

Summary of 2022 winter steelhead (*Oncorhynchus mykiss*) surveys in the Elwha River

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Executive Summary

Winter Steelhead spawning ground surveys have been conducted as part of the Elwha River Restoration Project since 2011, making 2022 the eleventh consecutive year of winter steelhead redd surveys. Consistent with previous years, we used data from an extensive series of redd surveys to characterize ongoing recolonization of adult winter steelhead into habitats formerly blocked by two impassable dams. Survey results from 2022 are significant in that it was the sixth 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 findings. We counted a total of 348 redds, the second largest recorded number for the life of the project. The 348 redds accounts for approximately 26.1-29.0% of the total estimated run size of winter steelhead based on SONAR estimates in 2022 which is the highest percentage to date. Moderate numbers of steelhead continue to volitionally spawn in multiple tributaries above the former Elwha and Glines Canyon dam sites. Consistent with previous years, a large number of steelhead redds (84) were observed in the mainstem reach between the former Glines Canyon Dam site to the entrance of Rica Canyon. Finally, two steelhead redds were observed in the upper Elwha (above Lost River and above Hayes River) on a single helicopter flight. Small numbers of redds have been observed in the upper Elwha in previous years¹, but this represents the first attempt at counting redds over a broader area of the Upper Elwha. The combined patterns suggest that the spatial distribution of spawning winter steelhead continues to expand as riverine conditions stabilize 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, as well as determining the timing and location of summer run and winter run steelhead in the upper Elwha.

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 "half-pounders." Half-pounders 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 (ERFRA PL 102-495), biologists with the Lower Elwha Klallam Tribe (LEKT), Olympic National Park (ONP), Washington Department of Fish and Wildlife (WDFW) and Trout Unlimited (TU) have

¹ Stony Creek (4) 2019, Elkhorn (1) 2019, Rkm 48.4 (1) 2019, Hayes River (1) 2020.

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 Dam². 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). These surveys were conducted in the summer and documented the presence of adult summer steelhead, however the timing of these surveys missed winter steelhead spawn timing. Thus, comprehensive surveys of winter steelhead redds in the upper Elwha (above Rkm 29.2) have not been conducted to date.

In four of eleven years since dam removal (2012, 2013, 2014 and 2016), a portion of the returning adult winter steelhead, which volunteered into 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 2017-2022, as sediment levels in the river have 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 2022 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 surveyed tributary and 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 2012-2022, 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 winter 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).

² Redd surveys were also conducted from 2005-2011 by LEKT but were limited to the mainstem downstream of Elwha dam.

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. In 2022, those completed mainstem surveys included the lower river below the former Elwha Dam site (Rkm 0-6.6), the former Aldwell Reservoir (Rkm 6.6-11.2), the Elwha Campground Channel (Rkm 15.7-16.5) and the former Lake Mills Reservoir above former Glines Canyon Dam (Rkm 19.7-22.5). No ground surveys were conducted in the Geyser Valley (Rkm 25.3-29.2) in 2022. It should be noted that the major canyons of the Elwha (Rica, Grand, Carlson) have never been surveyed).

Redd counts occurred from early-February through June or early July and were ideally conducted once every 7-10 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 tail spill 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.

A single helicopter survey of the mainstem Elwha River was conducted on May 10, 2022, during the peak of steelhead spawning on the Elwha. Two Washington Department of Fish and Wildlife (WDFW) biologists and a pilot (Northwest Helicopters, Olympia, WA) flew in a downstream direction from Chicago Camp (Rkm 65.3) to the river mouth and counted redds within 25 index areas that were defined by obvious and identifiable landmarks, described in Table 2. Approximate location of redds observed in the helicopter survey were marked with a Garmin InReach GPS device. Redd counts among the two observers were averaged. Additionally, ground crews (ONP) surveyed Glines Canyon to Rica Canyon concurrent with the aerial survey for potential ground to air redd count comparison (not included in this report).

Data were analyzed in several ways. Cumulative redd counts were organized by date for all sites combined and by tributary to describe spawn timing as a function of Julian day. In 2022, data from Indian Creek, Hughes Creek, Boulder Creek, Cat, Griff and Little River were used in this analysis. Redd locations were also mapped to show the spatial distribution of steelhead spawning using ArcGIS.

