEKT Hatchery) | 2.8 | 1.2 | 2.0 | 1.6 | LEKT |
| Hunt's Road channel | 2.8 | 1.2 | 2.0 | 1.6 | LEKT |
| Elwha bluff to mouth | 1.2 | 0.0 | 0.6 | 1.2 | LEKT |

Table 3. Revised survey reaches, Rkm, and lead survey agency since 2016. ONP = Olympic National Park, LEKT = Lower Elwha Klallam Tribe, and WDFW = Washington Department of Fish and Wildlife. Assistance in these surveys included other partners including the USGS, NOAA, and independent contractors.

| Survey Reach | Rkm start | Rkm end | Midpoint (Rkm) | Length (km) | Lead survey team |
|---|---|---|---|---|---|
| **Upper Elwha** | | | | | |
| Baltimore Camp to Chicago Camp | 38.6 | 65.3 | 49.9 | 27.1 | ONP |
| Rica Canyon to Dodger Point (Geyser) | 26.0 | 29.5 | 27.7 | 3.5 | ONP |
| Glines Powerhouse to Rica Canyon (Mills) | 19.5 | 23.5 | 21.5 | 4.5 | ONP |
| Cat Creek | 0.0 | 1.5 | 0.75 | 1.5 | ONP |
| Boulder Creek | 0.0 | | 0.2 | 0.4 | ONP |
| Long Creek | 0.0 | 0.4<br>0.3 | 0.15 | 0.3 | ONP |
| **Middle Elwha** | | | | | |
| Glines Powerhouse to Altaire Canyon | 18.7 | 19.5 | 19.1 | 0.8 | ONP/WDFW |
| Altaire Canyon to Elwha Ranger St. | 17.5 | 18.7 | 18.1 | 1.2 | ONP/WDFW |
| Elwha Ranger Station to Hughes Creek | 16.9 | 17.5 | 17.8 | 0.6 | ONP/WDFW |
| Hughes Creek to Fishermans Corner | 15.5 | 16.9 | 16.2 | 1.4 | ONP/WDFW |
| Fishermans Corner to Park Boundary | 14.4 | 15.5 | 14.9 | 1.1 | WDFW |
| Park Boundary to McDonald Bridge Gage | 12.7 | 14.4 | 13.5 | 1.7 | WDFW |
| McDonald Gage to 101 Bridge | 11.2 | 12.7 | 11.9 | 1.5 | WDFW |
| Little River | 0.0 | 1.9 | 12.2 | 1.9 | LEKT |
| Indian Creek | 0.0 | 1.9 | 12.1 | 1.9 | LEKT |
| Aldwell South (101 Bridge to Gooseneck) | 8.9 | 11.2 | 10.0 | 2.3 | LEKT |
| Aldwell North (Gooseneck to Elwha Dam) | 6.5 | 8.9 | 7.7 | 2.4 | LEKT |
| **Lower River** | | | | | |
| Elwha Dam to Hwy 112 bridge | 5.7 | 6.5 | 6.1 | 0.8 | LEKT |
| Hwy 112 bridge to County bridge | 4.2 | 5.7 | 4.9 | 1.5 | LEKT |
| County bridge to Spruce Hole | 2.3 | 4.2 | 3.2 | 1.9 | LEKT |
| East Channel (LEKT Hatchery) | 0.0 | 2.3 | 1.1 | 2.3 | LEKT |
| Hunt's Road Channel | 0.8 | 2.3 | 1.5 | 1.5 | LEKT |

Table 4. Discharge, turbidity levels and suspended sediment concentration during Chinook salmon spawning ground surveys conducted in the Elwha River, 2012-2022. Water quality measurements were measured at monitoring station 12046200, while discharge measurements were at station 12045500 (Curran et al. 2014). Note the turbidity gauge went off-line in 2020.

| Year | Date | Flow (cms) | Turbidity level (FNU) (±S.D.) | Median SSC (mg/L) | Comments |
|---|---|---|---|---|---|
| 2012 | Sept 12-17 | 11.9 (±2.9) | 72 (±30) | 57 | High turbidity below Elwha Dam |
| 2013 | Sept 17 | 11.1 (±0.7) | 45 (±2.0) | 77 | High turbidity below Elwha Dam |
| 2014 | Sept 17 | 7.0 (±0.2) | 5 (±2.0) | 55 | Visibility excellent |
| 2015 | Sept 23-24 | 9.9 (±0.2) | 0.8 (±0.4) | - | Visibility excellent |
| 2016 | Sept 19-23 | 8.5 (±0.2) | 5.0 (±2.0) | - | Visibility excellent |
| 2017 | Sept 18-25 | 11.3 (±0.3) | 2.3 (±0.3) | - | Visibility excellent |
| 2018 | Sept 12-28 | 11.3 (±1.4) | (5.0 ±3.0) | - | Two flow spikes during survey period. Flows quickly receded |
| 2019 | Sept 26 | 11.3 (±1.8) | (2.1±0.1) | - | Visibility excellent |
| 2020 | Sept 21-23 | 8.5 (±0.1) | - | - | Visibility excellent |
| 2021 | Sept 15-21 | 1.3 (±1.1) | - | - | Visibility excellent |
| 2022 | Sept 19-27 | 8.5(±0.1) | - | - | Visibility excellent |
| 2023 | Sept 18-29 | 7.3(±0.5) | - | - | Visibility excellent |
| 2024 | Sept 16-27 | 6.7(±0.5) | - | - | Visibility excellent |
| 2025 | Sept 22-26 | 6.5(±0.5) | - | - | Visibility excellent |

Table 5. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2012. NS = Not Surveyed.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Male | Female | Unknown | Dead | Jacks |
|---|---|---|---|---|---|---|---|---|
| **Above Glines** | 21.5 | NS | NS | NS | NS | NS | NS | NS |
| | | | | | | | | |
| **Middle Elwha** | | | | | | | | |
| Glines Powerhouse | 20.6 | 6 | 5.5 | 0 | 0 | 23 | 1 | 1 |
| Altaire Canyon | 19.8 | NS | NS | NS | NS | NS | NS | NS |
| Altaire Bridge | 19.4 | 0 | 0.0 | 2 | 3 | 3 | 1 | 1 |
| Griff Creek | 18.5 | 8 | 8.0 | 0 | 0 | 0 | 1 | 0 |
| Hughes Creek | 17.7 | NS | NS | NS | NS | NS | NS | NS |
| Rabbit Hole | 17.3 | 33 | 22.0 | 7 | 1 | 102 | 18 | 1 |
| Fishermans Corner | 16.1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Park Boundary | 14.7 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| McDonald Bridge | 13.1 | 2 | 1.7 | 0 | 0 | 0 | 1 | 0 |
| A-Frame | 12.3 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Little River | 12.2 | 40 | 21.1 | 28 | 16 | 0 | 18 | 8 |
| Indian Creek | 12.1 | 58 | 30.5 | 29 | 28 | 0 | 27 | 14 |
| 101 Bridge | 12.0 | 10 | 33.3 | 0 | 0 | 6 | 0 | 0 |
| Boat launch | 11.6 | 1 | 2.5 | 0 | 0 | 3 | 2 | 0 |
| Oxbow Reach | 11.3 | 30 | 100.0 | 0 | 0 | 31 | 5 | 0 |
| Oxbow Reach2 | 10.5 | 15 | 11.5 | 0 | 0 | 5 | 8 | 0 |
| Gooseneck | 8.7 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| **ME Subtotal** | | **203 (93.5%)** | **11.0** | **66** | **48** | **173** | **82** | **25** |
| | | | | | | | | |
| **Lower Elwha**[5] | | | | | | | | |
| Dam outflow | 7.1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Hwy 112 bridge | 6.1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Weir | 5.2 | 4 | 5.7 | 0 | 0 | 0 | 2 | 0 |
| New bridge | 4.4 | 4 | 4.4 | 0 | 0 | 0 | 0 | 0 |
| Sisson's riffle1 | 3.6 | 4 | 6.7 | 0 | 0 | 0 | 0 | 0 |
| Sisson's riffle2 | 3.1 | 2 | 4.0 | 0 | 0 | 0 | 0 | 0 |
| Right bank channel | 2.0 | 0 | 0.0 | NS | NS | NS | NS | NS |
| Hunt's Road channel | 2.0 | 0 | 0.0 | NS | NS | NS | NS | NS |
| Elwha bluff to mouth | 0.6 | 0 | 0.0 | NS | NS | NS | NS | NS |
| **LE Subtotal** | | **14 (6.5%)** | **1.5** | **0** | **0** | **0** | **2** | **0** |
| **TOTAL** | | **217** | | **66** | **48** | **173** | **84** | **25** |

[5]Observations of redds in the lower Elwha below Rkm 5.2 were limited or not possible during 2012 surveys because of limited visibility associated with dam removal activities.

Table 6. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2013. NS = Not Surveyed.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Male | Female | Unknown | Dead | Jacks |
|---|---|---|---|---|---|---|---|---|
| **Above Glines** | 21.5 | NS | NS | NS | NS | NS | NS | NS |
| | | | | | | | | |
| **Middle Elwha** | | | | | | | | |
| Glines Powerhouse | 20.6 | 162 | 147.3 | 132 | 103 | 60 | 77 | 2 |
| Altaire Canyon | 19.8 | 11 | 22.0 | 0 | 2 | 0 | 10 | 0 |
| Altaire Bridge | 19.4 | 42 | 52.5 | 11 | 14 | 25 | 30 | 0 |
| Griff Creek | 18.5 | 73 | 73.0 | 30 | 18 | 22 | 51 | 1 |
| Hughes Creek | 17.7 | 8 | 11.4 | 6 | 7 | 0 | 39 | 1 |
| Rabbit Hole | 17.3 | 59 | 39.3 | 8 | 19 | 14 | 32 | 0 |
| Fishermans Corner | 16.1 | 13 | 16.3 | 7 | 3 | 23 | 33 | 0 |
| Park Boundary | 14.7 | 45 | 22.5 | 4 | 0 | 108 | 47 | 4 |
| McDonald Bridge | 13.1 | 8 | 6.7 | 1 | 3 | 6 | 35 | 0 |
| A-Frame | 12.3 | 16 | 40.0 | 0 | 0 | 13 | 6 | 0 |
| Little River | 12.2 | 23 | 12.1 | 23 | 12 | 0 | 9 | 0 |
| Indian Creek | 12.1 | 58 | 30.5 | 43 | 19 | 0 | 64 | 5 |
| 101 Bridge | 12.0 | 68 | 29.6 | 19 | 19 | 24 | 20 | 0 |
| Boat launch | 11.6 | | | | | | | |
| Oxbow Reach | 11.3 | | | | | | | |
| Oxbow Reach2 | 10.5 | | | | | | | |
| Gooseneck | 8.7 | 16 | 7.0 | 12 | 6 | 20 | 7 | 0 |
| **ME Subtotal** | | **602 (78.6%)** | **32.7** | **296** | **225** | **315** | **460** | **13** |
| | | | | | | | | |
| **Lower Elwha**[6] | | | | | | | | |
| Dam outflow | 7.1 | 51 | 63.8 | 0 | 0 | 81 | 16 | 0 |
| Hwy 112 bridge | 6.1 | 100 | 83.3 | 0 | 0 | 251 | 25 | 0 |
| Weir | 5.2 | 9 | 12.9 | 0 | 0 | 13 | 20 | 0 |
| New bridge | 4.4 | 3 | 3.3 | 0 | 0 | 0 | 0 | 0 |
| Sisson's riffle | 3.6 | 0 | 0.0 | 0 | 0 | 13 | 0 | 0 |
| Right bank channel | 2.0 | 0 | 0.0 | 0 | 0 | 23 | 1 | 0 |
| Hunt's Road channel | 2.0 | NS | NS | NS | NS | NS | NS | NS |
| Elwha bluff to mouth | 0.6 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| **LE Subtotal** | | **163 (21.4%)** | **19.0** | **0** | **0** | **381** | **62** | **0** |
| **TOTAL** | | **765** | | **296** | **225** | **696** | **522** | **13** |

[6] Observations of redds in the lower Elwha below Rkm 5.2 were limited or not possible during 2013 surveys because of limited visibility associated with dam removal activities.

Table 7. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2014.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Male | Female | Unknown | Dead | Jacks |
|---|---|---|---|---|---|---|---|---|
| **Above Glines** | 21.5 | 1 | - | 4 | 1 | 3 | 0 | 0 |
| | | | | | | | | |
| **Middle Elwha** | | | | | | | | |
| Glines Powerhouse | 20.6 | 241 | 219.1 | 0 | 0 | 257 | 57 | 0 |
| Altaire Canyon | 19.8 | 29 | 58.0 | 0 | 0 | 23 | 19 | 0 |
| Altaire Bridge | 19.4 | 63 | 78.8 | 18 | 22 | 29 | 21 | 0 |
| Griff Creek | 18.5 | 82 | 82.0 | 9 | 12 | 24 | 49 | 0 |
| Hughes Creek | 17.7 | 12 | 17.1 | 3 | 5 | 0 | 3 | 0 |
| Rabbit Hole | 17.3 | 69 | 46.0 | 43 | 29 | 14 | 56 | 0 |
| Fishermans Corner | 16.1 | 55 | 68.8 | 25 | 7 | 58 | 49 | 0 |
| Park Boundary | 14.7 | 82 | 41.0 | 36 | 22 | 148 | 49 | 0 |
| McDonald Bridge | 13.1 | 17 | 14.2 | 2 | 1 | 24 | 17 | 0 |
| A-Frame | 12.3 | 35 | 87.5 | 3 | 2 | 73 | 12 | 0 |
| Little River | 12.2 | 1 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| Indian Creek | 12.1 | 26 | 13.7 | 0 | 0 | 89 | 0 | 0 |
| 101 Bridge | 12.0 | 57 | 24.8 | 0 | 0 | 62 | 26 | 0 |
| Boat launch | 11.6 | | | | | | | |
| Oxbow Reach | 11.3 | | | | | | | |
| Oxbow Reach2 | 10.5 | | | | | | | |
| Gooseneck | 8.7 | 42 | 18.3 | 0 | 0 | 61 | 40 | 0 |
| **ME Subtotal** | | **811** | **44.1** | **139** | **100** | **862** | **398** | **0** |
| | | **(61.9%)** | | | | | | |
| | | | | | | | | |
| **Lower Elwha** | | | | | | | | |
| Dam outflow | 7.1 | 50 | 62.5 | 0 | 0 | 10 | NA | 0 |
| Hwy 112 bridge | 6.1 | 125 | 104.2 | 0 | 0 | 65 | NA | 0 |
| Weir | 5.2 | 25 | 35.7 | 0 | 0 | 33 | NA | 0 |
| New bridge | 4.4 | 14 | 15.6 | 0 | 0 | 36 | NA | 0 |
| Sisson's riffle1 | 3.6 | 83 | 138.3 | 0 | 0 | 87 | NA | 0 |
| Right bank channel | 2.0 | 154 | 96.3 | 0 | 0 | 0 | NA | 0 |
| Hunt's Road channel | 2.0 | 47 | 29.4 | 0 | 0 | 14 | NA | 0 |
| Elwha bluff to mouth | 0.6 | 1 | 0.8 | 0 | 0 | 0 | NA | 0 |
| **LE Subtotal** | | **499** | **27.1** | **0** | **0** | **245** | **0** | **0** |
| | | **(38.1%)** | | | | | | |
| **TOTAL** | | | | **139** | **100** | **1111** | **398** | **0** |
| | | **1310** | | | | | | |

