

Summary of 2021 winter steelhead (*Oncorhynchus mykiss*) surveys in the Elwha River

**A report submitted by the Lower Elwha Klallam
Natural Resources Department to the Olympic National Park**

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Executive Summary

Winter Steelhead spawning ground surveys have been part of the Elwha River Restoration Project since 2011, thus making 2021 the tenth consecutive year of steelhead redd surveys. Consistent with previous years, we used data from an extensive series of redd surveys to characterize ongoing recolonization of adult steelhead into habitats formerly blocked by two impassable dams. Survey results from 2021 are significant in that it was the fifth consecutive year in which no adult steelhead were relocated from downstream hatcheries and all observations of redds were the result of volitional migration of natural and hatchery origin fish.

Based on these data we report several important preliminary findings. First, we counted a total of 190 redds, which accounts for approximately 14.9-16.5% of the total estimated run size of winter steelhead based on SONAR estimates in 2021. Second, a record number of steelhead continue to volitionally colonize and spawn in several tributaries above the former Elwha dam site. Third, as with last year, a record high number of steelhead redds were observed in the Upper Elwha (above the former Glines Canyon Dam site). The combined patterns suggest that the spatial distribution of spawning winter steelhead is expanding as riverine conditions continue to improve and the abundance of steelhead increases. The results of this year's survey effort strongly suggest the need to expand survey efforts in the upper river to improve knowledge about the spatial distribution of steelhead redds in the watershed as a whole.

Introduction

Visual surveys of salmonid nests (hereafter "redds") and observations of spawning adults can be used to characterize features such as the spatial and temporal distribution of breeding activity (Gallagher et al. 2007) and the presence of alternative life histories including early (summer) entry timing and potential "half-pounders", which are fish that migrate to the sea for a short period before returning to freshwater in an immature state where they over-winter and then migrate back to the ocean to spend one to two years at sea before returning as mature adults (McMillan et al. 2007). The overall purpose of our monitoring effort with respect to spawning steelhead (*Oncorhynchus mykiss*) in the Elwha River Basin is to document the spatial distribution of spawning steelhead as they regain access to their historic habitats in the Elwha River.

As part of the Elwha River Ecosystem and Fisheries Restoration Act, biologists with the Lower Elwha Klallam Tribe (LEKT), Olympic National Park (ONP), and Trout Unlimited (TU) have conducted systematic foot surveys to estimate winter steelhead spawn timing and document the spatial distribution of redds within the watershed. The spatial extent of these surveys includes multiple tributaries as well as opportunistic surveys, as visibility allows, in the mainstem Elwha River from the river mouth upstream, beyond the former Glines Canyon Dam to below the Dodger Point Bridge (entrance to Grand Canyon of the Elwha) (rkm 29.2) (Figure 1). Annual winter steelhead surveys began in 2012 following the removal of the Elwha Dam. These surveys were further expanded above Glines Canyon Dam following its removal in 2014, but have, to date, been limited in extent from the river mouth upstream to the Dodger Pt. Bridge (Rkm 0-29.2), with the exception of some

opportunistic surveys that took place during River Scape snorkel and summer electrofishing surveys (ONP). Comprehensive surveys of winter steelhead redds in the upper Elwha (above Rkm 29.2) have not been conducted to date.

In four of ten years since dam removal (2012, 2013, 2014 and 2016), a portion of the adult winter steelhead, which returned to hatchery facilities in the lower river were relocated above the former Elwha Dam to two tributaries, Little River and Indian Creek. Adult steelhead relocation occurred as a requirement of the NMFS Biological Opinion for the Elwha Project (2012) to avoid potential negative impacts from high sediment levels during dam removal. Adult steelhead were not relocated from 2017-2021, as sediment levels in the river returned to background levels (Ritchie et al. 2018), and adults that returned to the hatchery were needed to support the native broodstock supplementation program at the LEKT Hatchery. Hence, all redd survey data in 2021 reflect those steelhead that spawned volitionally in the tributaries and main-stem Elwha River. Those fish likely represent a mixture of natural origin fish as well as an unknown number from the LEKT hatchery brood program.

In this report we: 1) identify the number of redds observed in each tributary and surveyed sections of the main-stem Elwha River; 2) identify their locations within the watershed; 3) conduct comparisons of the timing and spatial distribution of redd excavation in tributaries from 2012-2021, and; 4) examine redd density levels and occupancy at the watershed-scale. It should be noted that estimates of steelhead abundance in the Elwha are made using SONAR and are reported annually in Denton et al. (2022).

Methods

Redd survey location and timing

Spawning ground surveys conducted on foot were used to determine the location and timing of adult steelhead spawning. Tributary survey areas (estimated percent of potential steelhead spawning habitat surveyed) included Cat Creek (100%), Long Creek (90%), Hurricane Creek (100%), Wolf Creek (100%) and Boulder Creek (100%) in the Upper Elwha and six tributaries in the Middle Elwha: Little River (100%), Indian Creek (25%), Griff (100%), Griff Jr. (100%), Madison (100%), and Hughes Creeks (100%) (Figure 1 and Table 1). Opportunistic surveys of the main stem channel were conducted when flow and visibility allowed through the survey season. However, because of high snowpack in the Olympic Mountains there were prolonged periods of snowmelt in the spring and early summer. Those completed mainstem surveys included the former Aldwell Reservoir (Rkm 7-10.8), former Lake Mills Reservoir above former Glines Canyon Dam (Rkm 21.7-25.7), and a two-time survey of Geyser Valley (Rkm 28.2-31.9). Redd counts took place from early-February through June or early July and were conducted once every 14-21 days as survey conditions allowed. Surveys were conducted in tributaries only when the bottom was visible in the deepest pools and in the mainstem Elwha when visibility allowed.

Surveyors generally walked upstream to enumerate redds. Steelhead redds were identified by disturbed areas in the streambed where gravels were overturned and where a clear depression and associated tailspill were identifiable (Gallagher et al. 2007). Each individual redd was geolocated (latitude and longitude) using a Garmin GPS (model *GPSmap 60CSx*) and marked with a flag that included the redd number for the individual stream,

date observed, surveyor initials and the distance (m) and direction to the redd from the flag.

Data were analyzed in several ways. First, redd counts were organized by date for all sites combined and by tributary to describe spawn timing as a function of Julian day. In 2021, only data from Indian Creek, Hughes Creek, Boulder Creek and Little River were used in this analysis because of the relatively low numbers of redds encountered in other survey areas. Second, redd locations were mapped to show the spatial distribution of steelhead spawning using ArcGIS.

Results

Redd enumeration

We conducted a combined total of 82 redd surveys from early February through late June in the tributaries, of which 64 (78%) surveys were conducted in the tributaries (Table 1). Tributary surveys were detailed and each creek was surveyed between 5-13 times during the season. We conducted nine redd surveys in the main-stem Elwha River, including five above the former Glines Canyon dam and two in the Press Valley. Surveys in the main-stem Elwha were opportunistic and could only be conducted during periods when water clarity was adequate for visibly observing redds.

We counted a total of 190 steelhead redds in the tributaries and main-stem Elwha River in 2021 (Table 1). Of those, we counted 150 (79%) redds in tributaries and their associated side-channels in 2021. In contrast, in three previous years we identified in total 159 redds in 2018, 186 redds in 2019 and 153 redds in 2020. As with previous years, most of those redds were counted in Hughes (41), Boulder (41), Cat (31), Little River (16), and Indian (11) (Table 1; Figure 2). It should be noted that for Griff and Hughes Creek the survey reach includes reaches that meanders across the main-stem Elwha River floodplain. This year's count was the lowest on record to date for Little River (Figure 2). In contrast, total redd numbers were records in two upper Elwha tributaries, Cat and Boulder Creek. We counted a total of 41 redds in the main-stem Elwha River, with the greatest concentrations of steelhead redds being observed in the former Lake Mills reservoir.