Results

Redd enumeration

We conducted a combined total of 101 redd surveys from early February through late June in the Elwha watershed, of which 76 (75.2%) surveys were conducted in the tributaries (Table 1). Tributary surveys were detailed and each creek was surveyed between 2-14 times during the season. We conducted twenty-five redd surveys in the main-stem Elwha River, including eight above the former Glines Canyon dam. 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 348 steelhead redds in the tributaries and main-stem Elwha River in 2022 (Table 1), the second highest (2015=400) number to date since dam removal began in 2011. In contrast, in the four previous years we identified a total of 159 redds in 2018, 186 redds in 2019, 153 redds in 2020 and 190 redds in 2021. Of the 348 redds documented in 2022, we counted 155 (44%) redds in tributaries and 193 (56%) in mainstem habitats (Figure 2). As with previous years, most of the tributary redds were counted in Hughes (24), Boulder (16), Cat (14), Little River (50), and Indian (29) (Table 1; Figure 2). This year's count was the third highest on record to date for Little River and second highest in Indian Creek. (Figure 3). In contrast, total redd numbers were less than half observed in 2022 in two upper Elwha tributaries, Cat and Boulder Creek. We counted a total of 193 redds in the main-stem Elwha River, with the greatest concentrations of steelhead redds being observed in the former Lake Mills reservoir (84) and the Elwha Campground channel (14).

Temporal and Spatial Redd Distribution

Temporal patterns indicated a protracted breeding season in 2022 that was similar to previous years. In tributaries the earliest redds were observed in the second week of March in Indian and Cat Creeks, while the latest redd was observed on the week of June in Cat and Boulder Creeks. As with the past spawning seasons the majority of redds were observed in tributaries from late-March through mid-May. The median date of spawning in Hughes Creek was first week of May which was similar to 2021. The median spawning date for Indian, Griff, Cat and Boulder Creek were similar (third week of April to early May) (Figure 4a-f). Data from Boulder Creek shows an expansion of spawn timing over time as steelhead colonized the creek following dam removal (Figure 4e). Comparisons of spawn timing were not possible for Little River because of the first survey did not occur until early April.

Spatially, there were three notable results. First, the number of redds counted in middle river tributaries, Little River and Indian Creek, was relatively high compared to previous years, while the number of redds in creeks above the former Glines Canyon dam area were moderate, suggesting that winter steelhead continue to colonize the upper watershed habitats (Figure 4) at an increasing rate. Second, based on the results of the WDFW helicopter flight, steelhead spawning has been documented in the upper Elwha, however it cannot be determined if those redds were of winter or summer life histories. Those redds were observed upstream of the Hayes River (Rkm 49.4) and upstream of Lost River confluence (Rkm 40.9). Third, Boulder and Hughes Creeks support a high density of spawning steelhead at 53.3 and 26.6 redds/km. It is interesting to note that high densities are observed in Hughes Creek despite the fact that the creek has essentially gained 0.4 km in length due to changes in the mainstem channel flow, which have allowed Hughes Creek to capture a portion of the former mainstem channel. The total redd count for Hughes Creek and this new section of tributary ("Lower Hughes Creek") was 46 redds over a distance of 1.3 km, or a redd density of 35.5 redds/km.

Overall, the number of redds in tributaries in 2022 was the third highest to date and the spatial distribution of steelhead has continued to expand and is now more continuous

than it was during the initial stages following dam removal. In 2022, 34.5% of the observed redds were located upstream of the former Glines Canyon dam site (Figure 5) which is the second highest to date. We summarized the distribution of winter steelhead redds observed in the Elwha graphically from 2013-2022 (Figure 6a-j).

Helicopter Survey Results

A total of 161 redds were observed from Chicago Camp to the Elwha River mouth during the aerial helicopter survey (Table 2). Two redds were present in the upper river, between Godkin Creek (Rkm 58.3) and Elkhorn Ranger Station (Rkm 43.0). The remaining redds were observed below Rica Canyon (Rkm 25.7). The index with the highest redd density was the east channel of the Hunt Road/mainstem split channel (38 redds; 20.8 redds/km). Redd counts by index reach are summarized in Table 2.

The ground survey from Rica Canyon to Glines Canyon observed 68 redds, in comparison to the aerial count of 18 redds in the same index, a difference of 74%. Dark coloration of redd gravels due to algal growth was reported by ground surveyors and likely contributed to the lower aerial count.

Discussion

As with previous year's surveys (McHenry et al. 2021, McMillan et al. 2018-2020; LEKT 2016-2017; McMillan et al. 2011-2015, McMillan and Moses 2012), 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 melt impacted mainstem surveys during some periods in the spring. Thus, we were still able to evaluate the timing of spawning in tributaries and we found additional evidence that winter steelhead continue to increase their spawning distribution above the former dam sites. Determining timing of winter steelhead in mainstem habitats was not possible as those surveys were generally opportunistic and not enough could be conducted throughout the prolonged spawning period of winter steelhead.