Table 8. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2015.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Jacks | Live Pinks | Dead Pinks |
|---|---|---|---|---|---|---|---|---|
| **Above Glines** | 21.5 | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| | | | | | | | | |
| **Middle Elwha** | | | | | | | | |
| Glines | 20.6 | 100 | 90.9 | 68 | 14 | 0 | 0 | 0 |
| Powerhouse | | | | | | | | |
| Altaire Canyon | 19.8 | 35 | 70.0 | 12 | 2 | 0 | 0 | 0 |
| Altaire Bridge | 19.4 | 24 | 30.0 | 14 | 4 | 0 | 0 | 0 |
| Griff Creek | 18.5 | 34 | 34.0 | 13 | 5 | 0 | 0 | 0 |
| Hughes Creek | 17.7 | 3 | 4.3 | 1 | 4 | 0 | 16 | 13 |
| Rabbit Hole | 17.3 | 50 | 33.3 | 37 | 6 | 0 | 0 | 0 |
| Fisherman's C. | 16.1 | 84 | 105.0 | 8 | 32 | 0 | 0 | 1 |
| ONP Boundary | 14.7 | 77 | 38.5 | 23 | 12 | 0 | 2 | 0 |
| McDonald Br. | 13.1 | 31 | 25.8 | 5 | 2 | 0 | 3 | 0 |
| A-Frame | 12.8 | 37 | 92.5 | 6 | 28 | 0 | 0 | 1 |
| Little River | 12.2 | 51 | 26.8 | 25 | 32 | 0 | 17 | 3 |
| Indian Creek | 12.1 | 18 | 9.5 | 24 | 5 | 0 | 5 | 2 |
| Aldwell South | 11.6 | 93 | 40.4 | 29 | 132 | 0 | 1 | 1 |
| Aldwell North | 8.7 | 82 | 35.6 | 34 | 87 | 0 | 5 | 3 |
| **ME Subtotal** | | **719** | **45.5** | **299** | **365** | **0** | **49** | **24** |
| | | **(76.7%)** | | | | | | |
| | | | | | | | | |
| **Lower Elwha** | | | | | | | | |
| Dam outflow | 7.1 | 8 | 10.0 | 0 | 2 | 0 | 0 | 0 |
| Hwy 112 | 6.1 | 66 | 55.0 | 5 | 2 | 0 | 19 | 0 |
| Bridge | | | | | | | | |
| County Bridge | 4.4 | 31 | 16.3 | 16 | 2 | 0 | 3 | 1 |
| Sisson's Riffle | 3.6 | 18 | 9.0 | 5 | 1 | 0 | 0 | 0 |
| East Channel | 2.0 | 40 | 25.0 | 18 | 9 | 0 | 3 | 2 |
| Hunt Rd. Chan. | 2.0 | 55 | 34.4 | 26 | 6 | 0 | 6 | 0 |
| Elwha Bluff | 0.6 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| **LE Subtotal** | | **218** | **21.4** | **67** | **22** | **0** | **31** | **3** |
| | | **(23.3%)** | | | | | | |
| **TOTAL** | | | | **366** | **387** | **0** | **80** | **27** |
| | | **937** | | | | | | |

Table 9. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2016. The former Mills reservoir counts include redds from Boulder and Cat Creeks.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Jacks |
|---|---|---|---|---|---|---|
| **Upper Elwha**[7] | | | | | | |
| Upper Watershed | 43.8 | 1 | 0.0 | 0 | 0 | 0 |
| Geyser Valley | 30 | 10 | 2.9 | 1 | 3 | 0 |
| Mills | 23.4 | 47 | 10.4 | 29 | 6 | 2 |
| **UE Subtotal** | | **58** | **1.5** | **33** | **6** | **2** |
| | | **(9.5%)** | | | | |
| | | | | | | |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 20.6 | 36 | 32.7 | 36 | 0 | 5 |
| Altaire Bridge | 19.5 | 19 | 19.0 | 15 | 0 | 0 |
| Griff Creek | 18.5 | 27 | 4.0 | 0 | 0 | 0 |
| Rabbit Hole | 17.3 | 30 | 20.0 | 24 | 0 | 0 |
| Fisherman's C. | 16.1 | 78 | 97.5 | 31 | 0 | 0 |
| ONP Boundary | 14.7 | 42 | 21.0 | 29 | 28 | 0 |
| McDonald Br. | 12.9 | 15 | 9.4 | | | 0 |
| Little River | 12.2 | 1 | 0.5 | 0 | 0 | 0 |
| Indian Creek | 12.1 | 28 | 14.7 | 24 | 14 | 0 |
| Aldwell South | 11.0 | 48 | 20.9 | 14 | 12 | 1 |
| Aldwell North | 8.8 | 86 | 45.3 | 13 | 20 | 0 |
| **ME Subtotal** | | **410** | **24.1** | **186** | **74** | **6** |
| | | **(66.7%)** | | | | |
| | | | | | | |
| **Lower Elwha** | | | | | | |
| Dam outflow | 7.3 | 16 | 13.3 | 17 | 8 | 0 |
| Hwy 112 Bridge | 6.1 | 74 | 38.9 | | | 0 |
| County Bridge | 3.8 | 23 | 11.5 | | | 0 |
| East Channel | 1.4 | 30 | 10.7 | 6 | 3 | 0 |
| Hunt Rd. Chan. | 2.0 | 3 | 1.9 | 2 | 0 | 0 |
| **LE Subtotal** | | **146** | **15.4** | **25** | **11** | **0** |
| | | **(23.8%)** | | | | |
| **TOTAL** | | | | **244** | **91** | **8** |
| | | **614** | | | | |

[7] Upper extent of survey in 2016 was the Elwha footbridge.

Table 10. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2017. Note that live and dead counts were accidentally aggregated among some reaches in the middle Elwha. The former Mills reservoir counts include redds from Boulder and Cat Creeks.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Jacks |
|---|---|---|---|---|---|---|
| **Upper Elwha**[8] | | | | | | |
| Upper Watershed | 43.8 | 2 | 0.07 | 2 | 0 | 0 |
| Geyser Valley | 30 | 2 | 0.33 | 19 | 1 | 0 |
| Former Mills Reservoir | 23.4 | 48 | 10.4 | 40 | 10 | 0 |
| **UE Subtotal** | | **52 (6.8%)** | | **71** | **11** | **0** |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 20.6 | 79 | 71.8 | 61 | 28 | |
| Altaire Bridge | 19.5 | 52 | 52.0 | | | |
| Griff Creek | 18.5 | 8 | 8.0 | | | |
| Rabbit Hole | 17.3 | 50 | 33.3 | 100 | 34 | |
| Fisherman's C. | 16.1 | 58 | 72.5 | | | |
| ONP Boundary | 14.7 | 32 | 16.0 | 127 | 22 | |
| McDonald Br. | 12.9 | 6 | 3.7 | | | |
| Little River | 12.2 | 9 | 4.7 | 26 | 0 | |
| Indian Creek | 12.1 | 35 | 18.4 | 68 | 13 | |
| Aldwell South | 11.0 | 128 | 55.6 | 100 | 47 | 4 |
| Aldwell North | 8.8 | 66 | 34.7 | 63 | 27 | 1 |
| **ME Subtotal** | | **523 (68.2)** | | **545** | **171** | **5** |
| **Lower Elwha** | | | | | | |
| Elwha Dam | 7.3 | 7 | 5.8 | | | |
| Hwy 112 Bridge | 6.1 | 77 | 40.5 | 115 | 20 | |
| County Bridge | 3.8 | 37 | 18.5 | | | |
| East Channel | 1.4 | 31 | 19.8 | 44 | 4 | |
| Hunt Rd. Chan. | 2.0 | 40 | 14.3 | 32 | 13 | |
| **LE Subtotal** | | **192 (25.0%)** | | **191** | **37** | |
| **TOTAL** | | **767** | | **807** | **219** | **5** |

[8] Upper extent of survey in 2017 was the Elwha footbridge.

Table 11. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2018.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Jacks |
|---|---|---|---|---|---|---|
| **Upper Elwha**[9] | | | | | | |
| Upper Watershed | 43.8 | 5 | 0.2 | 6 | 0 | 0 |
| Long Creek | | 0 | 0.0 | 0 | 0 | 0 |
| Geyser Valley | 30 | 11 | 1.8 | 36 | 3 | 0 |
| Cat Creek | | 25 | 25.0 | 26 | 10 | 0 |
| Boulder Creek | | 21 | 42.0 | 91 | 25 | 1 |
| Mills | 23.4 | 149 | 32.4 | 129 | 32 | 1 |
| **UE Subtotal** | | **211** | | **288** | **70** | **2** |
| | | **(13.2%)** | | | | |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 20.6 | 71 | 64.5 | 91 | 26 | 0 |
| Altaire Bridge | 19.5 | 28 | 28.0 | 112 | 45 | 0 |
| Griff Creek | 18.5 | 42 | 42.0 | 38 | 55 | 0 |
| Rabbit Hole (Hughes) | 17.3 | 132 | 88.0 | 133 | 65 | 0 |
| Fisherman's C. | 16.1 | 49 | 61.2 | 18 | 37 | 0 |
| ONP Boundary | 14.7 | 33 | 16.5 | 26 | 18 | 1 |
| McDonald Br. | 12.9 | 43 | 26.9 | 49 | 15 | 0 |
| Little River | 12.2 | 63 | 33.2 | 108 | 52 | 0 |
| Indian Creek | 12.1 | 144 | 75.8 | 97 | 58 | 0 |
| Aldwell South | 11.0 | 206 | 89.6 | 149 | 115 | 0 |
| Aldwell North | 8.8 | 98 | 51.6 | 62 | 71 | 0 |
| **ME Subtotal** | | **909** | | **883** | **557** | **1** |
| | | **(56.8%)** | | | | |
| **Lower Elwha** | | | | | | |
| Elwha Dam | 7.3 | 84 | 70.0 | 151 | 40 | 0 |
| Hwy 112 Bridge | 6.1 | 186 | 97.9 | 182 | 104 | 0 |
| County Bridge | 3.8 | 87 | 43.5 | - | - | - |
| East Channel | 1.4 | 82 | 29.3 | - | - | - |
| Hunt Rd. Chan. | 2.0 | 42 | 26.3 | 26 | 29 | 0 |
| **LE Subtotal** | | **481** | | **359** | **17** | |
| | | **(30.0%)** | | | | |
| **TOTAL** | | **1,601** | | **1,530** | **800** | **3** |

[9] Upper extent of survey in 2018 was Chicago Camp.

Table 12. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2019.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Jacks |
|---|---|---|---|---|---|---|
| **Upper Elwha**[10] | | | | | | |
| Upper Watershed | 43.8 | 1 | 0.04 | 2 | 0 | 0 |
| Geyser Valley | 30 | 5 | | 56 | 2 | |
| Cat Creek | | 9 | 6.0 | 3 | 8 | 0 |
| Boulder Creek | | 22 | 44.0 | 8 | 39 | 0 |
| Mills | 23.4 | 67 | 14.5 | 202 | 61 | 0 |
| **UE Subtotal** | | **104 (6.2%)** | | **271** | **115** | **0** |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 20.6 | 46 | 41.8 | 51 | 164 | 0 |
| Altaire Bridge | 19.5 | 34 | 34.0 | 23 | 16 | 0 |
| Griff Creek | 18.5 | 34 | 34.0 | 176 | 125 | 0 |
| Rabbit Hole (Hughes)[11] | 17.3 | 133 | 88.7 | - | - | - |
| Fisherman's | 16.1 | 67 | 83.7 | 17 | 0 | 0 |
| ONP Boundary | 14.7 | 42 | 21.0 | 29 | 0 | 0 |
| McDonald Br. | 12.9 | 14 | 8.7 | 6 | 0 | 0 |
| Little River | 12.2 | 124 | 65.3 | 30 | 91 | 0 |
| Indian Creek | 12.1 | 215 | 113.2 | 48 | 159 | 0 |
| Aldwell South | 11.0 | 259 | 112.6 | 33 | 60 | 0 |
| Aldwell North | 8.8 | 131 | 68.9 | 8 | 69 | 0 |
| **ME Subtotal** | | **1099 (65.7%)** | | **421** | **684** | **0** |
| **Lower Elwha** | | | | | | |
| Elwha Dam | 7.3 | 36 | 45.0 | - | - | - |
| Hwy 112 Bridge | 6.1 | 248 | 145.9 | - | - | - |
| County Bridge[12] | 3.8 | 120 | 66.7 | 400 | 398 | 0 |
| East Mainstem | 1.4 | 42 | 18.3 | 11 | 45 | 0 |
| Hunt Rd. Chan. | 2.0 | 24 | 16.0 | 11 | 12 | 0 |
| **LE Subtotal** | | **470 (28.1%)** | | **422** | **455** | |
| **TOTAL** | | **1673** | | **1,114** | **1,254** | **0** |

[10] Upper extent of survey was Chicago Camp in 2019.
[11] Live/Dead Counts aggregated for Hughes/Griff survey reaches
[12] Live/Dead Counts aggregated for Dam/112 Bridge/County Bridge reaches

Table 13. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2020. COVID-19 restrictions resulted in slightly fewer surveys in 2020.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Jacks |
|---|---|---|---|---|---|---|
| **Upper Elwha**[13] | | | | | | |
| Upper Watershed | 43.8 | 0 | 0 | 0 | 0 | 0 |
| Geyser Valley | 30 | 0 | 0 | 0 | 0 | 0 |
| Cat Creek | | 6 | 4.0 | 0 | 1 | 0 |
| Boulder Creek | | 18 | 36.0 | 1 | 1 | 0 |
| Mills | 23.4 | 82 | 17.8 | 67 | 32 | 2 |
| **UE Subtotal** | | **106** | | **68** | **34** | **2** |
| | | **(16.9%)** | | | | |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 20.6 | 41 | 37.3 | 30 | 15 | 0 |
| Altaire Bridge | 19.5 | 19 | 19.0 | 18 | 1 | 0 |
| Griff Creek | 18.5 | 15 | 15.0 | 27 | 2 | 0 |
| Rabbit Hole (Hughes) | 17.3 | 26 | 17.3 | 11 | 2 | 0 |
| Fisherman's C. | 16.1 | 20 | 25.0 | 15 | 4 | 0 |
| ONP Boundary | 14.7 | 12 | 6.0 | 14 | 7 | 0 |
| McDonald Br. | 12.9 | 21 | 13.1 | 25 | 9 | 0 |
| Little River | 12.2 | 6 | 3.2 | 9 | 0 | 0 |
| Indian Creek | 12.1 | 76 | 33.0 | 60 | 33 | 0 |
| Aldwell South | 11.0 | 52 | 22.6 | 37 | 30 | 0 |
| Aldwell North | 8.8 | 41 | 21.6 | 22 | 12 | 0 |
| **ME Subtotal** | | **329** | | **268** | **115** | **0** |
| | | **(52.6%)** | | | | |
| **Lower Elwha** | | | | | | |
| Elwha Dam | 7.3 | 19 | 23.7 | | | |
| Hwy 112 Bridge | 6.1 | 109 | 64.2 | | | |
| County Bridge[14] | 3.8 | 26 | 14.4 | 65 | 95 | |
| East Channel | 1.4 | 36 | 15.6 | 43 | 12 | 0 |
| Hunt Rd. Chan. | 2.0 | 0 | 0 | 0 | 0 | 0 |
| **LE Subtotal** | | **190** | | **108** | **107** | |
| | | **(30.4%)** | | | | |
| **TOTAL** | | **625** | | **444** | **256** | **2** |

[13] Upper extent of survey in 2020 was Godkin Creek.

[14] Live/Dead Counts aggregated for Elwha Dam to County Bridge

Table 14. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2021.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Jacks |
|---|---|---|---|---|---|---|
| **Upper Elwha**[15] | | | | | | |
| Upper Watershed | 49.9 | 0 | 0 | 0 | 0 | 0 |
| Geyser Valley | 30 | 0 | 0 | 0 | 0 | 0 |
| Cat Creek | 0.7 | 4 | 2.7 | 3 | 1 | 0 |
| Boulder Creek | 0.2 | 27 | 54.0 | 43 | 4 | 0 |
| Mills | 21.5 | 58 | 14.5 | 137 | 4 | 2 |
| **UE Subtotal** | | **89** | | **183** | **9** | **2** |
| | | **(17.9%)** | | | | |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 19.1 | 26 | 32.5 | 50 | 4 | 0 |
| Altaire Bridge | 18.1 | 2 | 1.7 | 4 | 1 | 0 |
| Elwha RS | 17.8 | 2 | 3.3 | 5 | 0 | 0 |
| Hughes Creek | 16.2 | 34 | 15.0 | 26 | 9 | 0 |
| Fisherman's | 16.1 | 21 | 24.2 | 81 | 11 | 0 |
| ONP Boundary | 14.9 | 16 | 9.4 | 39 | 14 | 0 |
| McDonald Br. | 11.9 | 11 | 7.3 | 21 | 5 | 0 |
| Little River | 12.2 | 40 | 21.0 | 76 | 15 | 0 |
| Indian Creek | 12.1 | 94 | 49.4 | 104 | 36 | 0 |
| Aldwell South | 11.0 | 62 | 26.9 | 104 | 36 | 0 |
| Aldwell North | 8.8 | 18 | 7.5 | 13 | 12 | 0 |
| **ME Subtotal** | | **326** | | **523** | **143** | **0** |
| | | **(65.9%)** | | | | |
| **Lower Elwha**[16] | | | | | | |
| Elwha Dam | 6.1 | 4 | 5.0 | | | |
| Hwy 112 Bridge | 4.9 | 31 | 20.6 | | | |
| County Bridge | 3.2 | 28 | 14.7 | | | |
| East Channel | 1.1 | 17 | 7.4 | 236 | 59 | 0 |
| Hunt Rd. Chan. | 1.5 | 0 | 0 | | | |
| **LE Subtotal** | | **80** | | **236** | **59** | |
| | | **(16.2%)** | | | | |
| **TOTAL** | | **495** | | **966** | **211** | **2** |

[15] Upper extent of survey in 2021 was Godkin Creek.