Temporal and Spatial Redd Distribution

Temporal patterns indicated a protracted breeding season in 2021 that was similar to previous years. In tributaries the earliest redds were observed February 4 and 10 in Hughes and Boulder Creeks, while the latest redd was observed on June 22 in Hughes Creek. As with the past three to four spawning seasons however, the majority of redds were observed in tributaries from late-March through mid-May. The median date of spawning in Hughes Creek was the third week of April which was similar to 2020. The median spawning date for Hughes, Little, Indian and Boulder Creek were similar (third or fourth week of April) (Figure 3). Data from Boulder Creek shows an expansion of spawn timing over time as steelhead colonized the creek following dam removal (Figure 3d). Comparisons of spawn timing were not possible with other tributaries because of the relatively small number of surveys and redds counted in those places. Additionally, a GPS malfunction resulted in the inability to download some time stamps for Indian Creek and Little River.

Spatially, there were three notable results. First, the number of redds counted in middle river tributaries, Little River and Indian Creek, was relatively low compared to previous years, while the number of redds in creeks above the former Glines Canyon dam area were record highs, suggesting that winter steelhead continue to recolonize the upper watershed habitats (Figure 4) at an increasing rate. Second, it is unknown what the upstream extent of winter steelhead is on the Elwha River and whether winter steelhead can ascend the Grand Canyon¹. Third, Hughes Creek continues to support a very high level and density of spawning steelhead and summer observations suggest a concomitant high level of steelhead fry and parr in the habitats within 1-3 km of where Hughes Creek enters the main-stem Elwha River. Overall the number of redds this past season was lower, the spatial distribution has continued to expand and is now more continuous than it was during the initial stages following dam removal (Figure 4). We summarize the distribution of winter steelhead redds observed in the Elwha graphically from 2013-2021 (Figure 5).

Discussion

As with previous year's surveys (McMillan et al. 2011-2015, 2018-2020; McMillan and Moses 2012; LEKT 2016, 2017), tributary flow and visibility conditions in the tributaries generally allowed for enough redd surveys to assess the spatial distribution of spawning by winter steelhead. Further, as with previous years, a substantial and protracted period of snow prevented mainstem surveys during periods in the spring. Thus, we were still able to evaluate the timing of spawning in some creeks and we found additional evidence that winter steelhead continue to increase their spawning distribution above the former dam sites.

The total of 190 winter steelhead redds in the main-stem Elwha and its tributaries is represents an increase of 19% over 2020. The SONAR monitoring estimated the 2021 winter steelhead run size to be 2,293 steelhead (Denton et al. 2021), a record high since the project began. If we assume a 50:50 sex ratio and that each female dug only one redd, the 190 redds equates to a total of 380 winter steelhead. Of course, those assumptions may vary if females excavate more than one redd. For example, WDFW assumes 1.8 fish per redd to account for females digging more than one redd. Their method would equate to approximately 342 winter steelhead. This means the total number of redds we observed in Elwha River, accounts for 14.9% (assuming 1.8 fish/redd) to 16.5% (assuming 2 fish/redd) of the population, per the Denton et al. (2021) estimate, which is slightly lower than 2020 when redd surveys accounted for 16-18% of the total (McMillan et al. 2018) and notably lower than 2019 when we accounted for 40-50% of the redds (SONAR estimate of 1,458) (McMillan et al. 2019). The low percentage of potential redds suggest that winter steelhead are spawning in areas that are not surveyed or only opportunistically surveyed, possibly the upper Elwha. The increase in numbers observed in the middle and upper Elwha, suggests steelhead continue to increase their presence in the upper Elwha.

Temporally, median spawn timing in Hughes Creek was relatively early compared to other seasons, while the timing in Little River fell well within the range documented in previous seasons. However, it should be noted that the spawn timing data in Little River is

¹ Summer run Steelhead have been documented upstream of the Grand Canyon.

based on fewer redds than found in most previous years, and we surveyed upper Little River too infrequently to draw inferences about spawn timing in that section. Consequently, the timing of spawning in upper Little River may differ from lower Little River.

We observed that much of the spawning in Hughes Creek occurs in the portion of the creek where it meanders across the floodplain near its confluence with the mainstem Elwha. In 2021, the majority of redds were observed in the first 30 m and the density of redds suggested that superimposition was occurring (Personal Communication, Pat Crane, ONP). It is likely that there is ample hyporheic recharge that may be attracting spawning steelhead to this area.

Among the tributaries in the middle river, Hughes Creek, Little River, and Indian Creek continue to provide important spawning habitats. There has been a steady increase in redds in Hughes Creek since dam removal and last year's count was higher than Little River and Indian Creek combined (McMillan et al. 2011-2016, 2018-2020; McMillan and Moses 2012). Still, we only survey a small portion of Indian Creek, and yet each year there are numerous steelhead smolts caught in the creek's trap, suggesting there are many more adults using the creek than we are aware of. This is likely because we can only survey a small portion of the total stream due to difficult access, or perhaps, additionally, juveniles are moving into Indian Creek from the main-stem Elwha or nearby Little River. Smolt outmigration numbers from Indian Creek indicate that large numbers of steelhead are emigrating out of Indian Creek (McHenry et al. 2022). The smolt trap data highlight the value of using different methods to monitor recolonization, because without the smolt data we would likely underestimate Indian Creek's contribution to Elwha steelhead recovery.

In the upper river, Boulder and Cat Creek's stands out for its increased redd counts over the past three years. Further, the entire former Lake Mills section appears to support many juvenile steelhead. This past summer John McMillan and Raymond Moses walked most of the former Lake Mills area and YOY steelhead were abundant in all the side channels and the main-stem channel margins, most of which are presumably offspring of winter steelhead. Juvenile sampling from the area also supports this hypothesis. As discussed in prior annual steelhead reports, the combination of a floodplain with larger substrate, numerous side channels, and large amount of solar radiation on the former Mills reservoir surface. Continued monitoring and evaluation of the survival and growth of juvenile steelhead in different areas of the Elwha River basin should help elucidate mechanisms that are potentially influencing their recolonization success.

The main-stem Elwha River is the most difficult habitat to visually observe redds because of increased turbidity during late spring and early summer, and also because much of the upper Elwha is located remotely in the backcountry, which is too difficult to access and survey. We opportunistically conducted eighteen single-day surveys and counted 41 redds, suggesting there are quite a few fish spawning in the main-stem Elwha many of which are unaccounted for. Given the conditions typical of each spring, it is unlikely surveyors will have much success trying to visually count redds covering short distances of the main-stem Elwha River. The sampling windows are simply too short. Another method is to conduct helicopter flights each spring as conditions allow with a focus on the upper Elwha. Washington Department of Fish and Wildlife (WDFW) has proposed conduction such

surveys in 2022 as part of their aerial redd monitoring program for coastal Washington steelhead. If successful this data would likely improve knowledge about the spatial distribution and abundance of redds in the main-stem Elwha River.

In summary, we report three important findings. First, a substantial number of steelhead continue to volitionally recolonize and spawn in several tributaries in the Upper and Middle Elwha River. Second, the spawn timing of steelhead was the earliest on record for Hughes Creek, despite a relatively cold winter. Third, despite the low redd counts overall in some tributaries, Boulder Creek and Cat Creek located in the Upper Elwha contained a relatively high number of redds, which is a positive sign for recolonization. These findings suggest that the spatial distribution of spawning winter steelhead is expanding and is likely to continue expanding as riverine processes continue to improve and the abundance and diversity of spawning steelhead increases.

Acknowledgements

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TABLES

Table 1. Description of survey locations, reach (100% surveyed - indicates entire section of anadromous habitat was surveyed), number of surveys conducted, number of steelhead relocated, and the total number of redds counted in 2021.