The total of 348 winter steelhead redds in the main-stem Elwha and its tributaries is the second largest since dam removal was initiated in 2011 and represents an increase of 46% over those observed in 2021. The SONAR monitoring estimated the 2022 winter steelhead run size to be 2,400 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 348 redds equates to a total of 696 adult 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 626 winter steelhead. This means the total number of redds we observed in Elwha River, accounts for 26.1% (assuming 1.8 fish/redd) to 29.0% (assuming 2 fish/redd) of the population, per the Denton et al. (2022) estimate, which is higher than 2021 when redd surveys accounted for 14.9-16.5% of the total (McMillan et al. 2018) and notably lower than 2020 when we accounted for 40-50% of the redds (SONAR estimate of 1,458) (McMillan et al. 2020). The relatively low percentage of potential redds suggests that winter steelhead

are spawning in areas that are not surveyed or only opportunistically surveyed, possibly including the upper Elwha.

Temporally, median spawn timing in the tributaries was consistent with previous year's seasons. Among the tributaries in the middle river, Hughes Creek, Griff Creek, Little River, and Indian Creek continue to provide important spawning habitats. There has been a general increase in the number of redds observed in middle and upper river tributaries over time since dam removal. The number of redds observed in Indian Creek is likely an underestimate as we only survey about 25% of the potential habitat in Indian Creek. Smolt trapping indicates there are increasing numbers of steelhead smolt out-migrants 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 have been colonized by winter steelhead and redd counts have generally increased over the past 4-5 years. The former Mills reservoir is being utilized for spawning by winter steelhead. The 84 redds observed in 2020 is the highest to date, by far, breaking the previous high of 35 in 2019. Further, the entire former Mills reservoir section appears to support numerous juvenile steelhead. Visual surveys of most of the former Mills reservoir 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 using electrofishing in 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 difficult to access and survey. We opportunistically conducted twenty-five single-day surveys and counted 193 redds, suggesting there are quite a few fish spawning in the main-stem Elwha, many of which are likely 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 in most years. We compared the number of mainstem redd observations by year with flow conditions and found that in years with high counts flows were generally less than 2000 cfs.

Another method is to conduct multiple helicopter flights each spring as conditions allow with a focus on the upper Elwha. In 2022, WDFW conducted a single flight of the Elwha River upstream of the former Glines Canyon Dam site. The aerial count was likely an underestimate due to the degree of discrepancy between concurrent ground and air

counts. The 2D view of redds from the air makes observation difficult of older redds that lack clean gravels typical of fresh, new redds. While this flight expanded knowledge about spatial distribution of steelhead spawning, particularly above Rica Canyon, abundance of redds in the upper watershed is still a significant data gap. Additional flights earlier in the spawning season could improve knowledge of both spatial distribution and abundance of redds in the main-stem Elwha River. However, moving forward it will be important to determine the spatial distribution of summer run and winter run spawning, because it seems unlikely that winter run steelhead are passing through the Grand Canyon. Hence, it could be that the area from Geyser Valley down through the former Lake Mills is an area where winter and summer steelhead spawning may overlap. More detailed information, either from DNA of juveniles or adults, will be needed to accurately estimate the distribution of the two life histories.

The total number of winter steelhead redds observed since 2011 has increased over time. This reflects an increase in adult abundance of winter steelhead documented by SONAR monitoring over time (Denton et al. 2022). This increase has been rapid and impressive. Redd surveys conducted by LEKT prior to dam removal (2005-2011) documented that the abundance of wild winter steelhead was estimated to be between 45-246 returning adults (average 132). In contrast the 2022 SONAR estimate is 2,400 returning adults.

In summary, we report three important findings in 2022. 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 within the range observed in past year with a median timing of late April to mid-May. Third, steelhead redds were documented in the upper Elwha in three of the last four years (2019, 2020, 2022). These findings, along with the consistent observation of summer run fish in the upper river, suggest that the spatial distribution of spawning steelhead is expanding and is likely to continue expanding as riverine processes continue to improve and the abundance and diversity of spawning steelhead increases.

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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 2022.