[16] Live/Dead Counts aggregated for Elwha Dam to County Bridge

Table 15. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2022.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Jacks |
|---|---|---|---|---|---|---|
| **Upper Elwha**[17] | | | | | | |
| Upper Watershed | 49.9 | 0 | 0 | 0 | 0 | 0 |
| Geyser Valley | 30 | 0 | 0 | 0 | 0 | 0 |
| Cat Creek | 0.7 | 12 | 36.6 | 0 | 2 | 0 |
| Boulder Creek | 0.2 | 0 | 0.0 | 0 | 0 | 0 |
| Mills | 21.5 | 66 | 18.6 | 87 | 41 | 0 |
| Rica | 23.9 | 7 | 8.7 | 13 | 2 | 5 |
| **UE Subtotal** | | **85 (8.6%)** | | **100** | **43** | **5** |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 19.1 | 44 | 55.0 | 19 | 21 | 0 |
| Altaire Bridge | 18.1 | 39 | 32.5 | 38 | 9 | 1 |
| Elwha RS | 17.8 | 92 | 153.3 | 74 | 23 | 0 |
| Fisherman's | 16.1 | 79 | 71.8 | 44 | 18 | 0 |
| ONP Boundary | 14.9 | 26 | 15.2 | 29 | 13 | 0 |
| McDonald Br. | 11.9 | 61 | 40.6 | 70 | 23 | 0 |
| Little River | 12.2 | 0 | 0.0 | 0 | 0 | 0 |
| Indian Creek | 12.1 | 91 | 47.9 | 135 | 49 | 10 |
| Aldwell South | 11.0 | 122 | 53.0 | 100 | 90 | 0 |
| Aldwell North | 8.8 | 70 | 29.1 | 89 | 35 | 0 |
| **ME Subtotal** | | **624 (63.2%)** | | **598** | **281** | **11** |
| **Lower Elwha**[18] | | | | 333 | 51 | 0 |
| Elwha Dam | 6.1 | 9 | 5.0 | | | |
| Hwy 112 Bridge | 4.9 | 99 | 20.6 | | | |
| County Bridge | 3.2 | 97 | 14.7 | | | |
| East Channel | 1.1 | 73 | 7.4 | 38 | 32 | 0 |
| Hunt Rd. Chan. | 1.5 | 0 | 0 | | | |
| **LE Subtotal** | | **278 (28.1%)** | | **371** | **83** | |
| **TOTAL** | | **987** | | **1,069** | **407** | **16** |

[17] Upper extent of survey in 2022 was Hayes River.

[18] Live/Dead Counts aggregated for Elwha Dam to County Bridge

Table 16. Number of redds, redds/kilometer and observation of live, dead and jack Chinook salmon on the Elwha River, 2023.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Pinks (live & dead) |
|---|---|---|---|---|---|---|
| **Upper Elwha**[19] | | | | | | |
| Upper Watershed | 49.9 | 1 | 0.04 | 1 | 0 | 0 |
| Geyser Valley | 30 | 0 | 0 | 2 | 0 | 0 |
| Cat Creek | 0.7 | 0 | 0 | 0 | 0 | 0 |
| Boulder Creek | 0.2 | 9 | 30.0 | 1 | 0 | 7 |
| Mills | 21.5 | 135 | 30.0 | 128 | 0 | 203 |
| Rica | 23.9 | 0 | 0 | 0 | 0 | 0 |
| **UE Subtotal** | | **145** | | **129** | **0** | **210** |
| | | **(17.9%)** | | | | |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 19.1 | 43 | 53.7 | 26 | 14 | 37 |
| Altaire Bridge | 18.1 | 51 | 42.5 | 96 | 28 | 52 |
| Elwha RS | 17.8 | 79 | 33.5 | 158 | 43 | 323 |
| Fisherman's | 16.1 | 43 | 32.3 | 48 | 15 | 115 |
| ONP Boundary | 14.9 | 21 | 14.0 | 21 | 4 | 37 |
| McDonald Br. | 11.9 | 31 | 16.3 | 74 | 24 | 155 |
| Little River | 12.2 | 10 | 5.2 | 23 | 8 | 1032 |
| Indian Creek | 12.1 | 80 | 42.1 | 129 | 35 | 132 |
| Aldwell South | 11.0 | 48 | 20.8 | 45 | 55 | 84 |
| Aldwell North | 8.8 | 69 | 28.7 | 42 | 15 | 65 |
| **ME Subtotal** | | **475** | | **732** | **308** | **2032** |
| | | **(58.9%)** | | | | |
| **Lower Elwha**[20] | | | | 499 | 66 | 923 |
| Elwha Dam | 6.1 | 21 | 26.2 | | | |
| Hwy 112 Bridge | 4.9 | 72 | 48.0 | | | |
| County Bridge | 3.2 | 75 | 39.5 | | | |
| East Channel | 1.1 | 18 | 7.8 | | | |
| Hunt Rd. Chan. | 1.5 | 0 | 0 | | | |
| **LE Subtotal** | | **186** | | **499** | **66** | **923** |
| | | **(23.1%)** | | | | |
| **TOTAL** | | **806** | | **1360** | **374** | **3165** |

[19] Upper extent of survey in 2023 was just upstream (rkm 52) of the Hayes River confluence.
[20] Lower river total live/dead counts

Table 17. Number of redds, redds/kilometer and observation of live, dead Chinook and pink salmon on the Elwha River, 2024.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Pinks (live & dead) |
|---|---|---|---|---|---|---|
| **Upper Elwha**[21] | | | | | | |
| Upper Watershed | 49.9 | 0 | 0 | 0 | 0 | 0 |
| Geyser Valley | 30 | 0 | 0 | 1 | 0 | 0 |
| Cat Creek | 0.7 | 31 | 20.7 | 15 | 11 | 0 |
| Boulder Creek | 0.2 | 4 | 10.0 | 8 | 2 | 0 |
| Mills | 21.5 | 93 | 20.7 | 92 | 64 | 0 |
| Rica | 23.9 | 0 | 0 | 0 | 0 | 0 |
| **UE Subtotal** | | **128 (13.1%)** | | **116** | **76** | **0** |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 19.1 | 53 | 66.2 | 59 | 21 | 0 |
| Altaire Bridge | 18.1 | 61 | 50.8 | 91 | 6 | 0 |
| Elwha RS | 17.8 | 90 | 45.0 | 108 | 46 | 1 |
| Fisherman's | 16.1 | 79 | 71.8 | 59 | 33 | 0 |
| ONP Boundary | 14.9 | 39 | 22.9 | 17 | 20 | 0 |
| McDonald Br. | 11.9 | 34 | 22.6 | 36 | 17 | 6 |
| Little River | 12.2 | 35 | 18.4 | 45 | 7 | 0 |
| Indian Creek | 12.1 | 86 | 45.3 | 105 | 73 | 1 |
| Aldwell South | 11.0 | 83 | 36.1 | 62 | 51 | 0 |
| Aldwell North | 8.8 | 111 | 46.2 | 197 | 13 | 0 |
| **ME Subtotal** | | **671 (68.8)** | | **779** | **287** | **7** |
| **Lower Elwha**[22] | | | | 186 | 146 | 5 |
| Elwha Dam | 6.1 | 20 | 25.0 | | | |
| Hwy 112 Bridge | 4.9 | 83 | 55.3 | | | |
| County Bridge | 3.2 | 52 | 27.4 | | | |
| East Channel | 1.1 | 22 | 9.5 | | | |
| Hunt Rd. Chan. | 1.5 | 0 | 0 | | | |
| **LE Subtotal** | | **177 (18.1%)** | | **186** | **146** | **5** |
| **TOTAL** | | **976** | | **1081** | **509** | **13** |

[21] Upper extent of survey in 2024 was just upstream (rkm 52) of the Hayes River confluence.
[22] Lower river total live/dead counts

Table 18. Number of redds, redds/kilometer and observation of live, dead Chinook and pink salmon on the Elwha River, 2025.

| Survey Reach | Rkm midpoint | Redds | Redds/km | Live Chinook | Dead Chinook | Pinks (live & dead) |
|---|---|---|---|---|---|---|
| **Upper Elwha[23]** | | | | | | |
| Upper Watershed | 49.9 | 1 | 0.03 | 1 | 0 | 0 |
| Geyser Valley | 30 | 0 | 0 | 0 | 0 | 0 |
| Cat Creek | 0.7 | 15 | 10.0 | 15 | 0 | 42 |
| Boulder Creek | 0.2 | 3 | 7.5 | 3 | 1 | 71 |
| Mills | 21.5 | 53 | 11.8 | 88 | 57 | 620 |
| Rica | 23.9 | 0 | 0 | 0 | 0 | 0 |
| **UE Subtotal** | | **72** | | **107** | **58** | **733** |
| | | **(8.3%)** | | | | |
| **Middle Elwha** | | | | | | |
| Glines Powerhouse | 19.1 | 34 | 42.5 | 57 | 51 | 395 |
| Altaire Bridge | 18.1 | 29 | 24.2 | 58 | 32 | 316 |
| Elwha RS | 17.8 | 92 | 153.3 | 107 | 23 | 427 |
| Fisherman's | 16.1 | 34 | 24.3 | 9 | 6 | 74 |
| ONP Boundary | 14.9 | 8 | 7.3 | 31 | 38 | 308 |
| McDonald Br. | 11.9 | 36 | 21.2 | 78 | 66 | 198 |
| Little River | 12.2 | 24 | 12.6 | 58 | 20 | 6,405 |
| Indian Creek | 12.1 | 71 | 37.4 | 174 | 110 | 467 |
| Aldwell South | 11.0 | 90 | 39.1 | 77 | 67 | 533 |
| Aldwell North | 8.8 | 61 | 25.4 | 111 | 86 | 235 |
| **ME Subtotal** | | **479** | | **760** | **499** | **9,358** |
| | | **(55.2%)** | | | | |
| **Lower Elwha[24]** | | | | 536 | 141 | 1,516 |
| Elwha Dam | 6.1 | 162 | 202.5 | | | |
| Hwy 112 Bridge | 4.9 | 52 | 34.6 | | | |
| County Bridge | 3.2 | 86 | 45.2 | | | |
| East Channel | 1.1 | 16 | 6.9 | | | |
| Hunt Rd. Chan. | 1.5 | 0 | 0 | | | |
| **LE Subtotal** | | **316** | | **536** | **141** | **1,516** |
| | | **(36.4%)** | | | | |
| **TOTAL** | | **867** | | **1,403** | **698** | **11,607** |

[23] Upper extent of survey in 2025 was just downstream of Chicago Camp (Rkm 65.3).
[24] Lower river total live/dead counts

Figures

Figure 1. The Elwha River watershed. Note that canyon areas depicted in white are generally not surveyed.