Site	Reach location (km)	# Surveys	Steelhead relocated	Redds (#/km)	% Surveyed
Little R.	0.0 – 4.7	5	None	16 (3.4)	100% ²
Indian Ck.	0.0 – 2.4	5	None	11 (4.6)	25%
Mainstem Elwha	various	6	None	41	<5%
Madison Ck.	0.0 - 0.6	8	None	0 (0)	100%
Griff Ck. & SC	0.0 - 0.95	11	None	7 (7.4)	100%
Griff Jr. Ck.	0.0 – 0.4	2	None	0 (0)	100%
Hughes Ck.	0.0 - 0.9	13	None	41 (45.5)	100%
Boulder Ck.	0.0 – 0.3	9	None	41 (136.6)	100%
Cat Ck.	0.0 – 1.1	9	None	31 (34.4)	100%
Wolf Ck.	0.0 – 0.2	7	None	2 (10.0)	100%
Hurricane Ck.	0.0 - 1.6	7	None	0 (0.0)	100%
Long Ck.	0.0 – 0.5	2	None	0 (0.0)	100%
Totals	13.1	82	0	190	

² Estimated proportion of usable habitat – total available habitat for steelhead is unknown for this tributary

Table 2. Numbers of wild (W) and hatchery-origin (H) steelhead relocated to Indian Creek and Little River and steelhead redds observed annually since the inception of steelhead monitoring in the Middle Elwha River in 2012.

Year	Indian Creek		Little River	
	W:H	Redds	W:H	Rd
2012	11:0	9	35:0	43
2013	0:0	24	53:35	47
2014	0:0	36	1:58	73
2015	0:0	6	0:0	36
2016	3:35	7	0:0	28
2017	0:0	16	0:0	37
2018	0:0	15	0:0	48
2019	0:0	29	0:0	43
2020	0:0	7	0:0	18
2021	0:0	11	0:0	16

FIGURES

Figure 1. Map of Elwha River basin and location of streams where redd surveys were conducted for winter steelhead from February-July 2021. Stars indicate locations of (working south to north) Long Creek, Cat Creek, Hurricane Creek, Wolf Creek, Boulder Creek, Griff Creek, Hughes Creek, Campground Creek (no longer surveyed), Madison Creek, Little River, Indian Creek, and the WDFW Hatchery outflow (no longer surveyed).

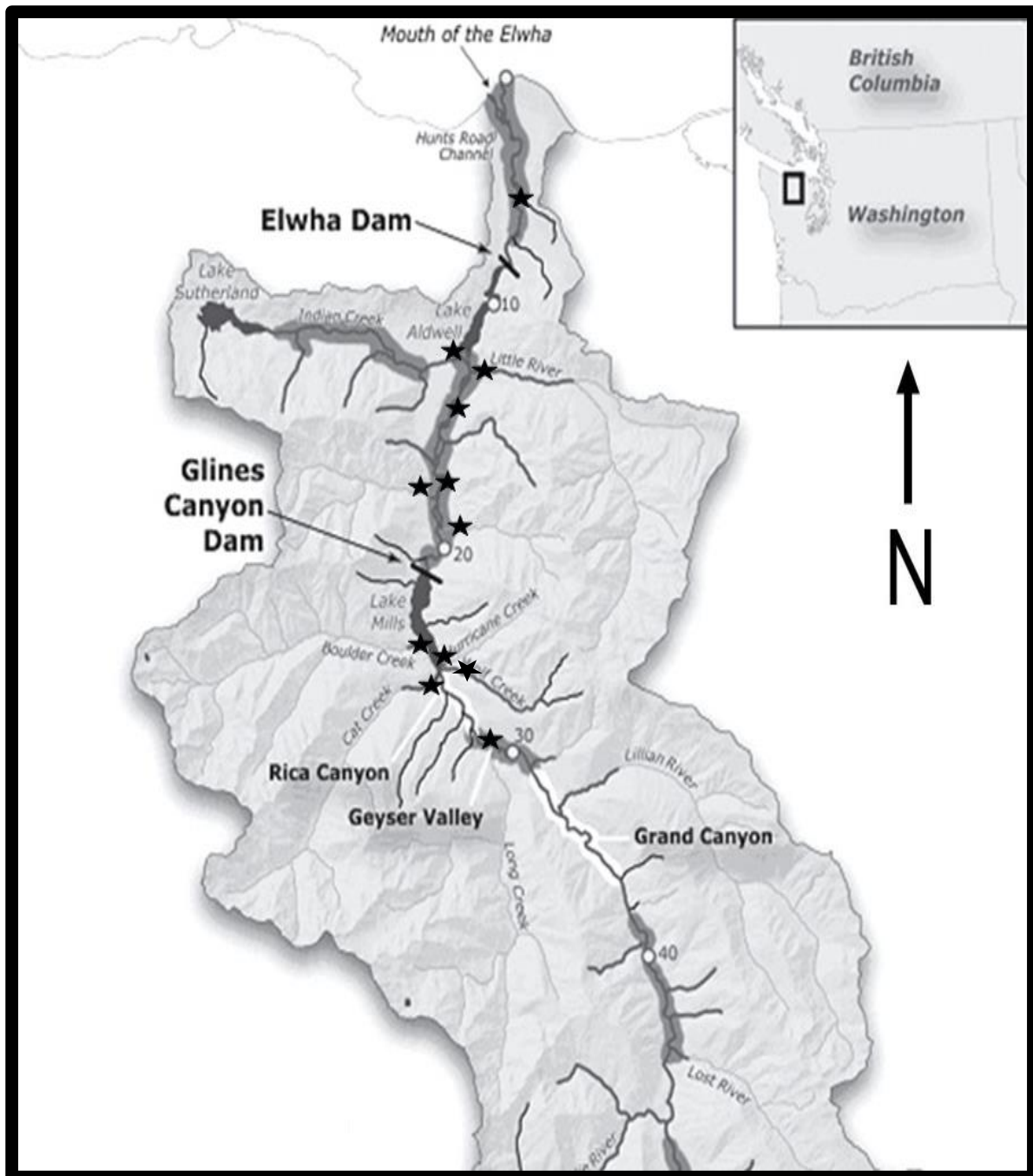


Figure 2. Number of winter steelhead redds counted in tributary by year in the Elwha River basin since steelhead were first reintroduced to habitat above the former Elwha Dam site. Location of stream confluence with main-stem Elwha River works upstream from left to right based on Figure 1, with Indian Creek being the lower most tributary and Long Creek the upper most stream that we have surveyed for steelhead redds. Asterisks indicate years in which surveys were not conducted, while blank areas indicate zero redds were observed.