Site	Reach location (km)	# Surveys	Steelhead relocated	Redds (#/km)	% Surveyed
Little R.	0.0 – 4.7	7	None	50 (10.6)	100% ³
Indian Ck.	0.0 – 2.4	5	None	29 (12.1)	25%
Mainstem Elwha	various	25	None	193	<15%
Madison Ck.	0.0 - 0.6	3	None	1 (1.7)	100%
Griff Ck.	0.0 - 0.95	14	None	21 (22.1)	100%
Griff Jr. Ck.	0.0 – 0.4	2	None	0 (0)	100%
Hughes Ck.	0.0 - 0.9	15	None	24 (26.6)	100%
Boulder Ck.	0.0 – 0.3	10	None	16 (53.3)	100%
Cat Ck.	0.0 – 1.1	10	None	14 (12.7)	100%
Wolf Ck.	0.0 – 0.2	7	None	0 (0.0)	100%
Hurricane Ck.	0.0 - 1.6	3	None	0 (0.0)	100%
Long Ck.	0.0 – 0.5	0	None	0 (0.0)	0%
Totals	13.1	101	0	348	

³ Estimated proportion of usable habitat – total available habitat for steelhead is unknown for this tributary

Table 2. Description of aerial redd survey indexes, Rkm of top and bottom of index, and aerial redd count within each index.

Reach	Rkm Bottom	Rkm Top	Redd Count
Mouth to bottom of split channel	0	1.3	1
Hunt Rd Channel	1.3	3.1	6
East Channel	1.3	3.1	38
Channel Split to Sisson Hole	3.1	4	6
Sisson Hole to Pedestrian Bridge	4	5.1	15
Pedestrian Bridge to Hwy 112 Bridge	5.1	7	4
Hwy 112 Bridge to Elwha Dam Site	7	7.9	0
Elwha Canyon to Gooseneck	7.9	9.7	16
Gooseneck to Hwy 101 Bridge	9.7	12.3	13
Hwy 101 Bridge to ONP boundary	12.3	15.4	9
ONP boundary to Fisherman's Bend	15.4	17	12
Fisherman's Bend to Altaire Bridge	17	20.2	15
Altaire Bridge to Glines Canyon	20.2	21.7	6
Glines Canyon to Windy Arm	21.7	23.5	17
Windy Arm to bottom of Rica Canyon	23.5	25.7	1
Rica Canyon	25.7	28.2	0
Geyser Valley	28.2	31.9	0
Grand Canyon	31.9	38.8	0
Top of Grand Canyon to Elkhorn	38.8	43	0
Elkhorn to Remann's Cabin	43	45.1	1
Remann's Cabin to Goldie River	45.1	47.3	0
Goldie River to Hayes River	47.3	49.4	0
Hayes River to Godkin Creek	49.4	58.3	1
Godkin Creek to Buckinghorse Creek	58.3	60.5	0
Buckinghorse Creek to Chicago Camp	60.5	65.3	0
Total			161

Table 3. 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
2022	0:0	29	0:0	50

FIGURES

Figure 1. Map of Elwha River basin and location of streams where redd surveys were conducted for winter steelhead from February-July 2022. Stars indicate locations of (working south to north) Long Creek (not surveyed), 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).