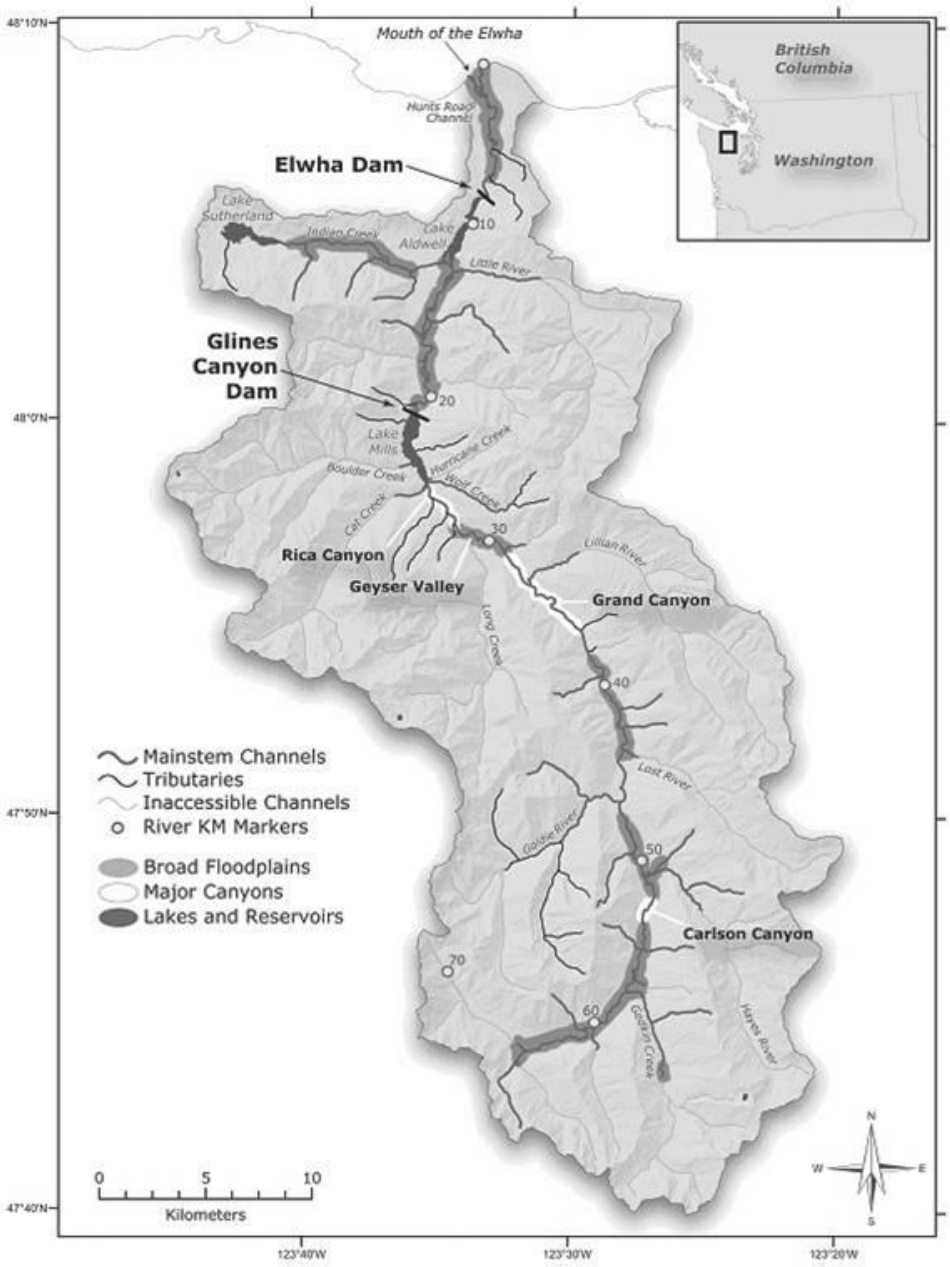
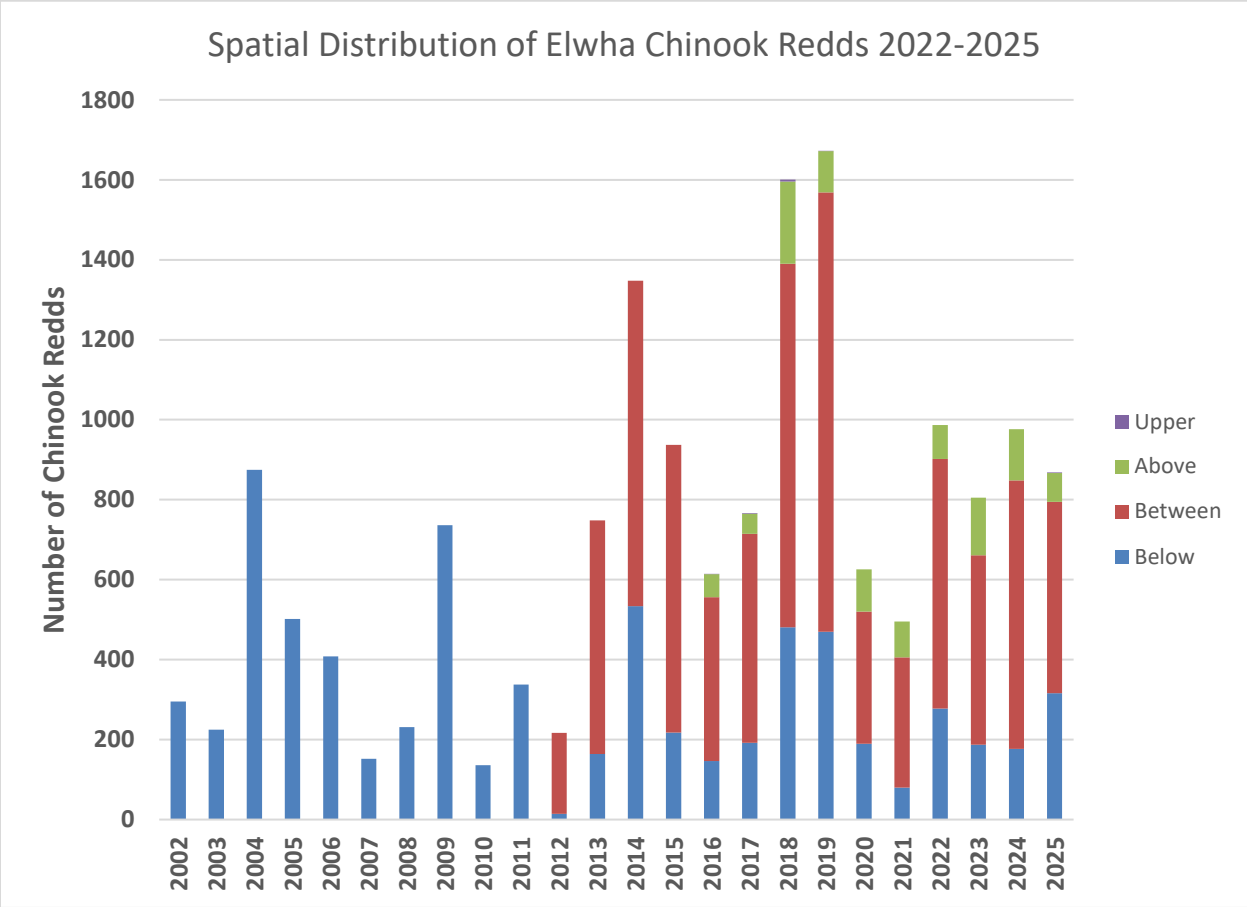
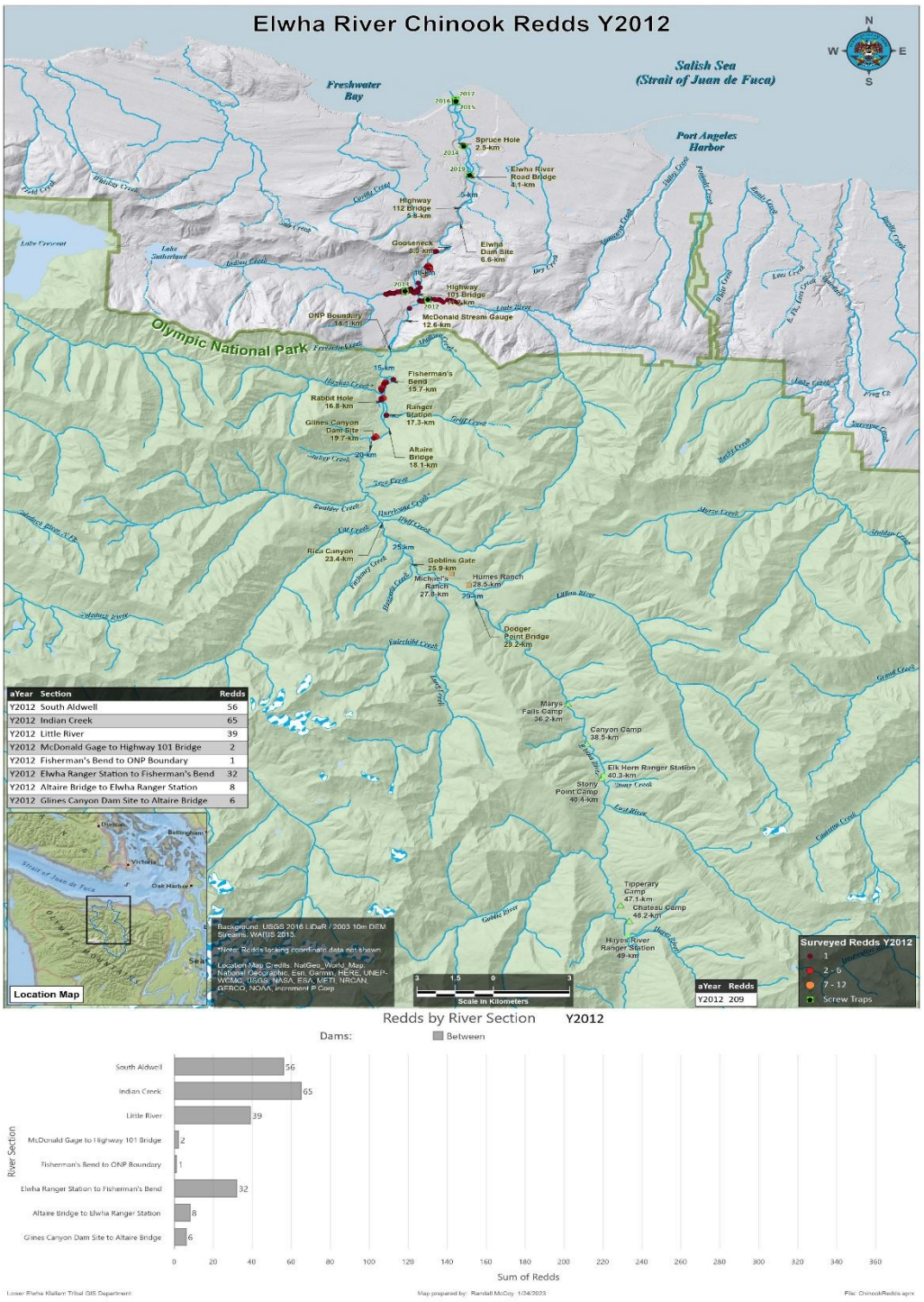


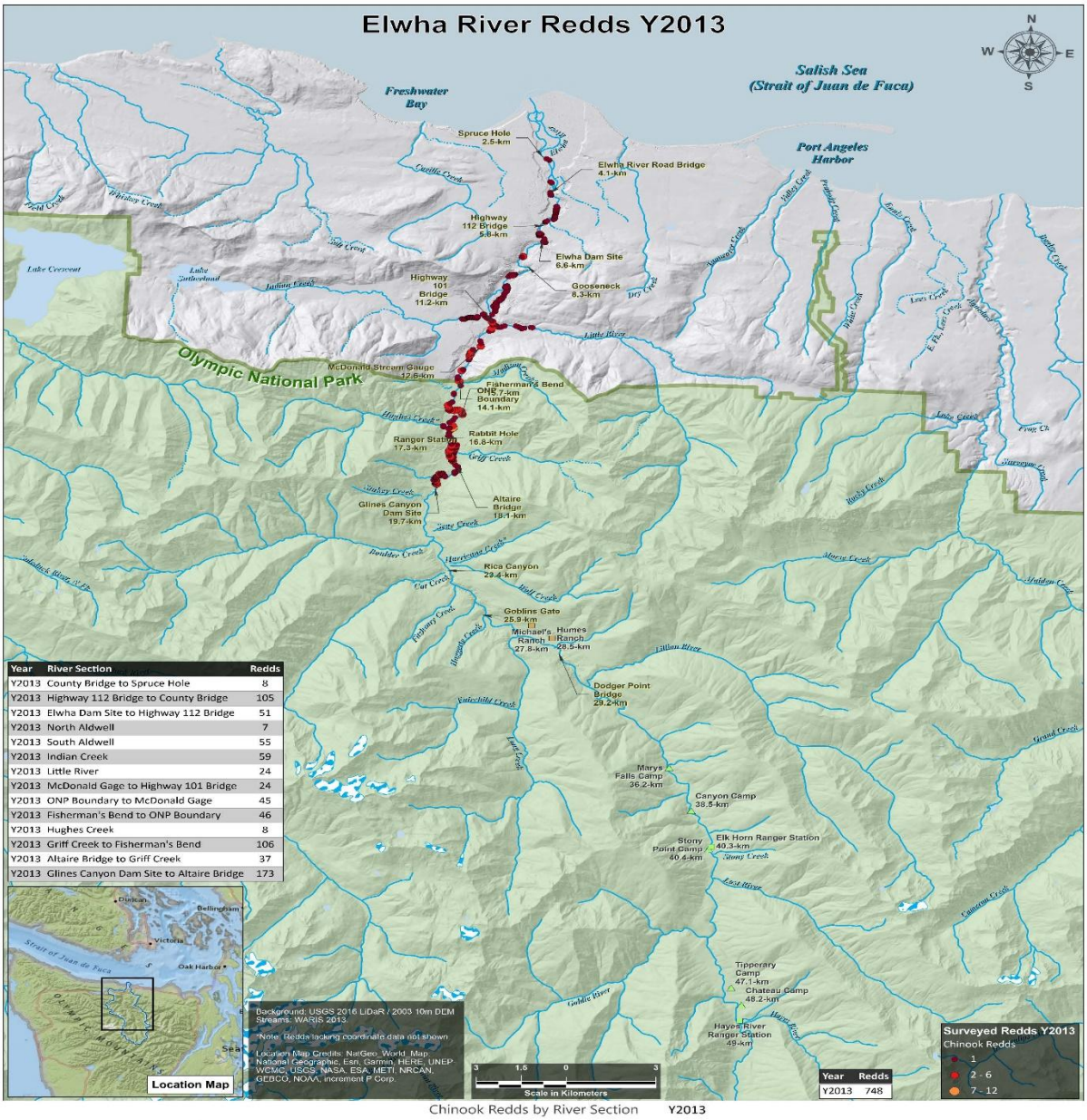
Figure 2. Total number of Chinook salmon redds between former Elwha dam and Glines Canyon dam 2012 to 2025. Blue bars indicate the number of Chinook redds below former Elwha dam. Red bars indicate the number of Chinook redds between former Elwha dam and former Glines Canyon dam, and green bars indicates the number of redds above former Glines Canyon dam. Upper refers to the number of redds above the Grand Canyon of the Elwha.



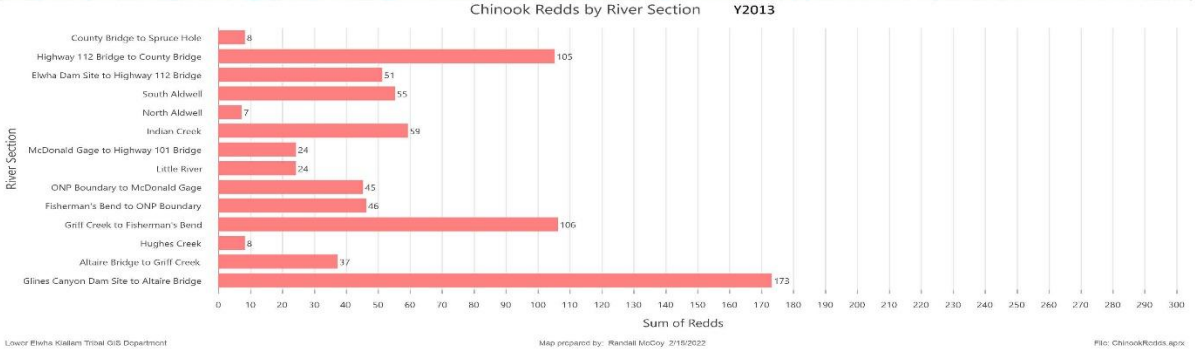
Figures 3. Distribution of Chinook redds in the Elwha River 2012.



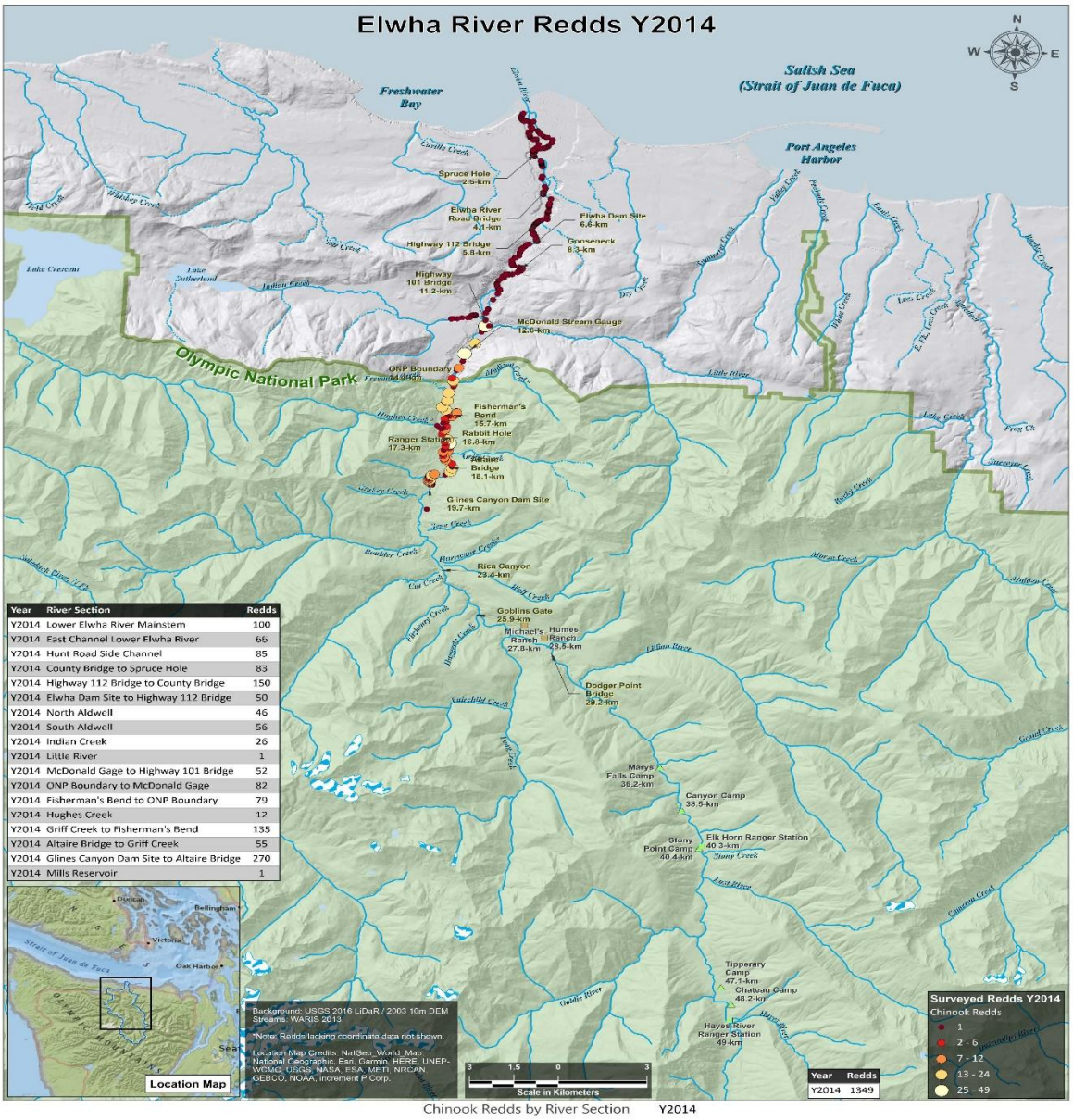
Figures 4. Distribution of Chinook redds in the Elwha River 2013.