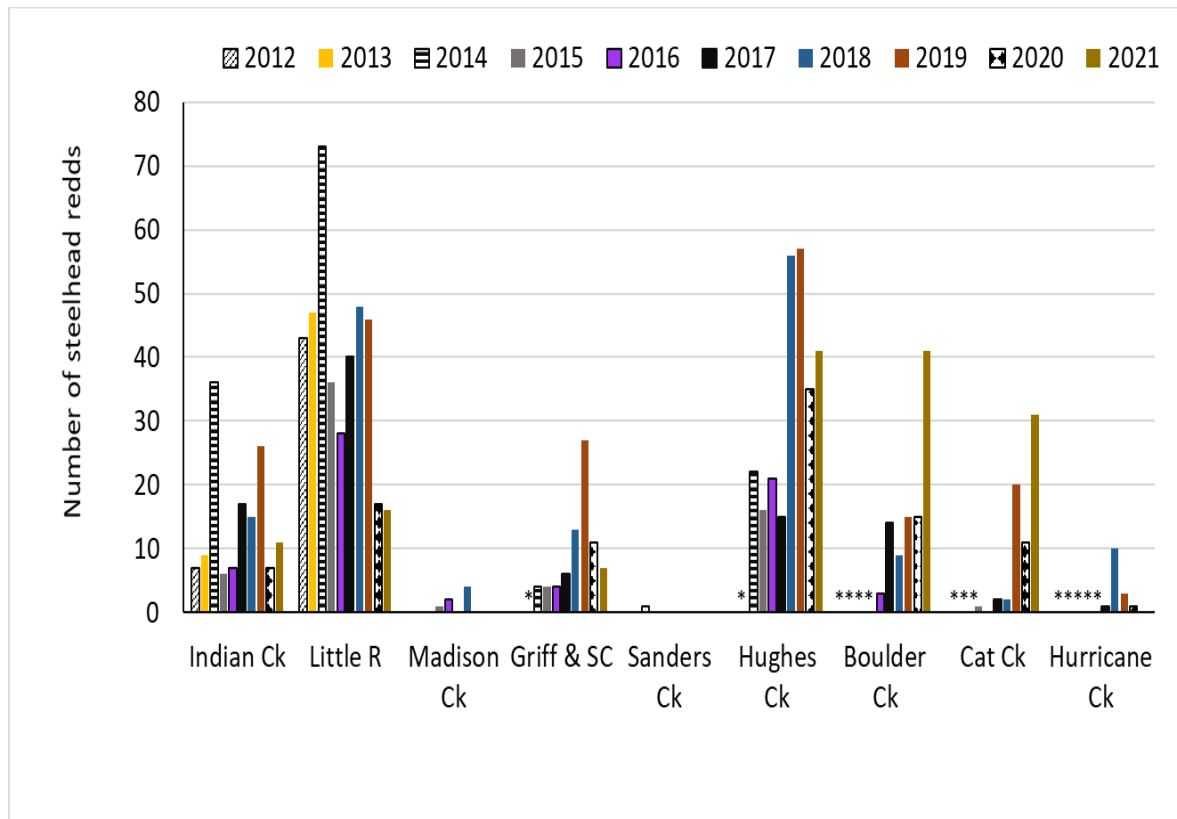
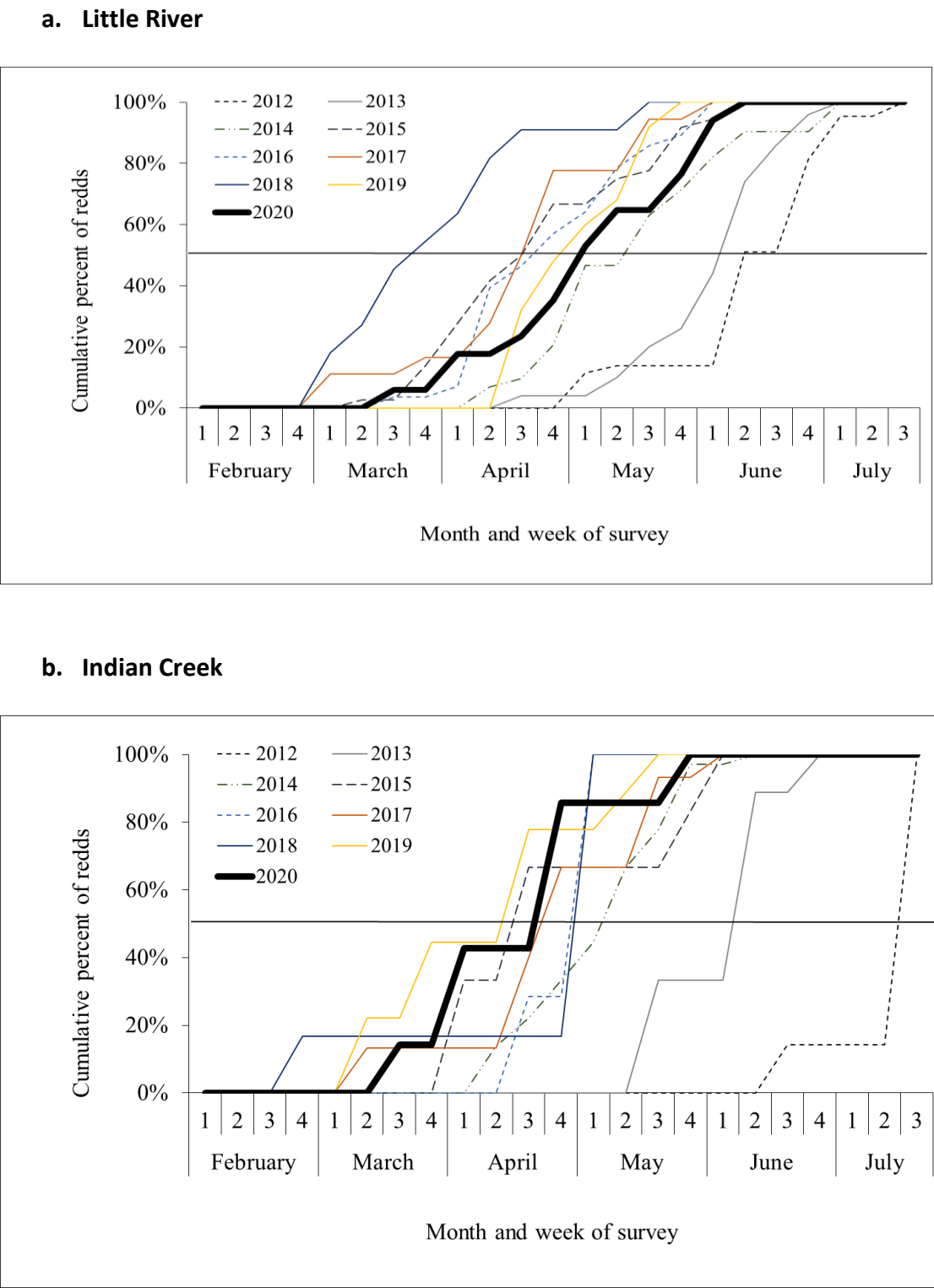
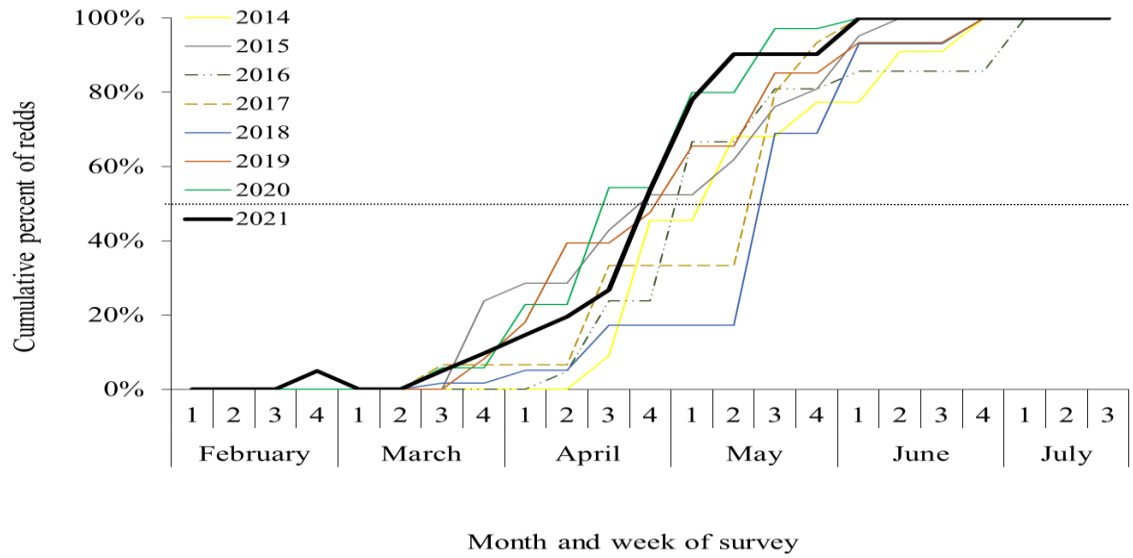