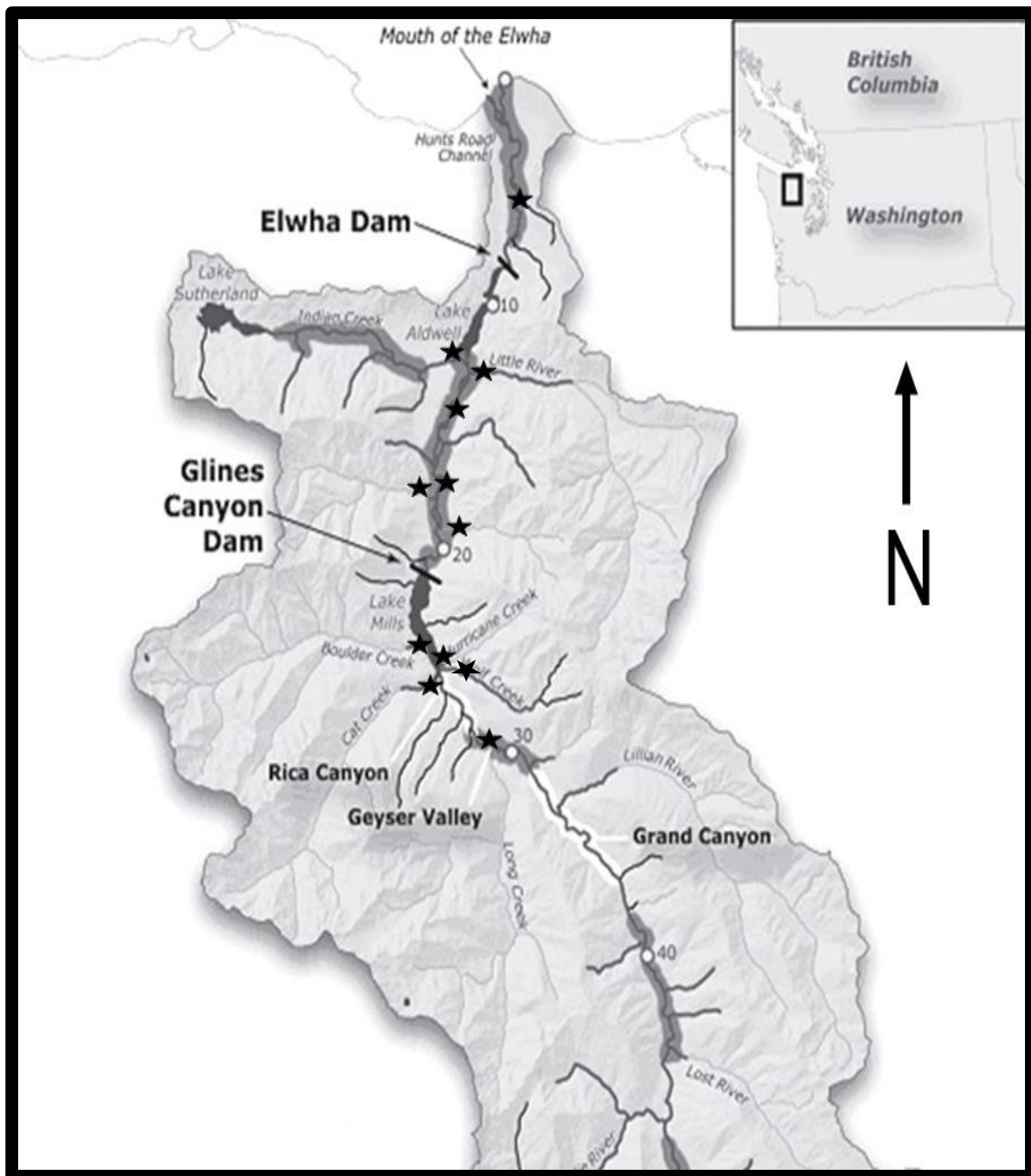
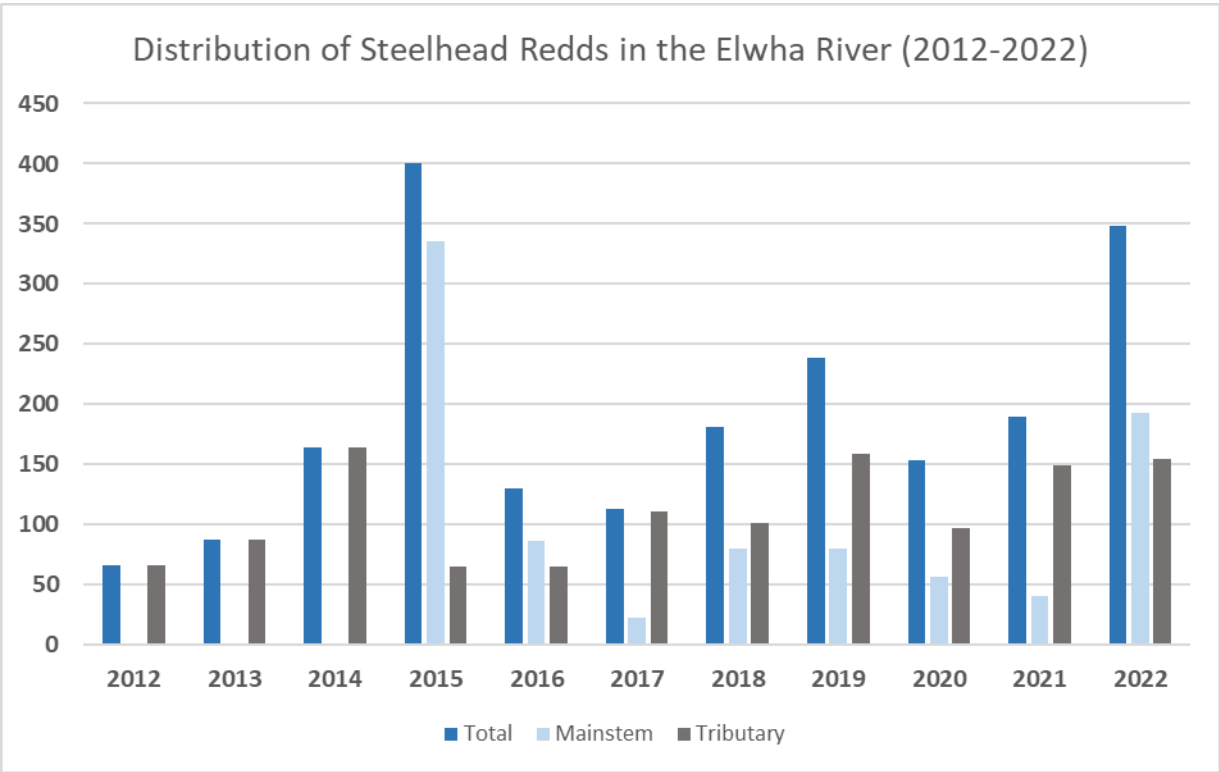