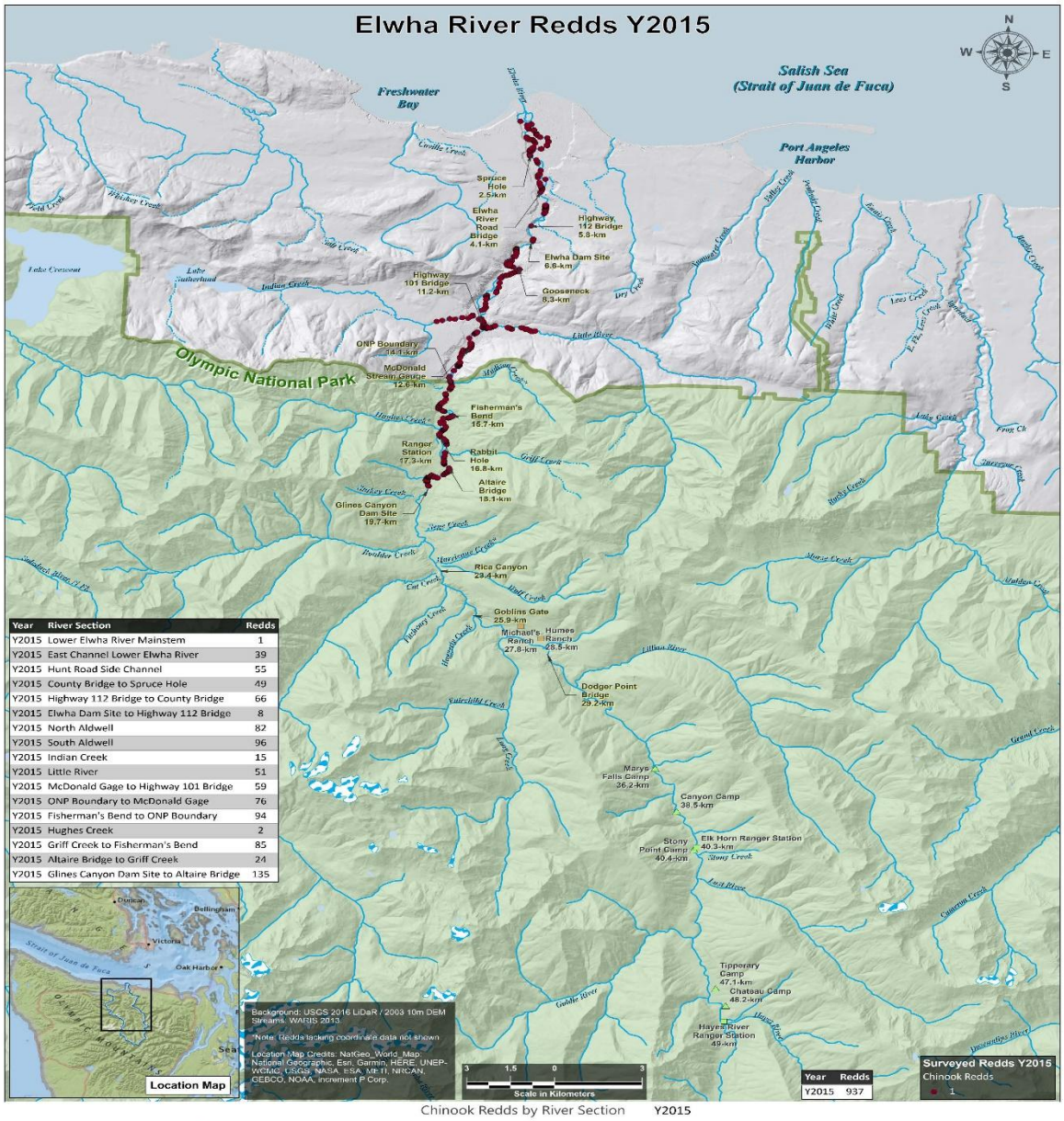

| Year | River Section | Redds |
|---|---|---|
| Y2013 | County Bridge to Spruce Hole | 8 |
| Y2013 | Highway 112 Bridge to County Bridge | 105 |
| Y2013 | Elwha Dam Site to Highway 112 Bridge | 51 |
| Y2013 | North Aldwell | 7 |
| Y2013 | South Aldwell | 55 |
| Y2013 | Indian Creek | 59 |
| Y2013 | Little River | 24 |
| Y2013 | McDonald Gage to Highway 101 Bridge | 24 |
| Y2013 | ONP Boundary to McDonald Gage | 45 |
| Y2013 | Fisherman's Bend to ONP Boundary | 46 |
| Y2013 | Hughes Creek | 8 |
| Y2013 | Griff Creek to Fisherman's Bend | 106 |
| Y2013 | Altaire Bridge to Griff Creek | 37 |
| Y2013 | Glines Canyon Dam Site to Altaire Bridge | 173 |



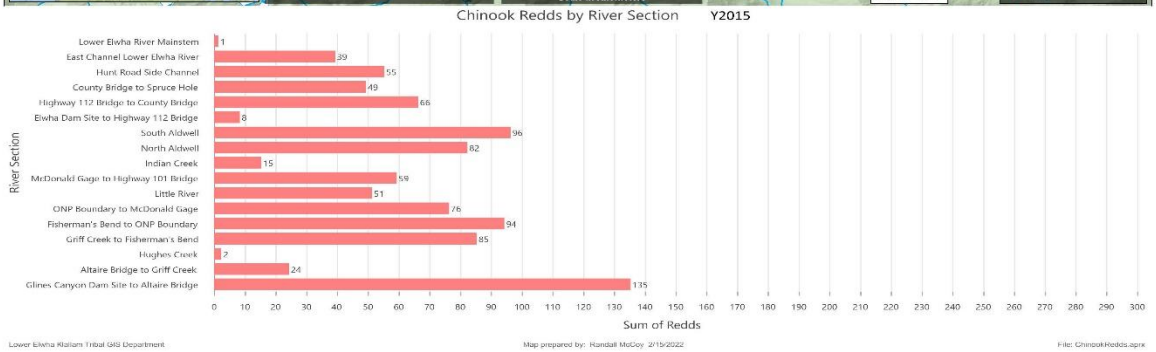
Figures 5. Distribution of Chinook redds in the Elwha River 2014.



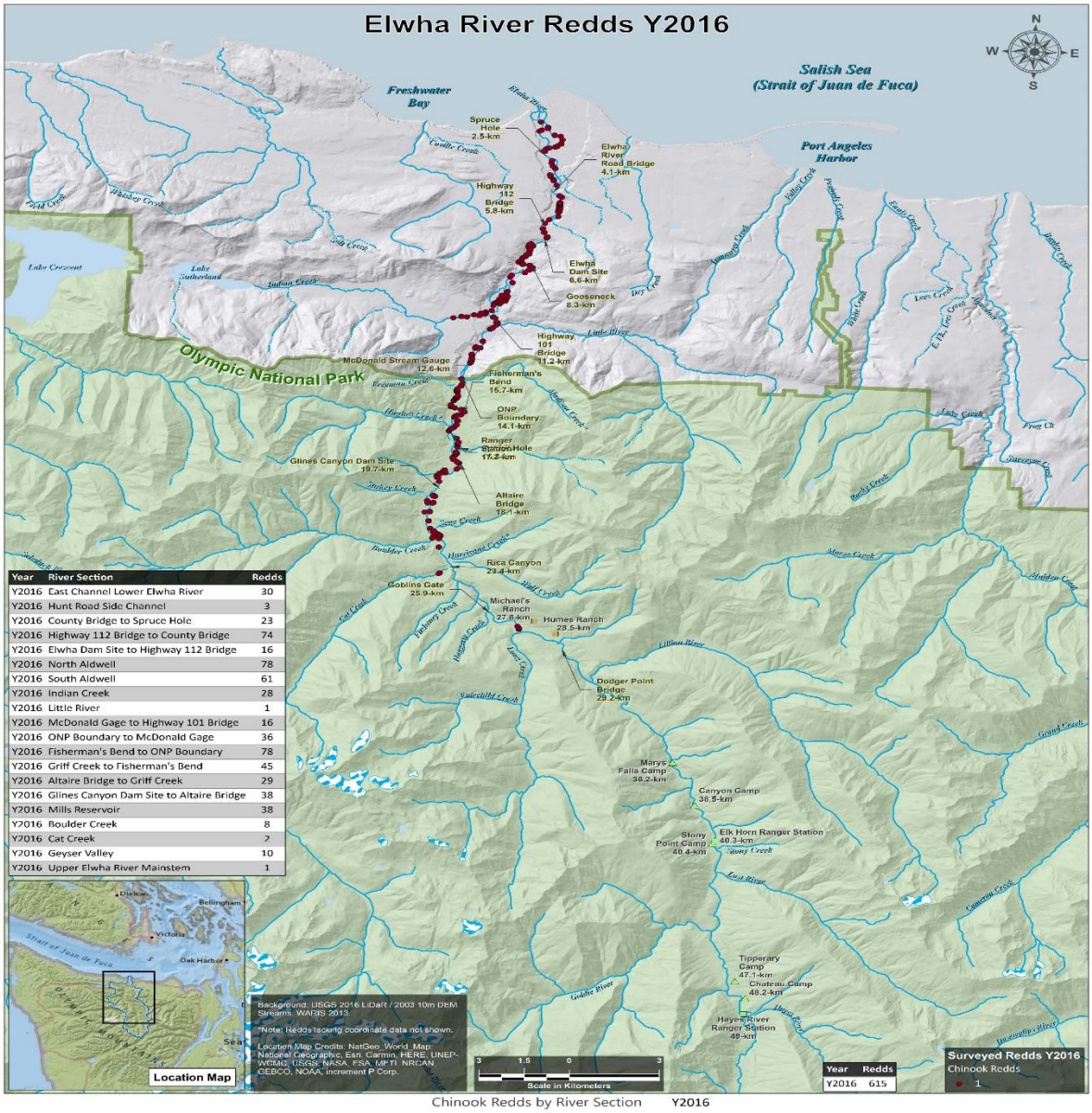
Figures 6. Distribution of Chinook redds in the Elwha River 2015.



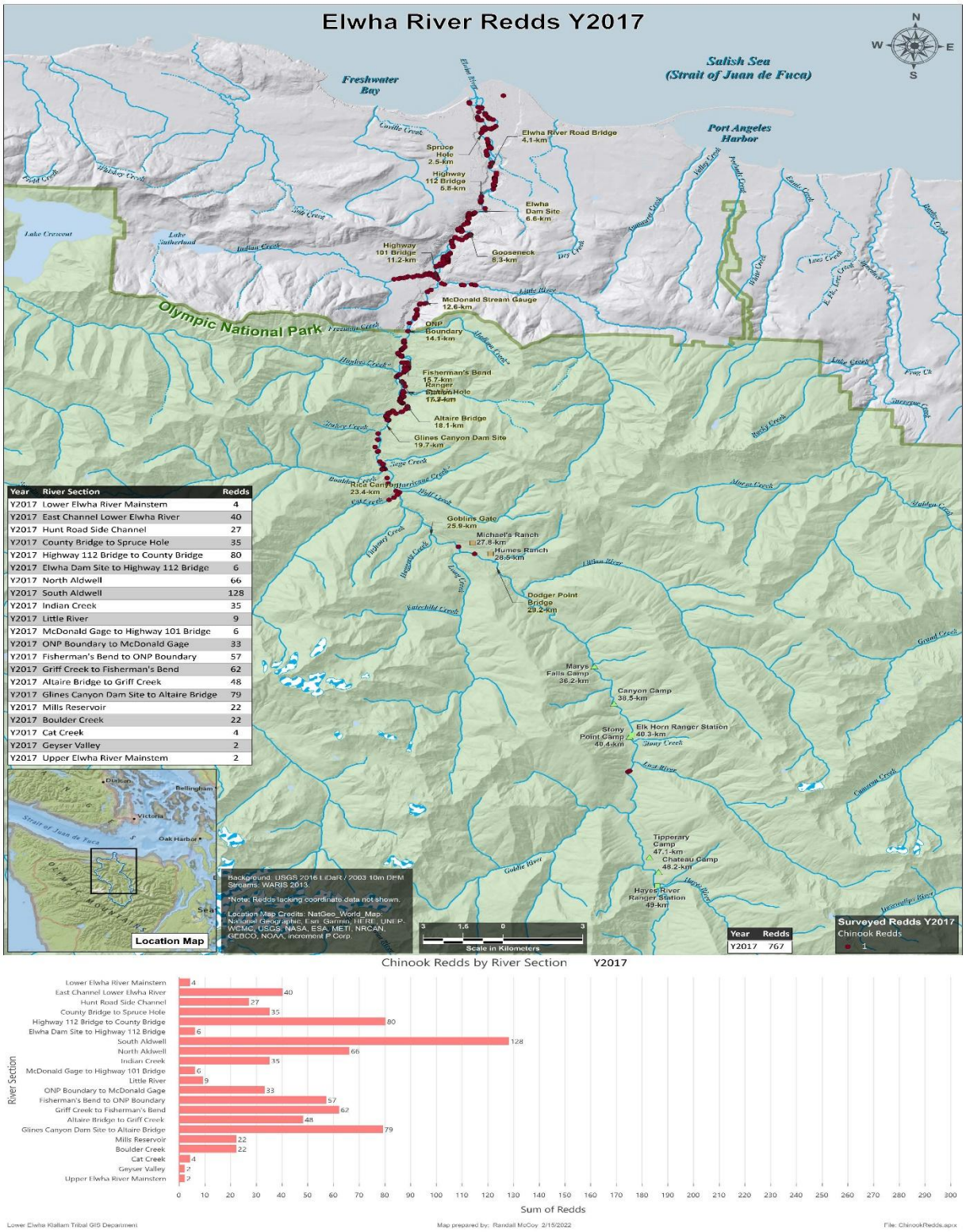

| Year | River Section | Redds |
|---|---|---|
| Y2015 | Lower Elwha River Mainstem | 1 |
| Y2015 | East Channel Lower Elwha River | 39 |
| Y2015 | Hunt Road Side Channel | 55 |
| Y2015 | County Bridge to Spruce Hole | 49 |
| Y2015 | Highway 112 Bridge to County Bridge | 66 |
| Y2015 | Elwha Dam Site to Highway 112 Bridge | 8 |
| Y2015 | North Aldwell | 82 |
| Y2015 | South Aldwell | 96 |
| Y2015 | Indian Creek | 15 |
| Y2015 | Little River | 51 |
| Y2015 | McDonald Gage to Highway 101 Bridge | 59 |
| Y2015 | ONP Boundary to McDonald Gage | 76 |
| Y2015 | Fisherman's Bend to ONP Boundary | 94 |
| Y2015 | Hughes Creek | 2 |
| Y2015 | Griff Creek to Fisherman's Bend | 85 |
| Y2015 | Altaire Bridge to Griff Creek | 24 |
| Y2015 | Glines Canyon Dam Site to Altaire Bridge | 135 |



Figures 7. Distribution of Chinook redds in the Elwha River 2016.



Figures 8. Distribution of Chinook redds in the Elwha River 2017.



Figures 9. Distribution of Chinook redds in the Elwha River 2018.

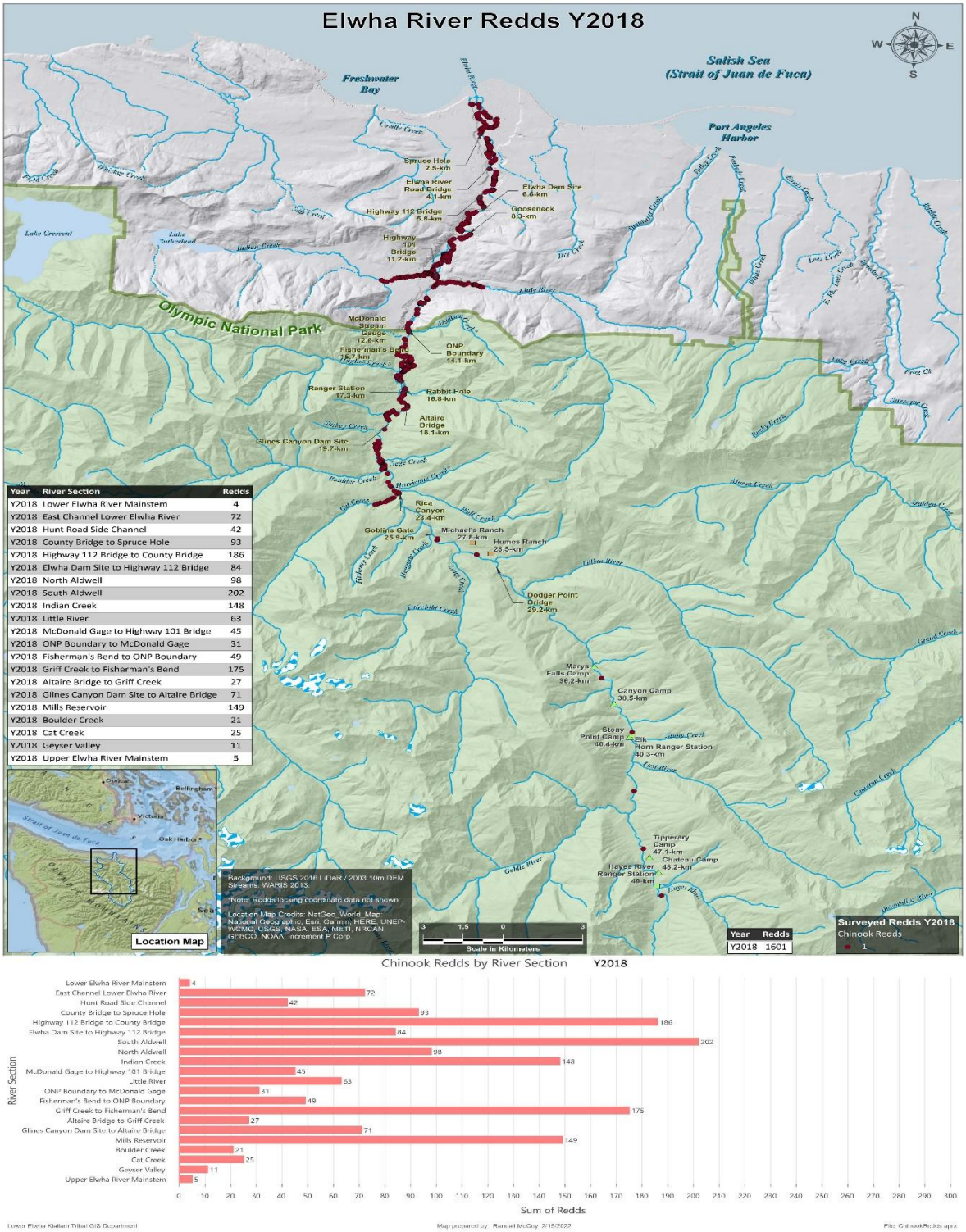


Figure 10. Distribution of Chinook redds in the Elwha River 2019.