Figure 3. Cumulative distribution of winter steelhead redds counted during weekly redd surveys in (a.) Little River, (b.) Indian Creek, (c.) Hughes Creek and Boulder Creek by year. Horizontal line indicates 50% threshold for cumulative distribution. Date stamps were lost for Little River and Indian Creek in 2021.



c. Hughes Creek



d. Boulder Creek

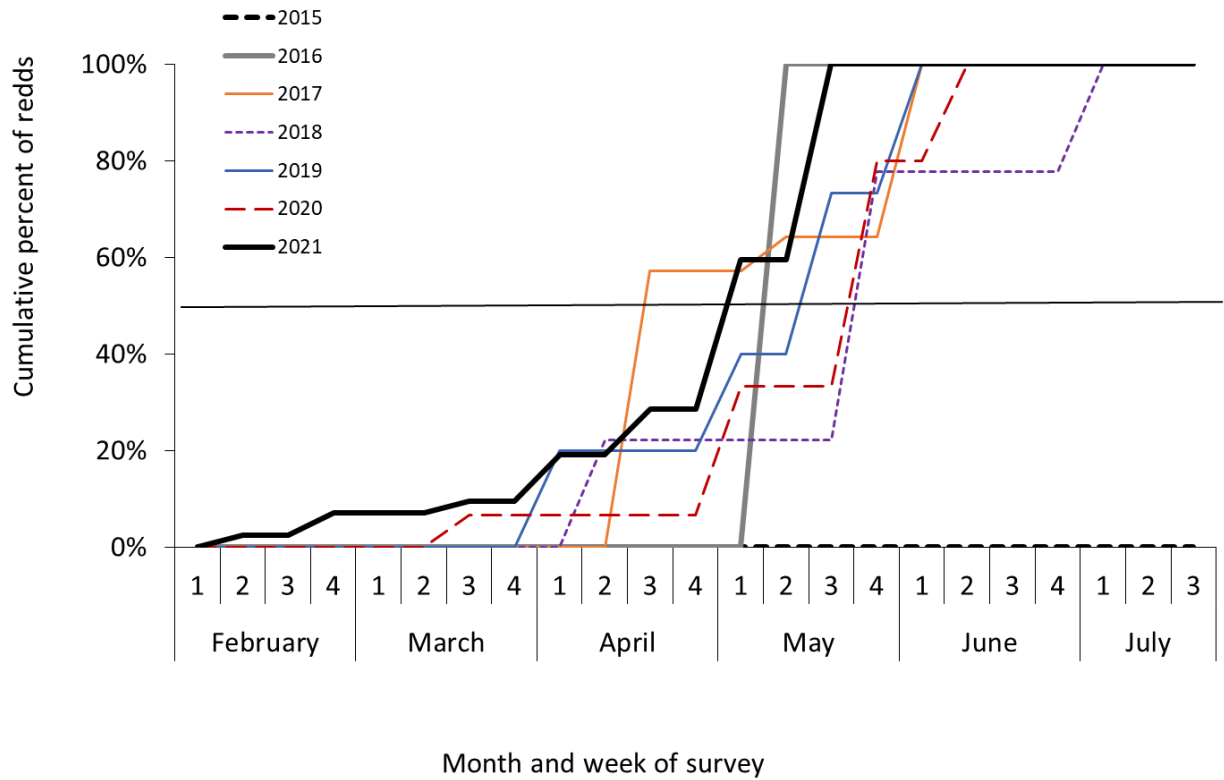


Figure 4. Distribution of steelhead redds in the Elwha River (2005-2020). Black bars are lower Elwha (below Elwha dam site), Gray bars are middle Elwha (Upstream of Elwha dam to Glines Canyon dam site), and red bars are upper Elwha (upstream of Glines Canyon site).