Figure 2. Total winter steelhead redds and distribution in mainstem and tributaries for the Elwha River, 2012-2022.



Number of steelhead redds

Legend: 2012 (diagonal lines), 2013 (yellow), 2014 (horizontal lines), 2015 (grey), 2016 (purple), 2017 (black), 2018 (blue), 2019 (brown), 2020 (cross-hatch), 2021 (olive), 2022 (dark blue)

Location	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Indian	7	36	6	17	15	26	29	25	7	11	
Little	43	47	73	36	28	40	48	46	17	16	50
Madison	1	2			2		4				*
Griff	4	4	5	5	4	5	13	27	11	8	21
Hughes	22	21	15	15	21	15	56	57	35	41	24
Boulder		3	3	14	15	15	9	15	15	41	16
Cat	1	1	2	2	2	2	2	20	11	31	14
Hurricane							10	3	1		

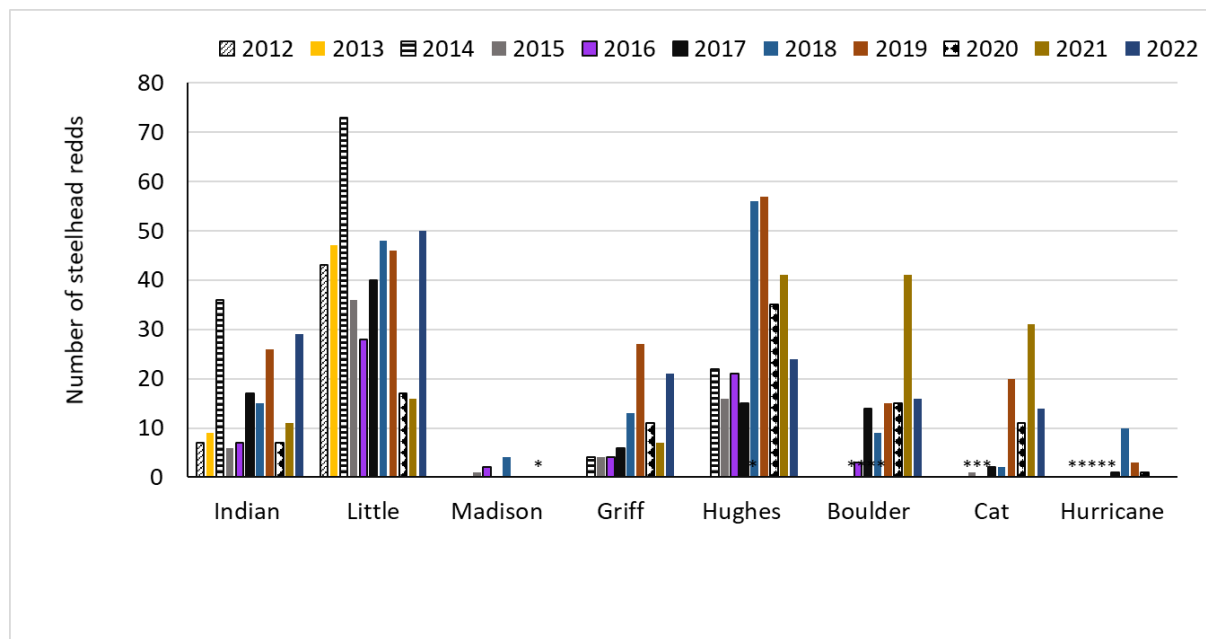
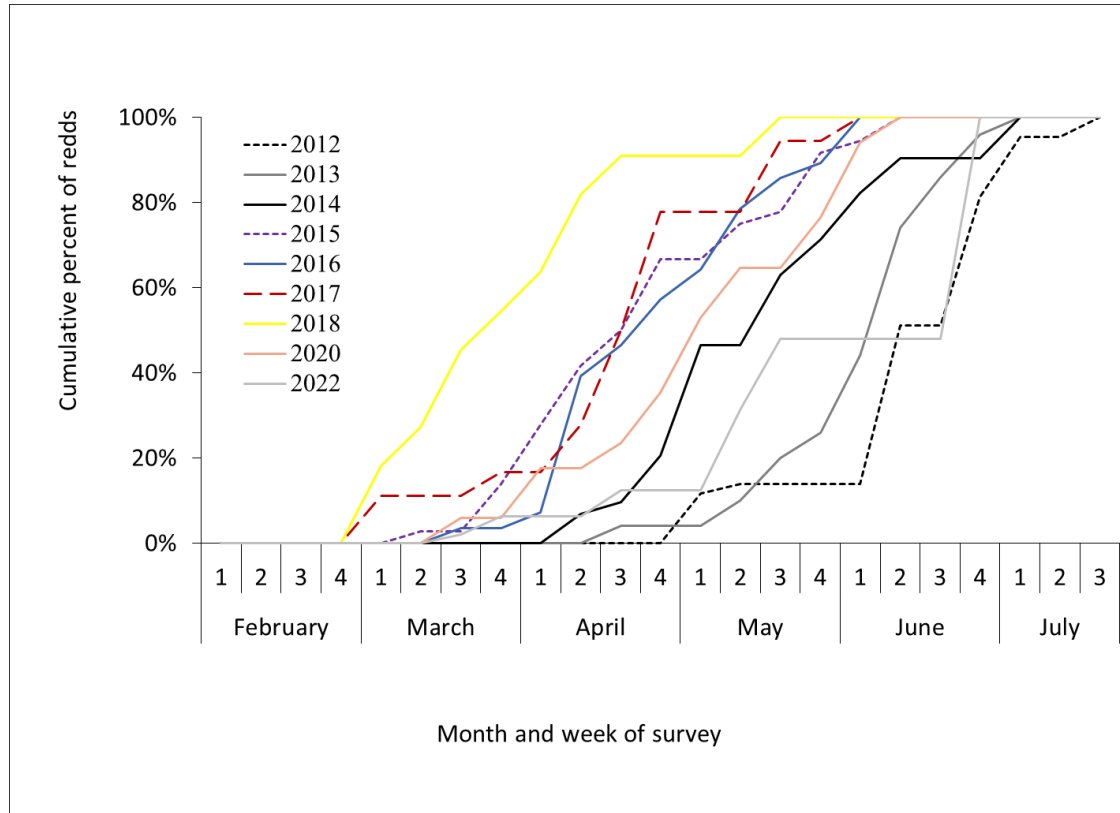
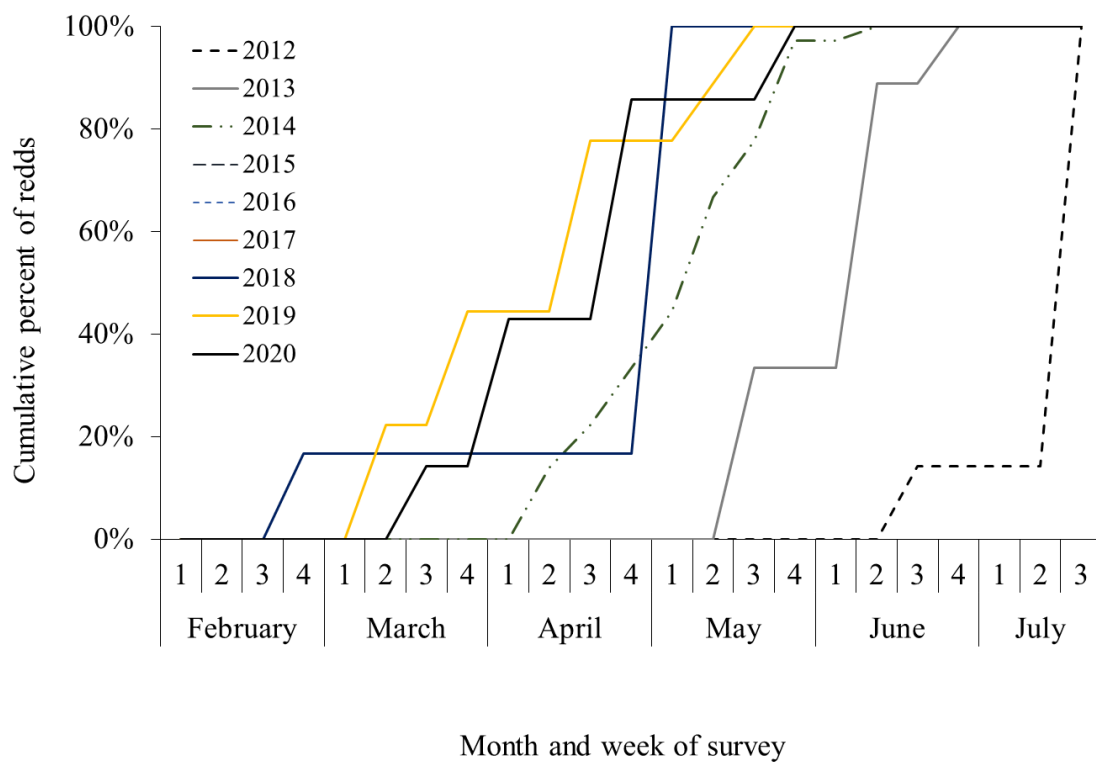