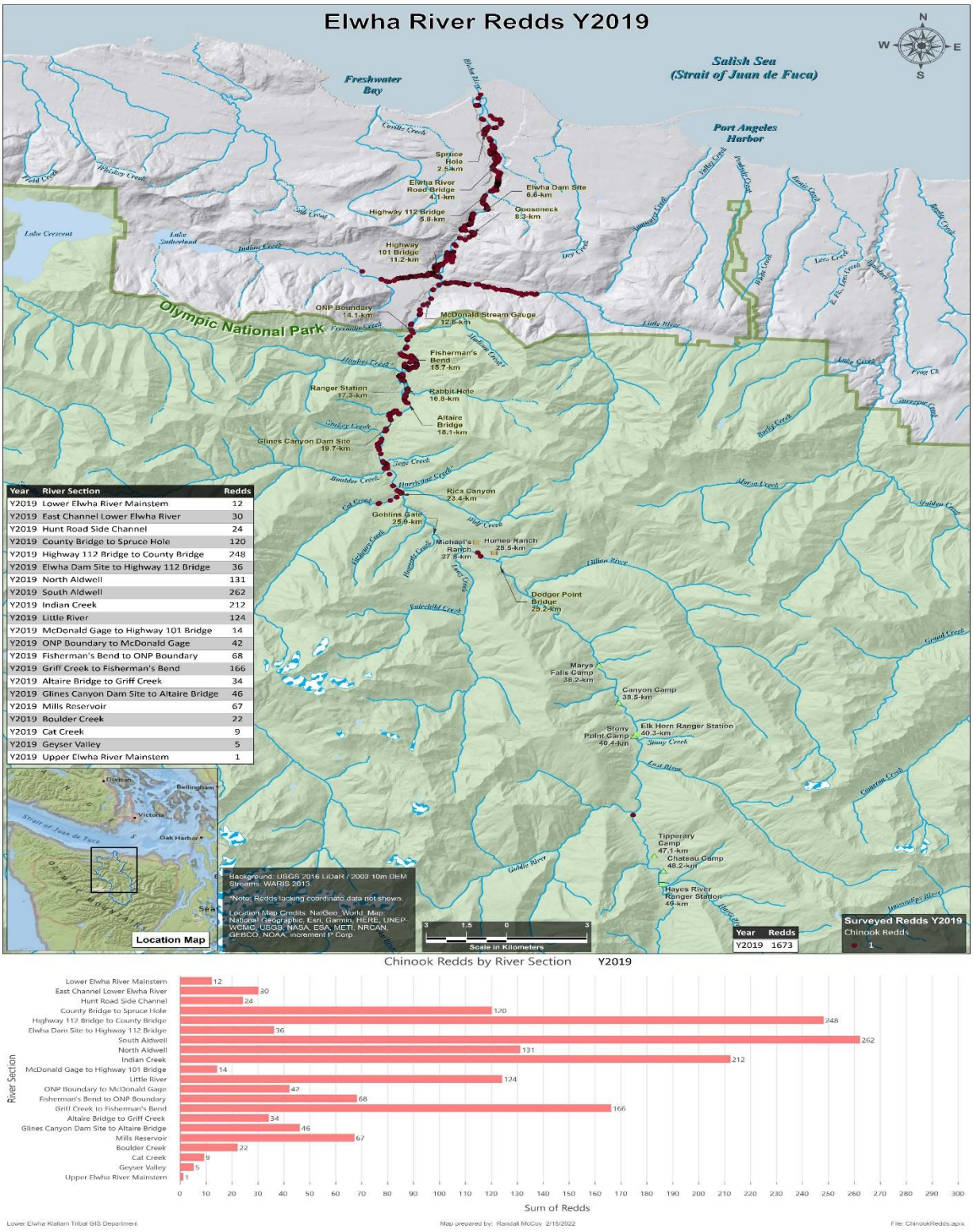
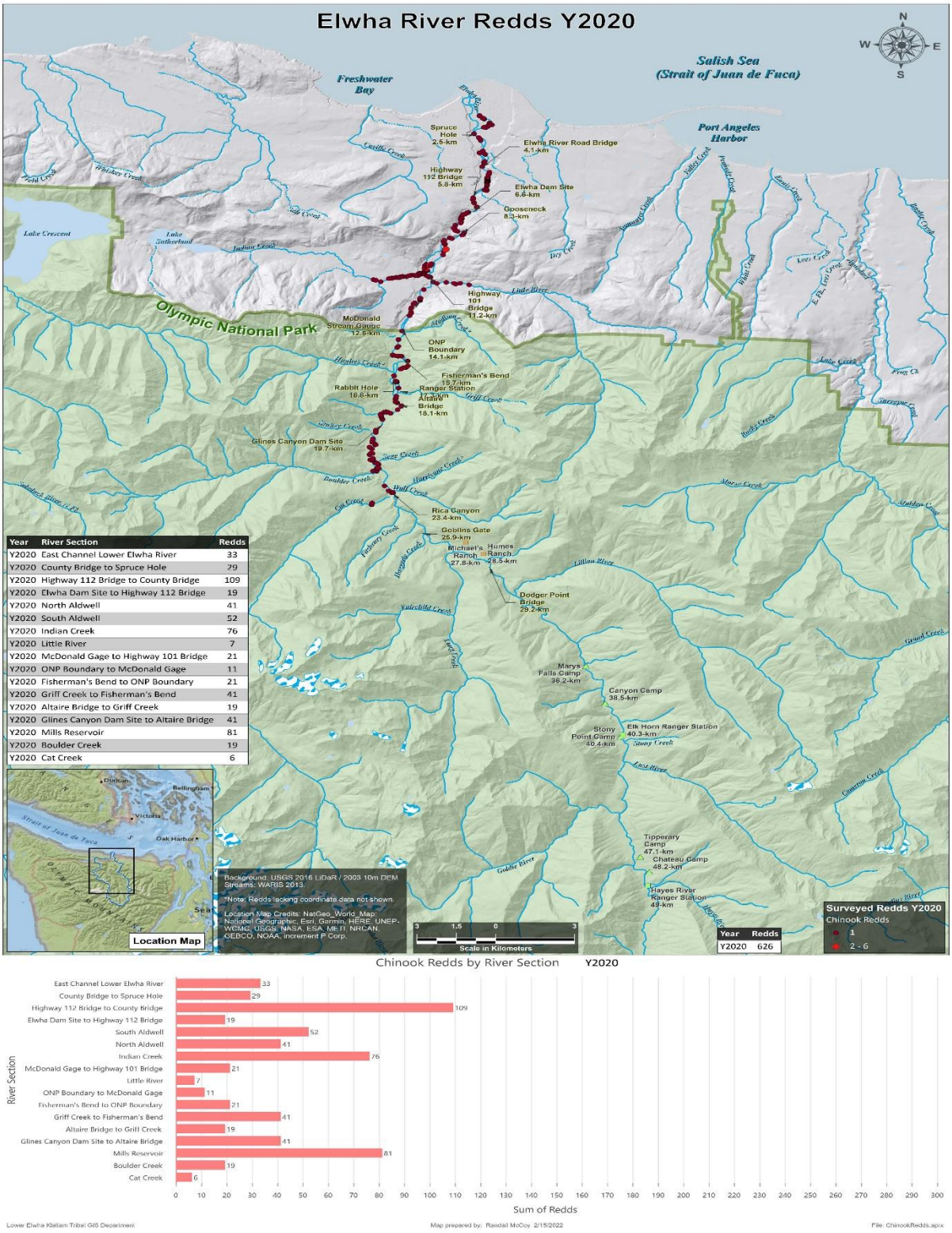


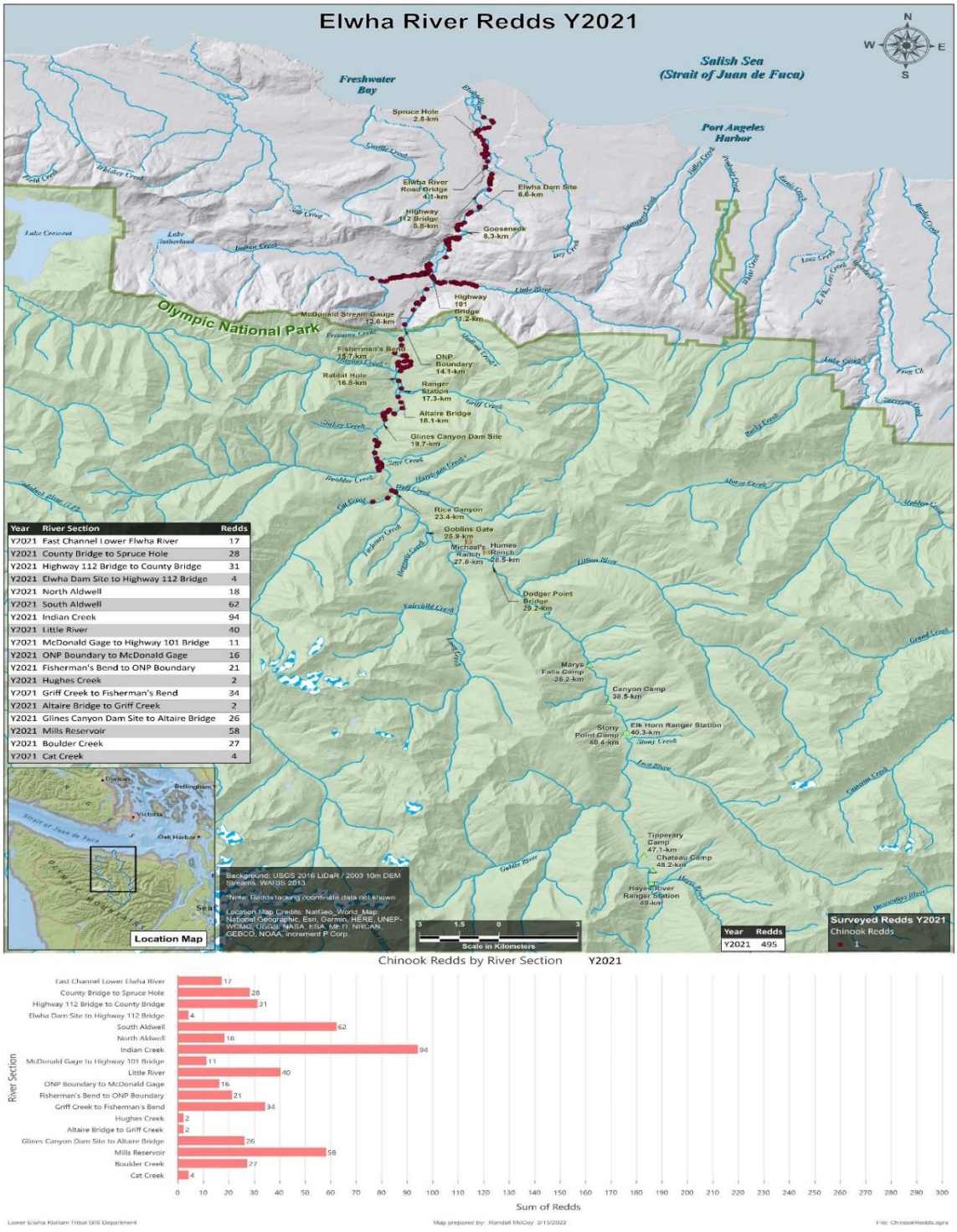
Figure 11. Distribution of Chinook redds in the Elwha River during 2020.




| Year | River Section | Redds |
|---|---|---|
| Y2020 | East Channel Lower Elwha River | 33 |
| Y2020 | County Bridge to Spruce Hole | 29 |
| Y2020 | Highway 112 Bridge to County Bridge | 109 |
| Y2020 | Elwha Dam Site to Highway 112 Bridge | 19 |
| Y2020 | North Aldwell | 41 |
| Y2020 | South Aldwell | 52 |
| Y2020 | Indian Creek | 76 |
| Y2020 | Little River | 7 |
| Y2020 | McDonald Gage to Highway 101 Bridge | 21 |
| Y2020 | ONP Boundary to McDonald Gage | 11 |
| Y2020 | Fisherman's Bend to ONP Boundary | 21 |
| Y2020 | Griff Creek to Fisherman's Bend | 41 |
| Y2020 | Altaire Bridge to Griff Creek | 19 |
| Y2020 | Glines Canyon Dam Site to Altaire Bridge | 41 |
| Y2020 | Mills Reservoir | 81 |
| Y2020 | Boulder Creek | 19 |
| Y2020 | Cat Creek | 6 |

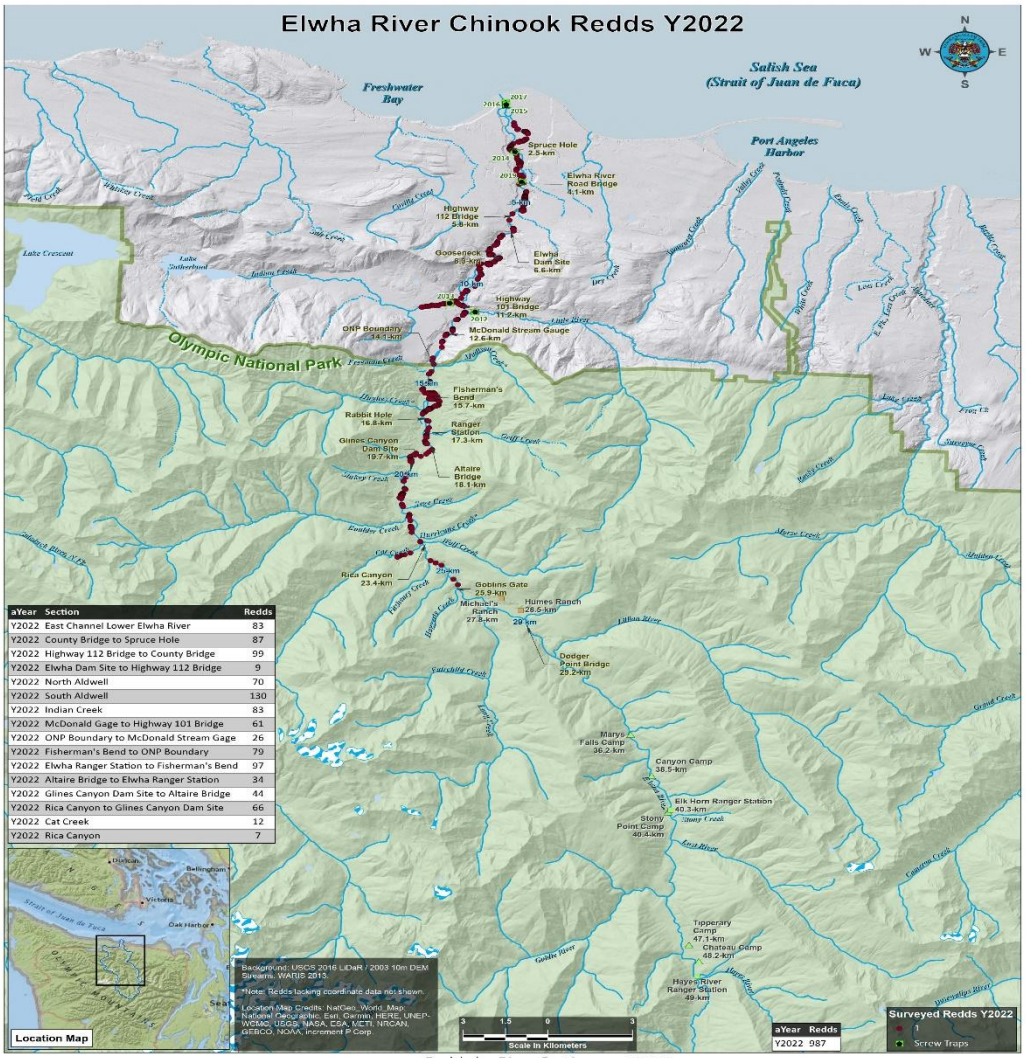
| Year | Redds |
|---|---|
| Y2020 | 626 |

Figure 12. Distribution of Chinook redds in the Elwha River during 2021.




| Year | River Section | Redds |
|---|---|---|
| Y2021 | East Channel Lower Elwha River | 17 |
| Y2021 | County Bridge to Spruce Hole | 28 |
| Y2021 | Highway 112 Bridge to County Bridge | 31 |
| Y2021 | Elwha Dam Site to Highway 112 Bridge | 4 |
| Y2021 | North Aldwell | 18 |
| Y2021 | South Aldwell | 62 |
| Y2021 | Indian Creek | 94 |
| Y2021 | Little River | 40 |
| Y2021 | McDonald Gage to Highway 101 Bridge | 11 |
| Y2021 | ONP Boundary to McDonald Gage | 16 |
| Y2021 | Fisherman's Bend to ONP Boundary | 21 |
| Y2021 | Hughes Creek | 2 |
| Y2021 | Griff Creek to Fisherman's Bend | 34 |
| Y2021 | Altaire Bridge to Griff Creek | 2 |
| Y2021 | Glines Canyon Dam Site to Altaire Bridge | 26 |
| Y2021 | Mills Reservoir | 58 |
| Y2021 | Boulder Creek | 27 |
| Y2021 | Cat Creek | 4 |

Figure 13. Distribution of Chinook redds in the Elwha River during 2022.