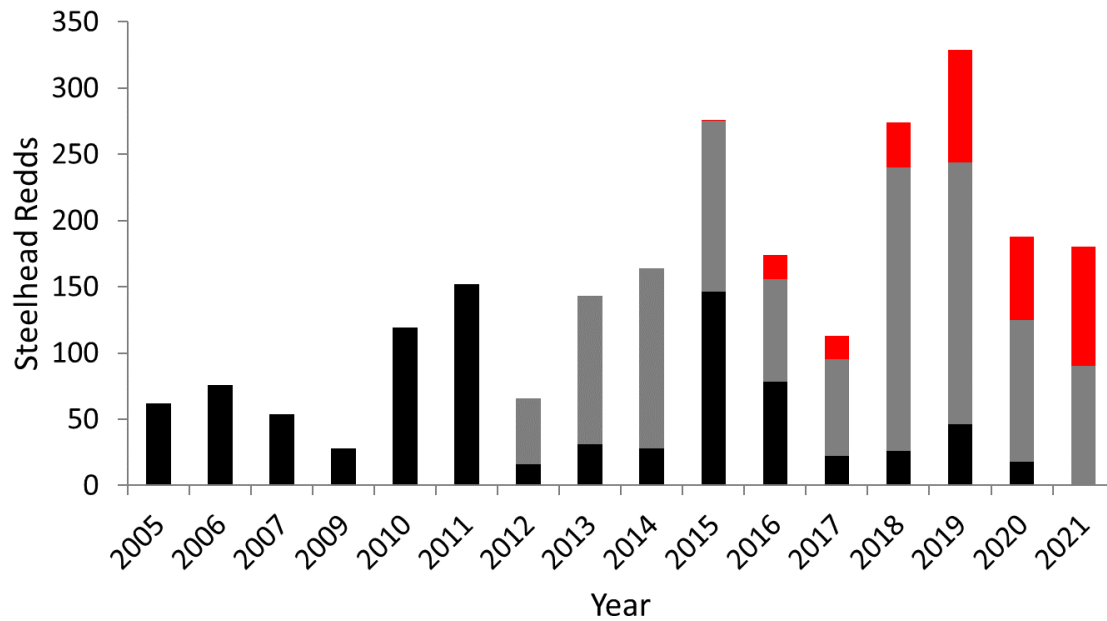
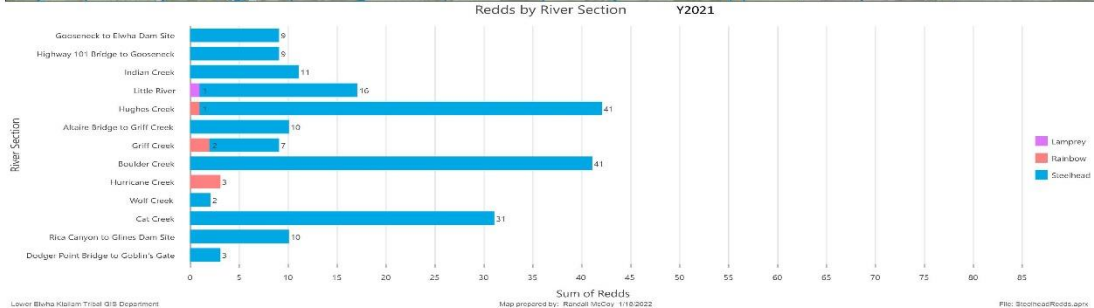
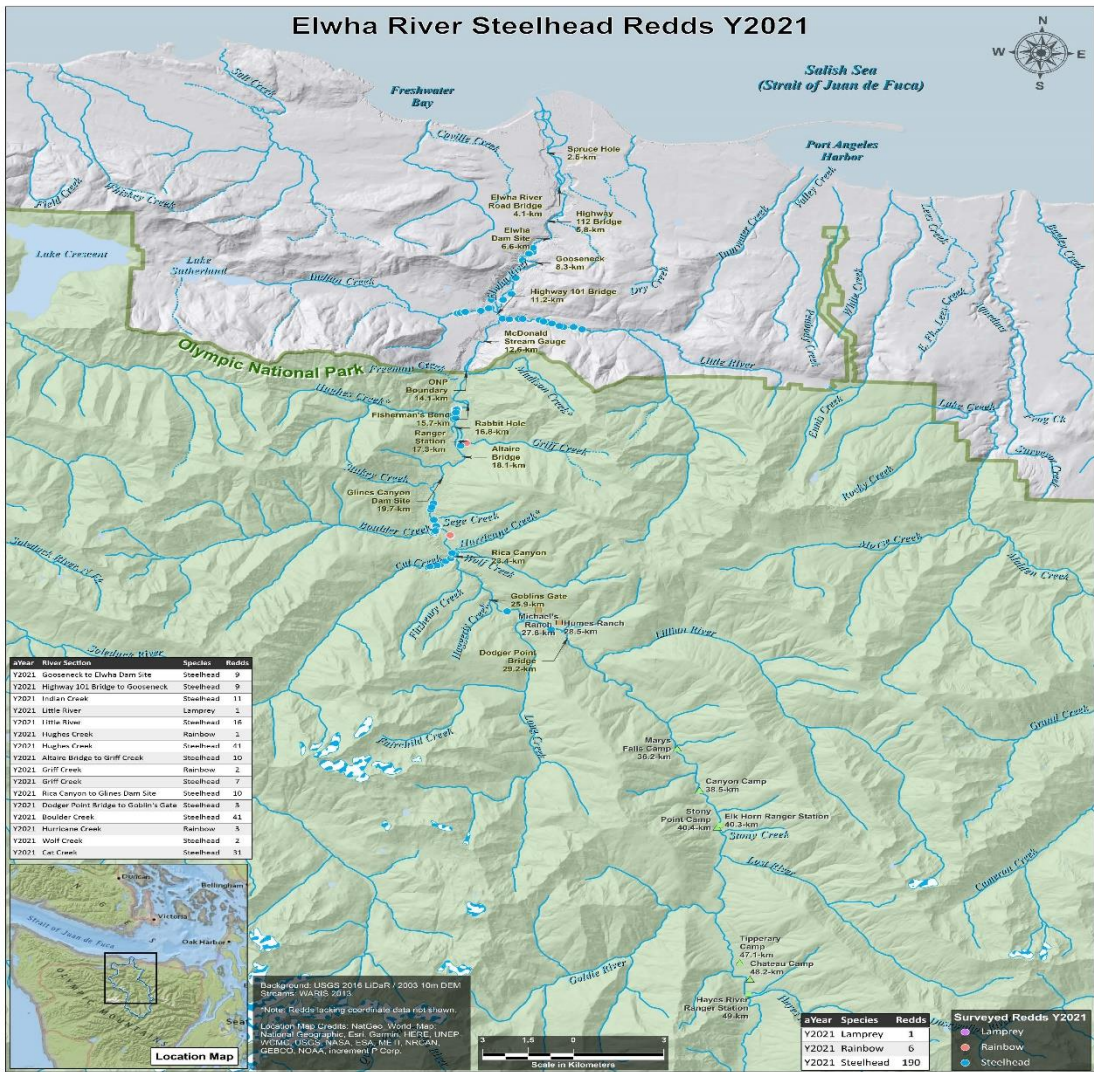
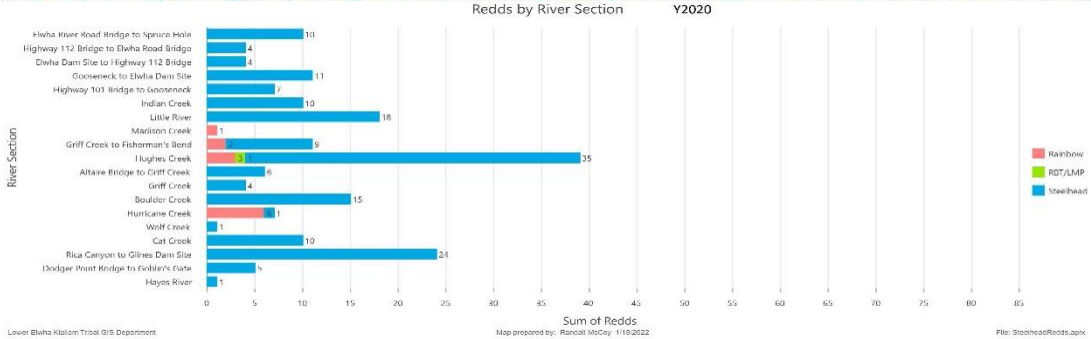


Figure 5. Map of steelhead redd locations in the mainstem Elwha River and tributaries in (a.) 2021, (b.) 2020, (c.) 2019, (d.) 2018, (e.) 2017, (f.) 2016, (g.) 2015, (h.) 2014 and (i.) 2013. Extensive surveys in the mainstem Elwha were not conducted in 2017 due to poor visibility and high flows.

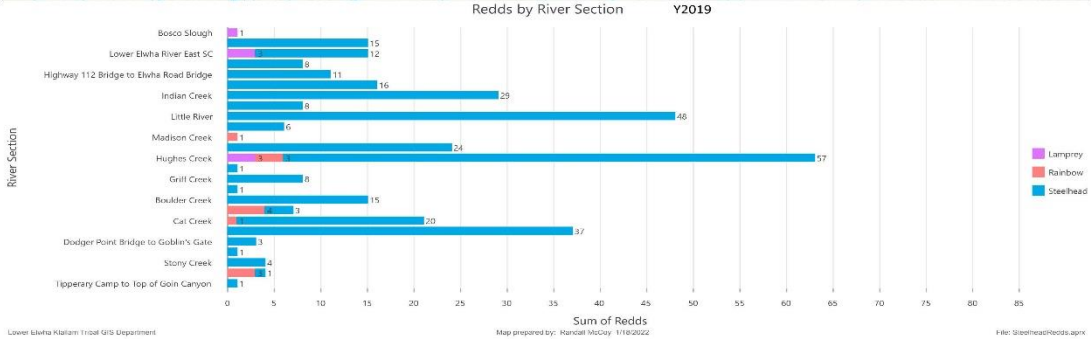
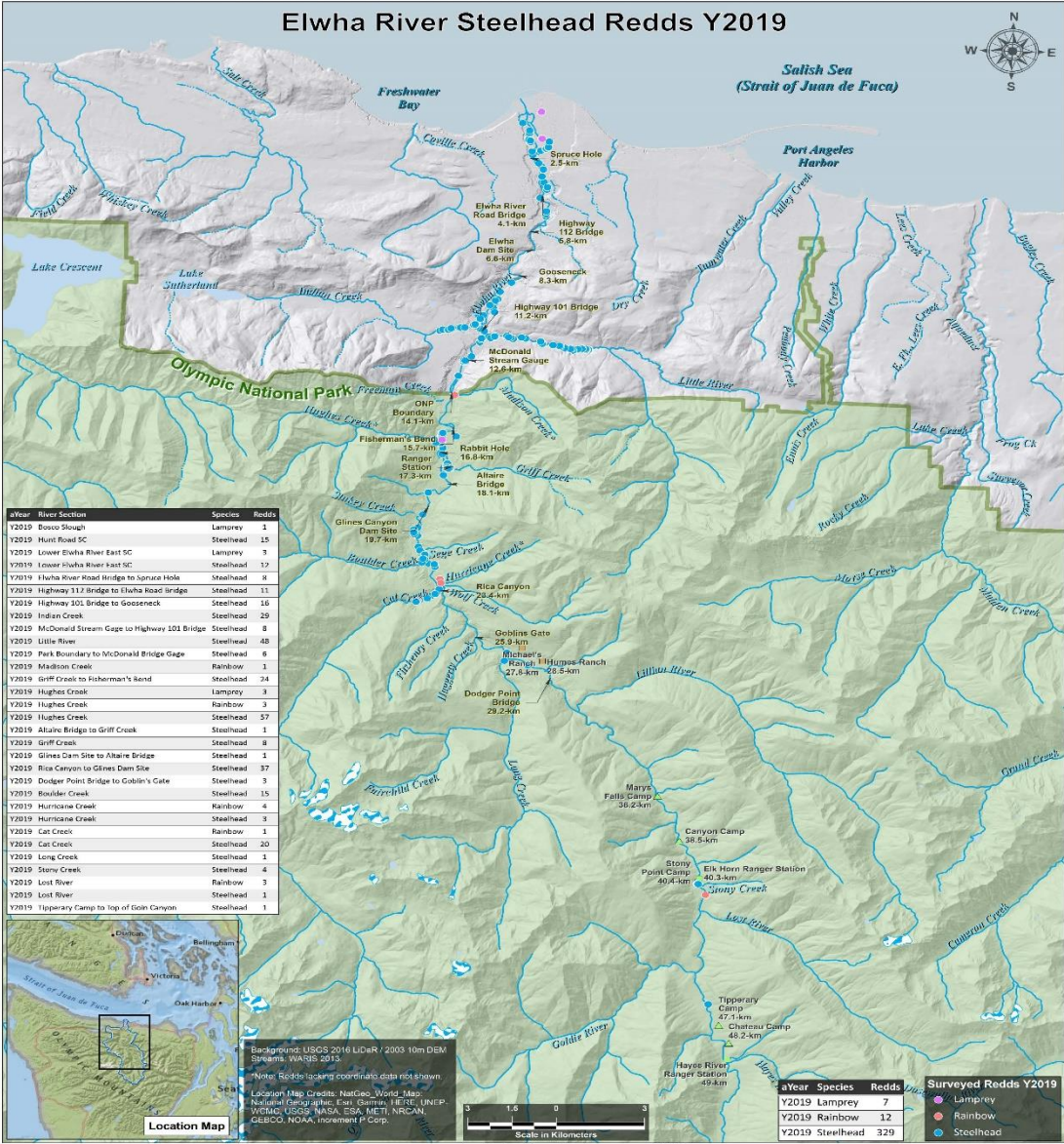
a. 2021



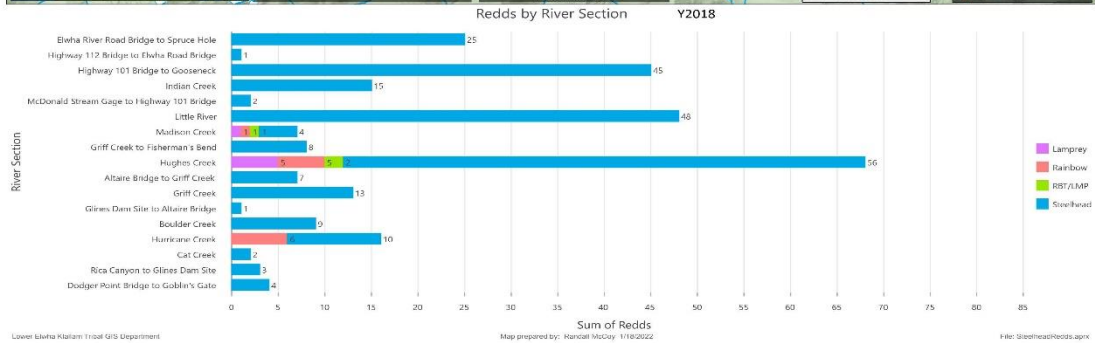
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c. 2019



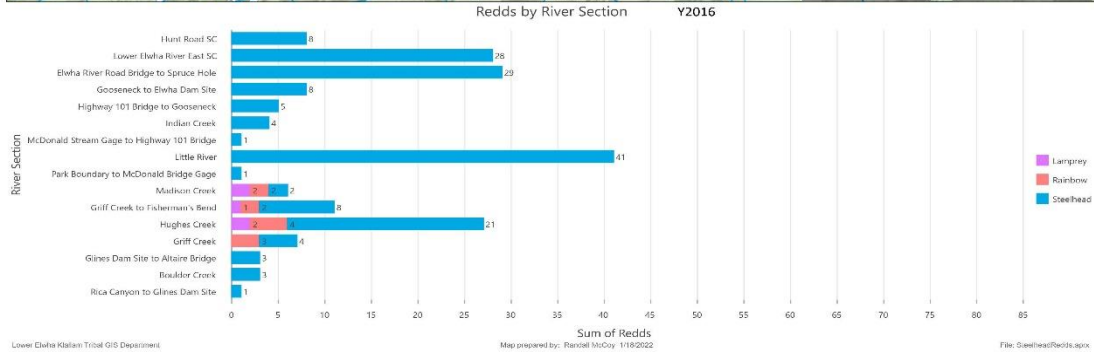
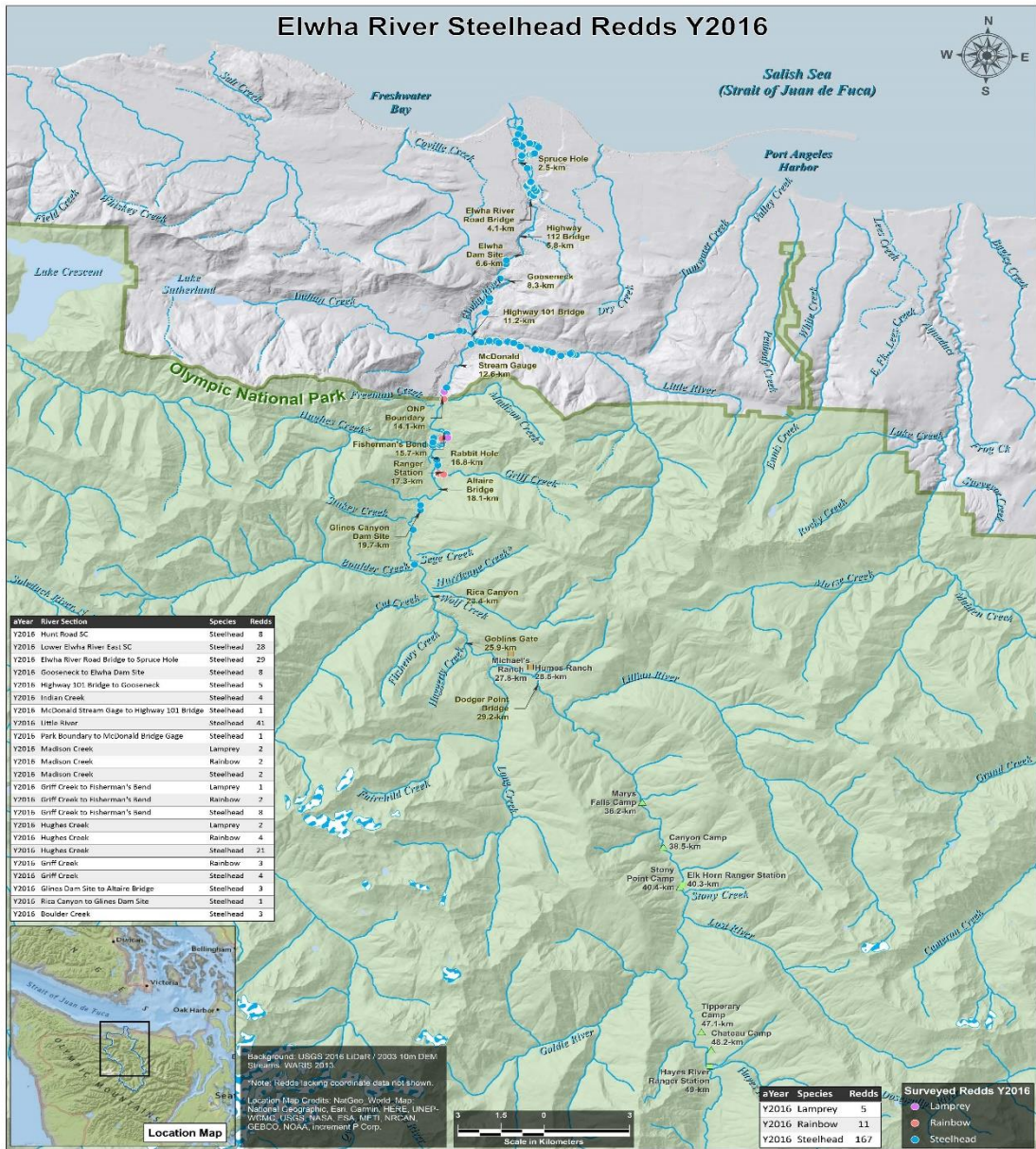
d. 2018