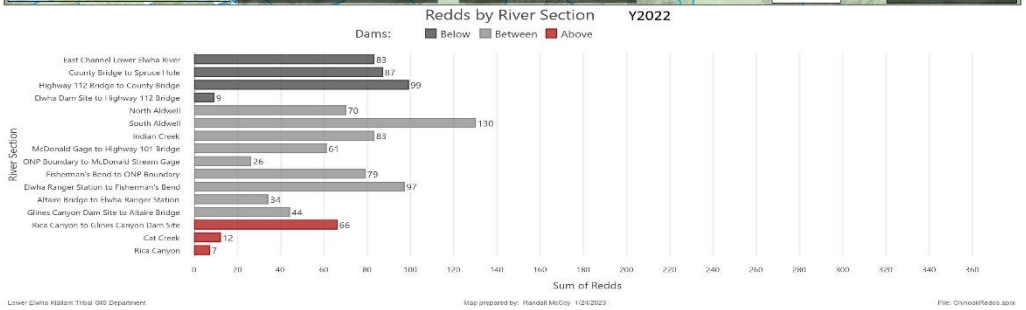



Figure 14. Distribution of Chinook redds in the Elwha River during 2023.

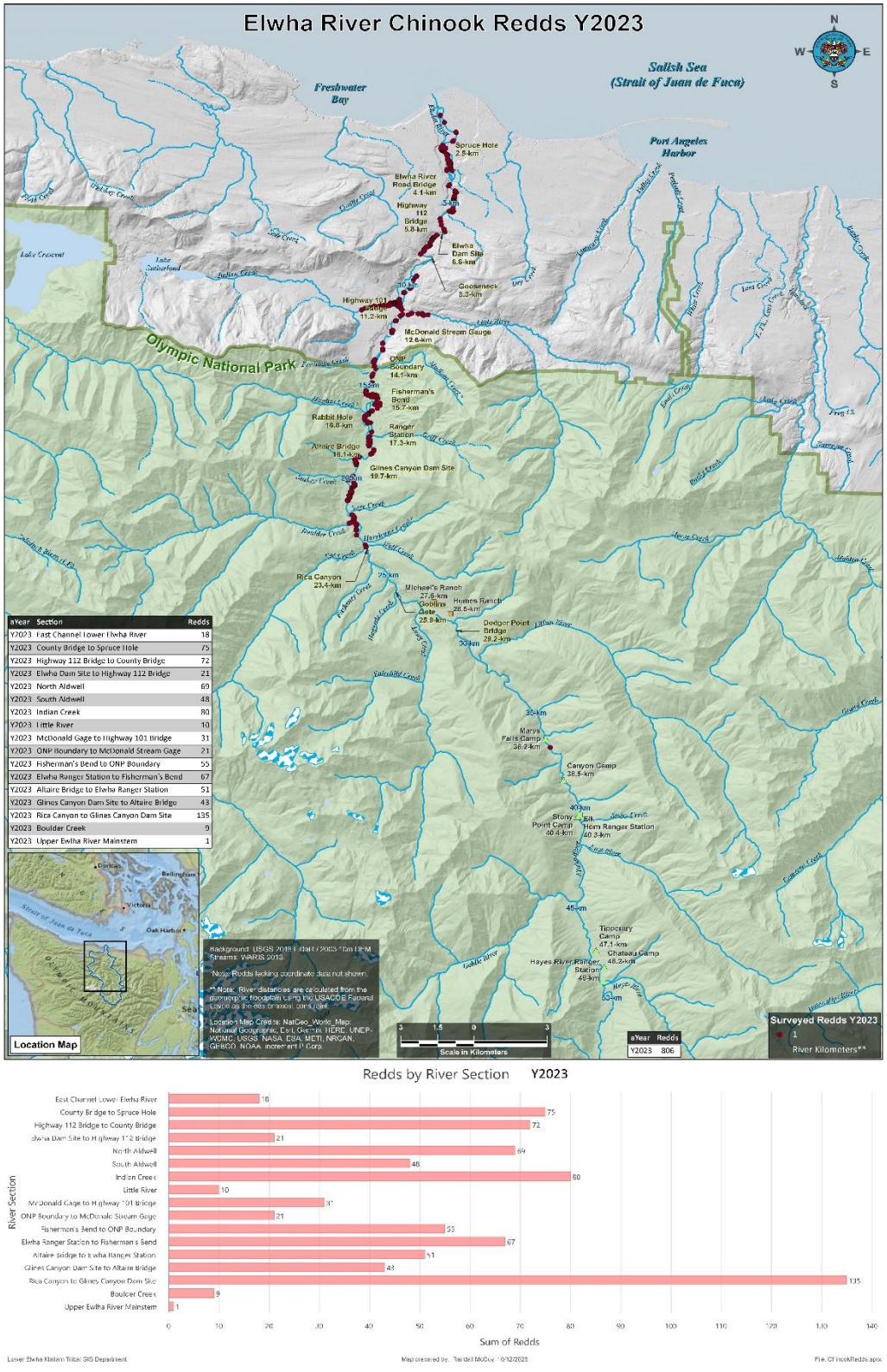
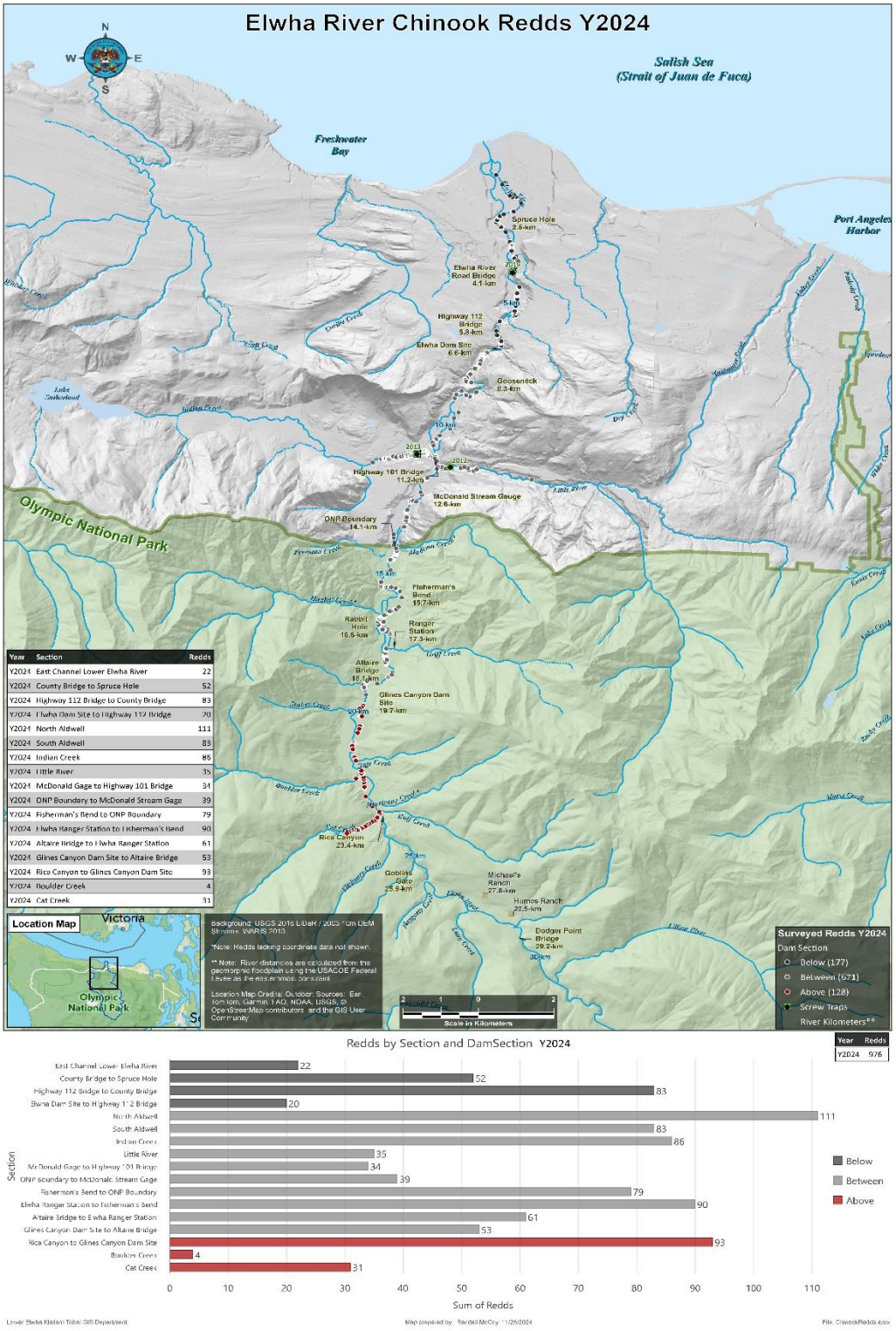


Figure 15. Distribution of Chinook redds in the Elwha River during 2024.




| Year | Section | Redds |
|---|---|---|
| Y2024 | East Channel Lower Elwha River | 22 |
| Y2024 | County Bridge to Spruce Hole | 52 |
| Y2024 | Highway 112 Bridge to County Bridge | 83 |
| Y2024 | Elwha Dam Site to Highway 112 Bridge | 20 |
| Y2024 | North Aldwell | 111 |
| Y2024 | South Aldwell | 83 |
| Y2024 | Indian Creek | 86 |
| Y2024 | Little River | 35 |
| Y2024 | McDonald Gage to Highway 101 Bridge | 34 |
| Y2024 | ONP Boundary to McDonald Stream Gage | 39 |
| Y2024 | Fisherman's Bend to ONP Boundary | 79 |
| Y2024 | Elwha Ranger Station to Fisherman's Bend | 90 |
| Y2024 | Altaire Bridge to Elwha Ranger Station | 61 |
| Y2024 | Glines Canyon Dam Site to Altaire Bridge | 53 |
| Y2024 | Rica Canyon to Glines Canyon Dam Site | 93 |
| Y2024 | Boulder Creek | 4 |
| Y2024 | Cat Creek | 31 |

| Year | Redds |
|---|---|
| Y2024 | 976 |

Figure 16. Distribution of Chinook redds in the Elwha River during 2025.

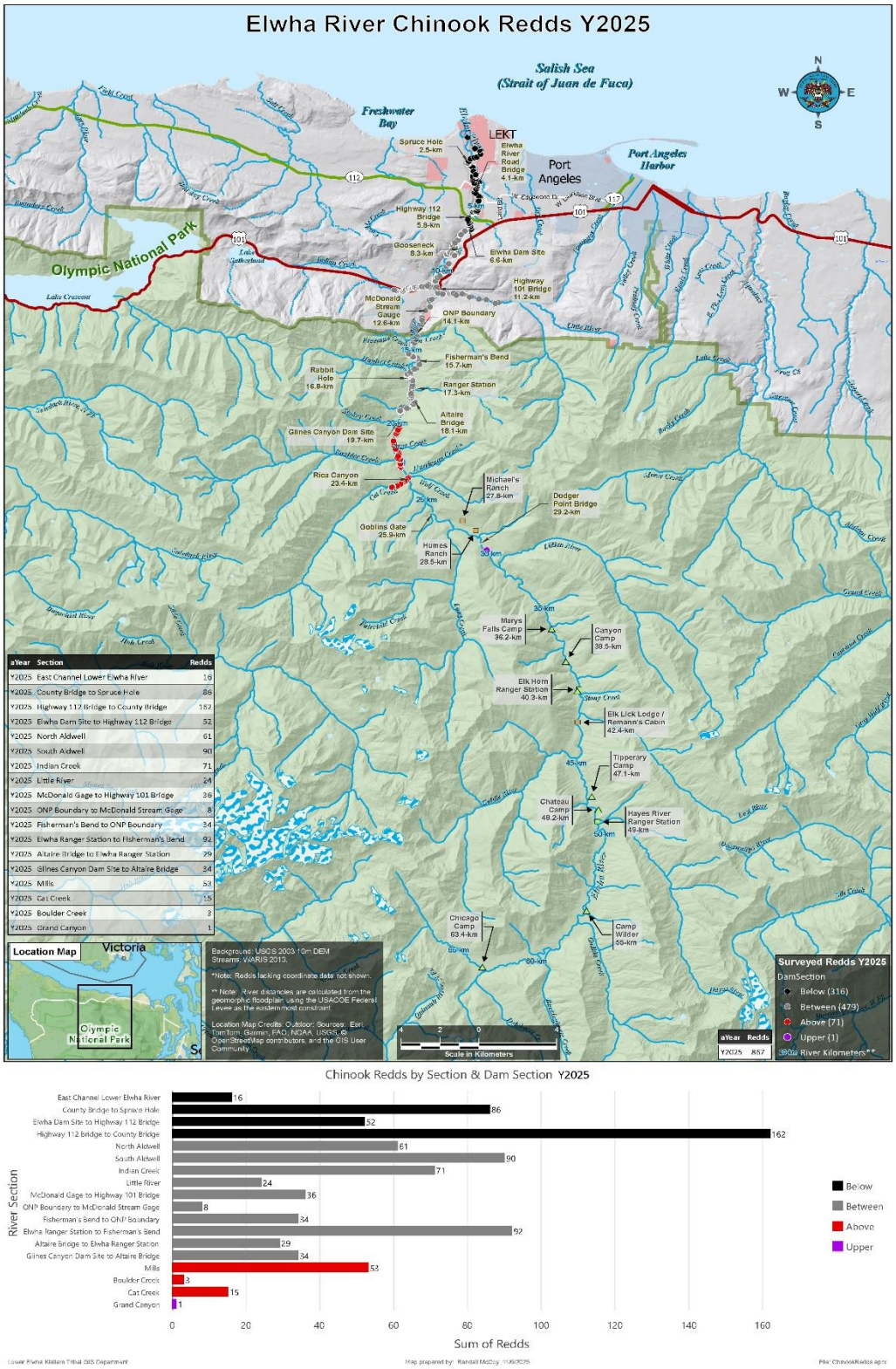


Figure 17. Distribution of Chinook redds in the Elwha River from 2012 to 2025.