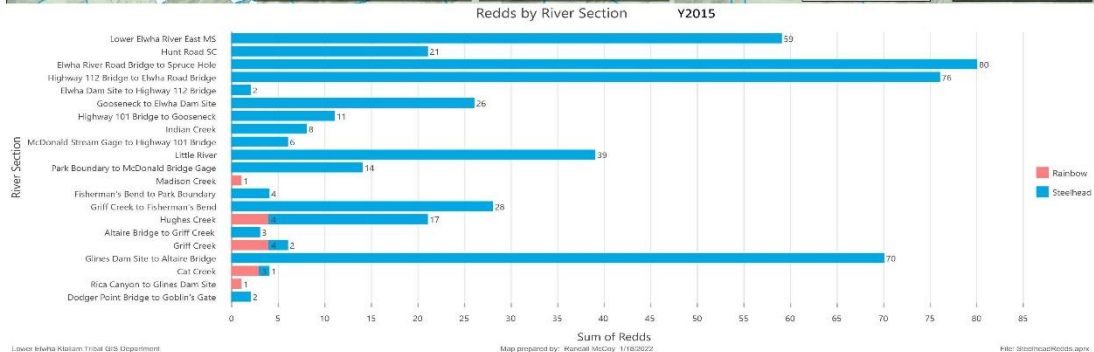
e. 2017



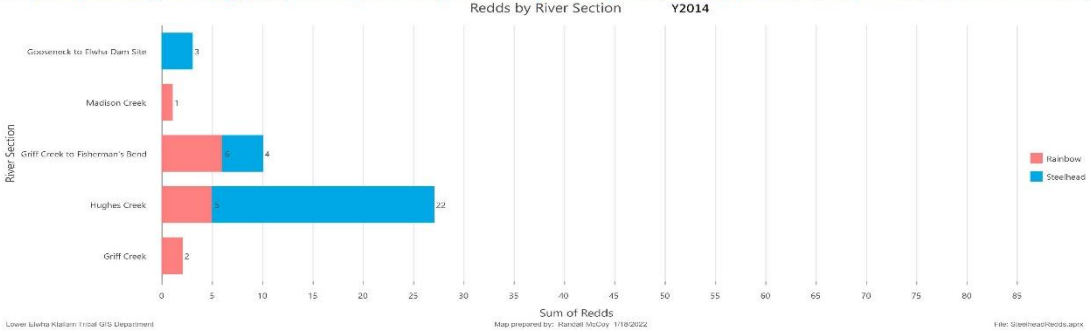
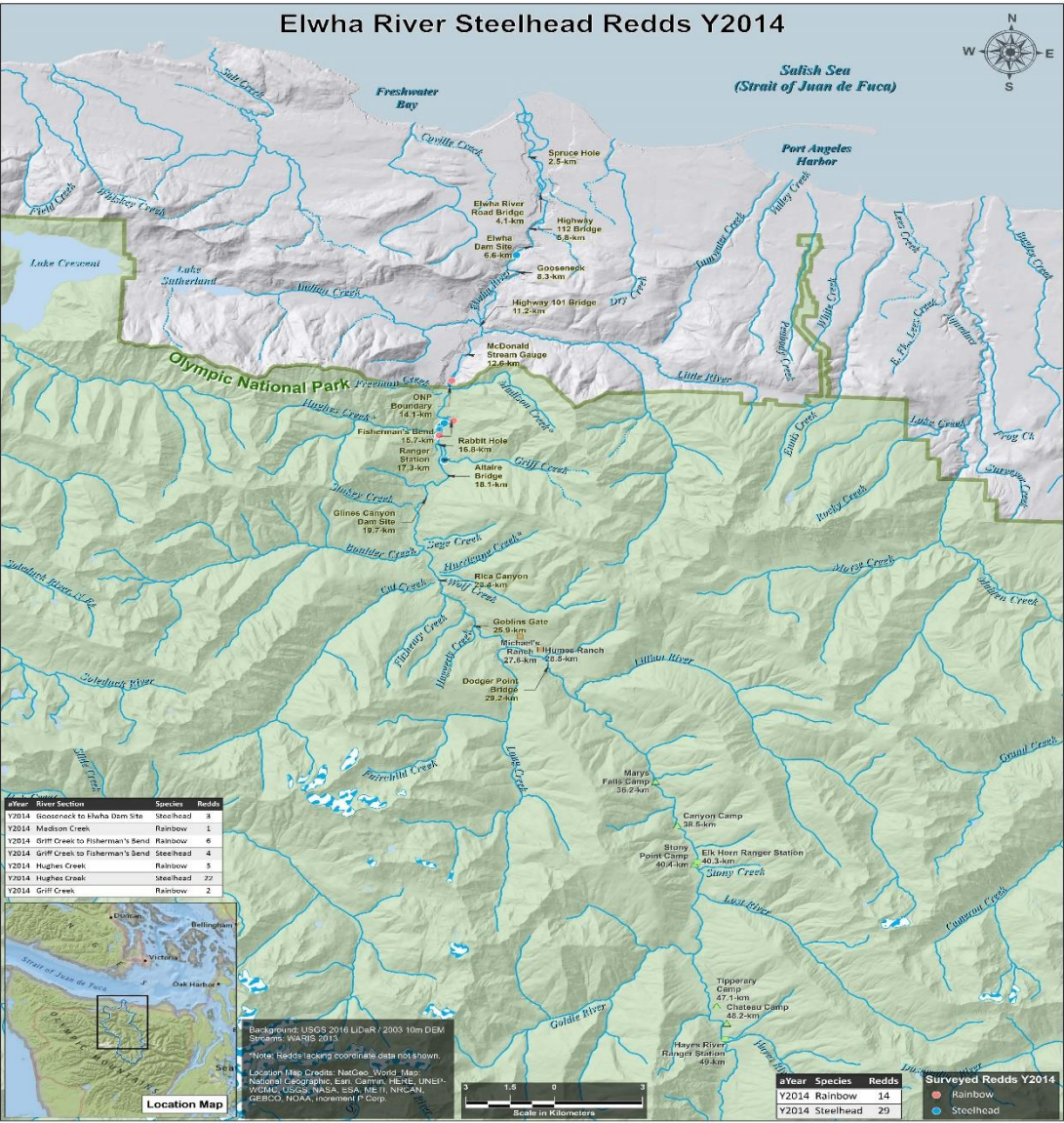
f. 2016



g. 2015



h. 2014



i. 2013