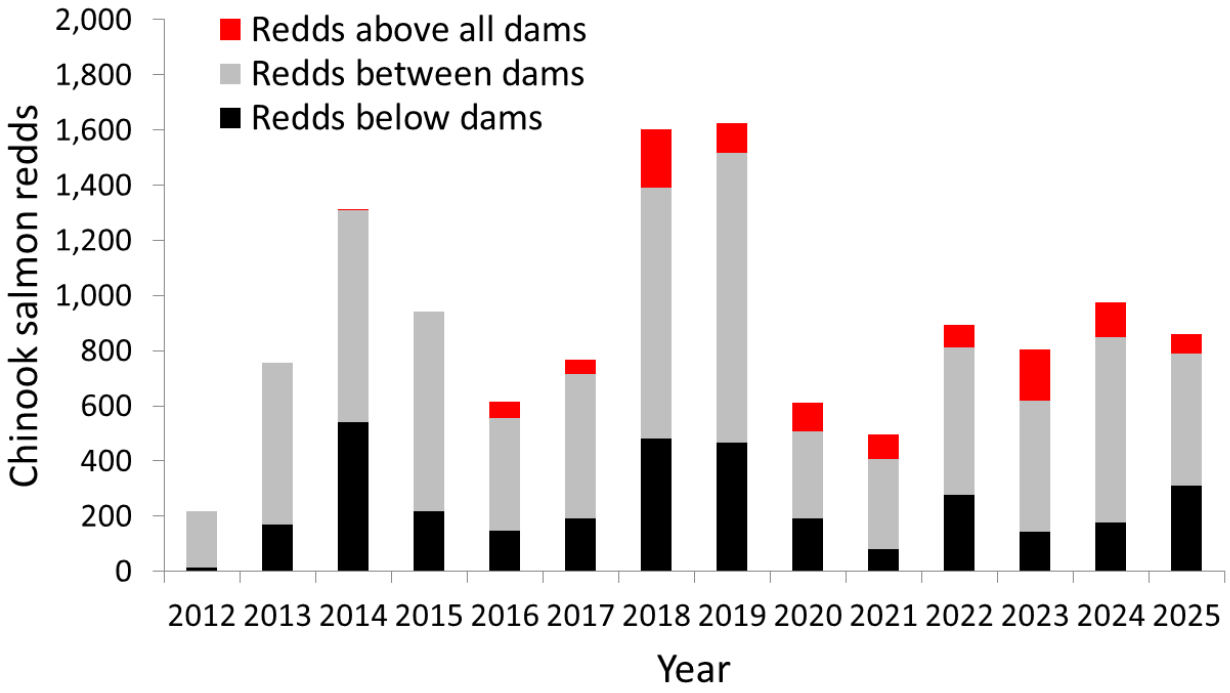


Figure 18. Density of Chinook salmon redds from river kilometer (RKM) 0.0 to 30.0 on the Elwha River 2012 to 2025. Open circles are the mean across years while solid lines with perpendicular bars are the standard errors.

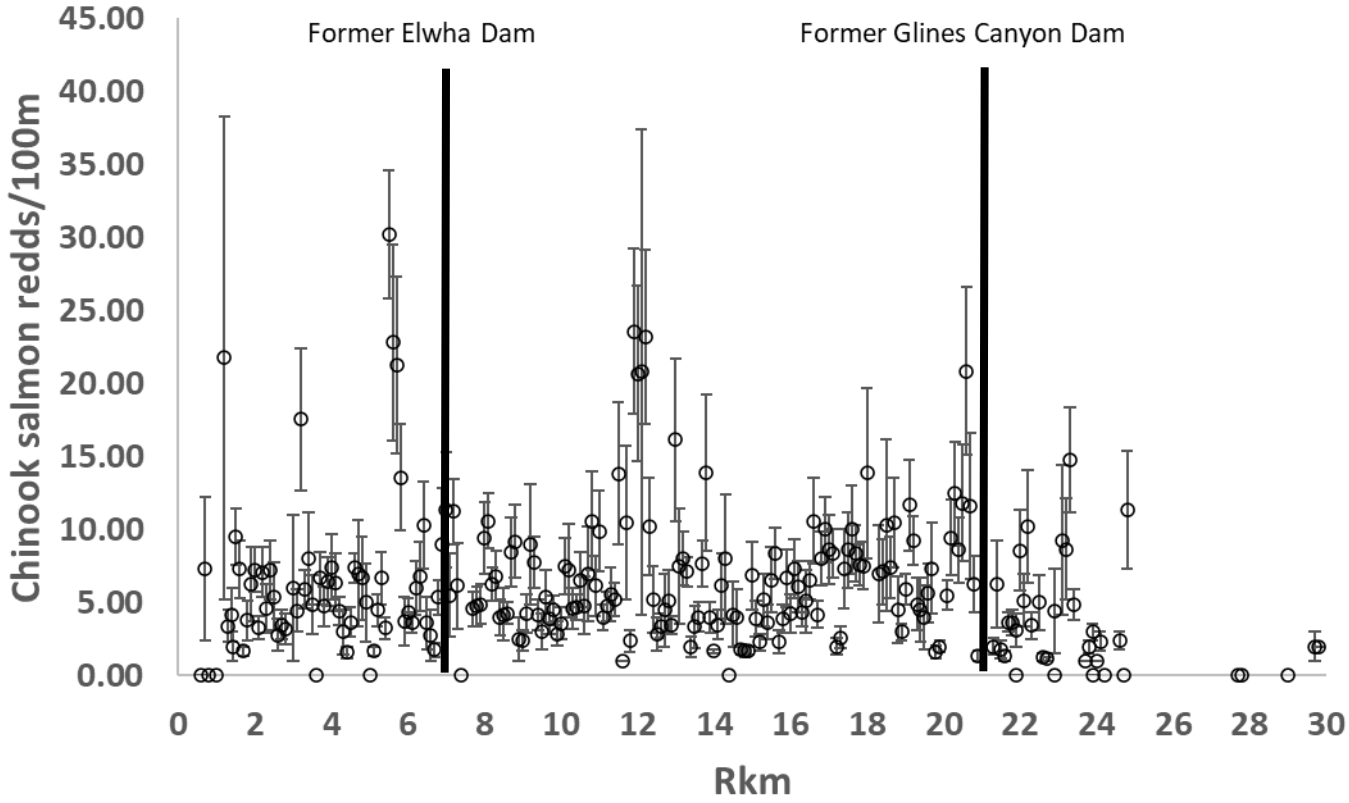
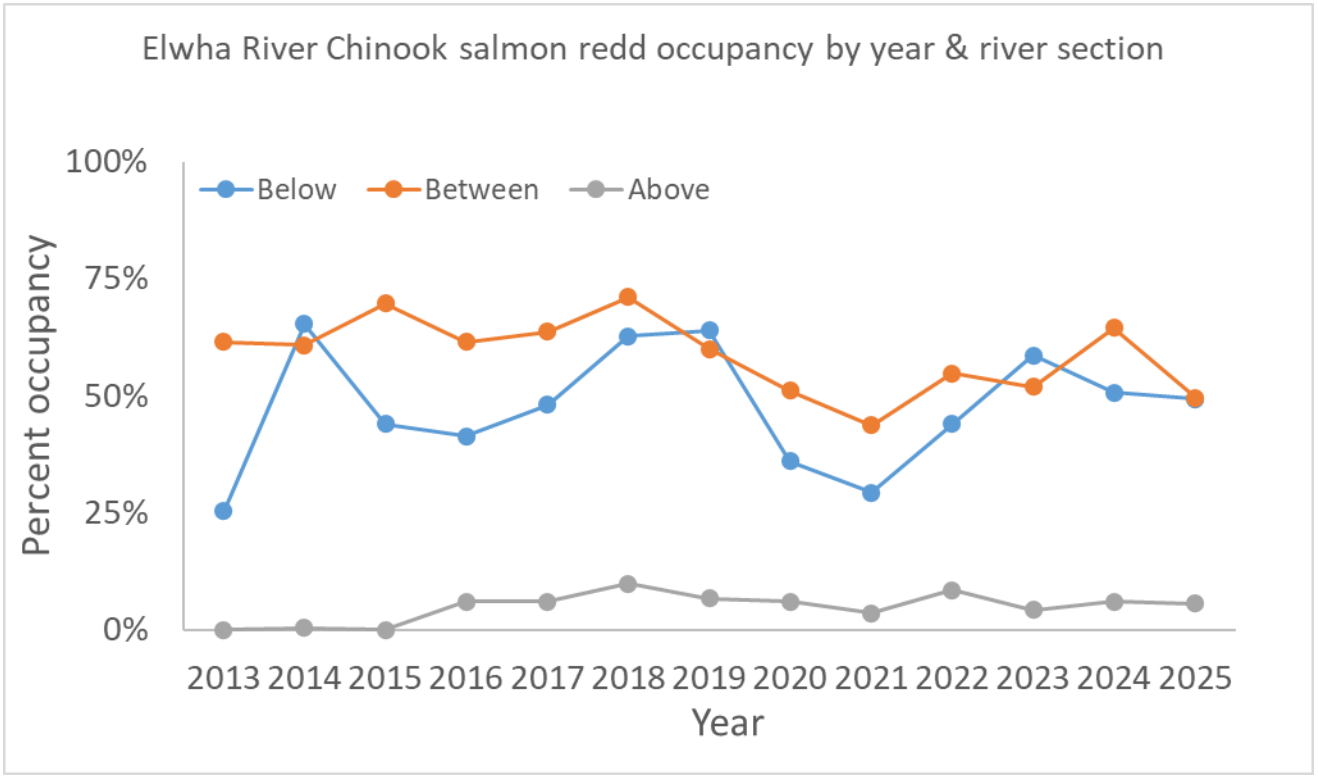


Figure 19. Chinook salmon redd occupancy by year. Chinook salmon redd location was identified to the nearest tenth of a Rkm surveyed from 2013 to 2025 to estimate the total percent linear occupancy for the lower, middle and upper Elwha River.



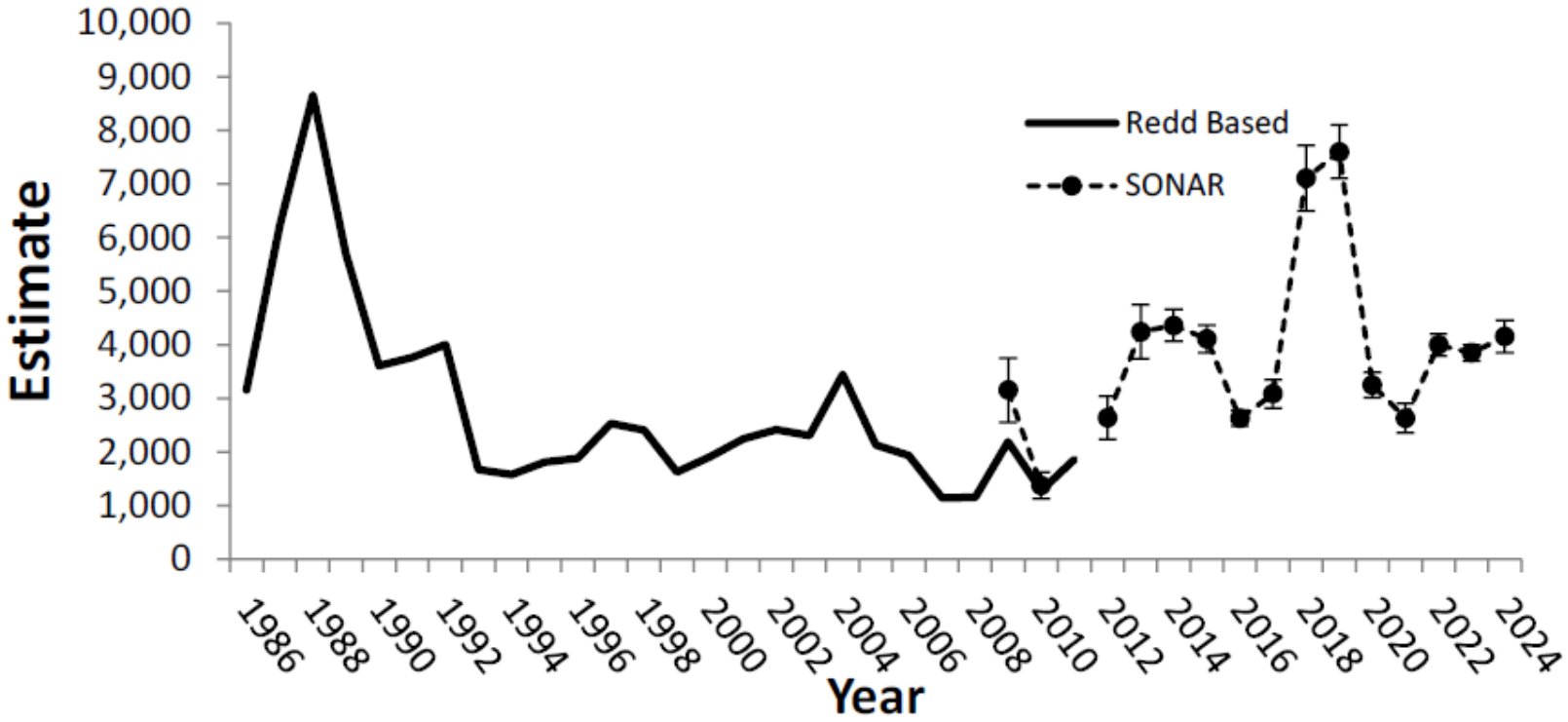



Figure 20. Chinook salmon escapement to the Elwha River 1984-2024 (from Denton et al. 2024). Estimates were made by Chinook salmon redd surveys from 1984-2010. Estimates from 2011-2024 were made using SONAR cameras. Vertical bars indicate 95% CI for SONAR estimates.

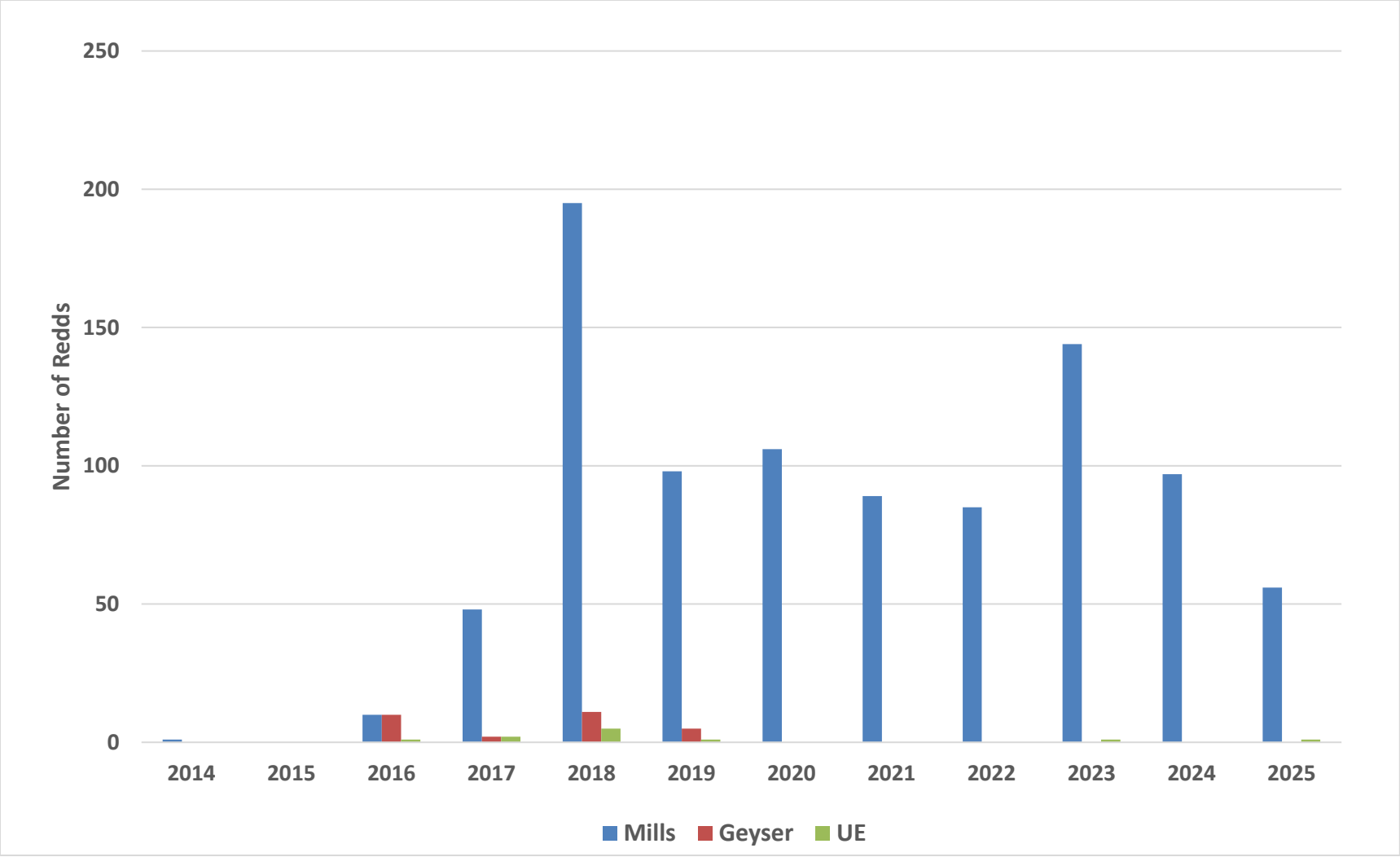



Figure 21. Distribution of Chinook Redds above the former Glines Canyon Dam Site (2014-2025).