Figure 4. Cumulative distribution of winter steelhead redds counted during weekly redd surveys in (a.) Little River, (b.) Indian Creek, (c.) Hughes Creek, (d.) Griff Creek, (e.) Boulder Creek and (f.) Cat Creek by year. Horizontal line indicates 50% threshold for cumulative distribution. Note: Surveys on Little did not begin until second week of April in 2022.

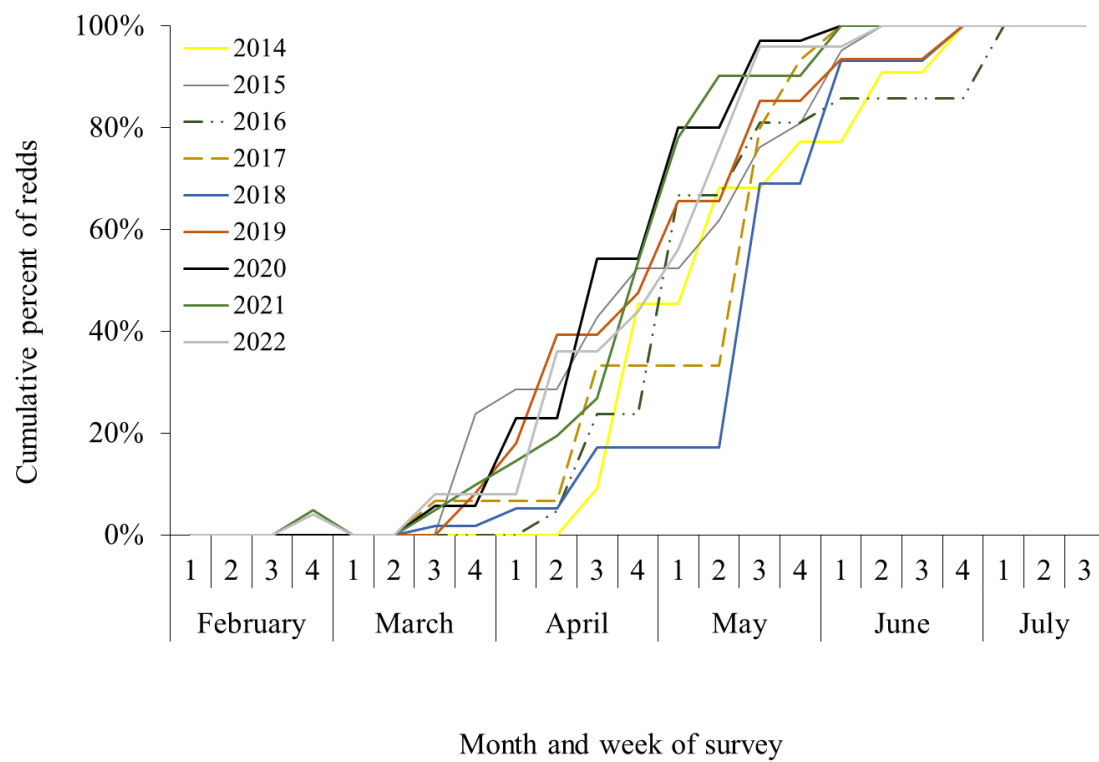
a. Little River



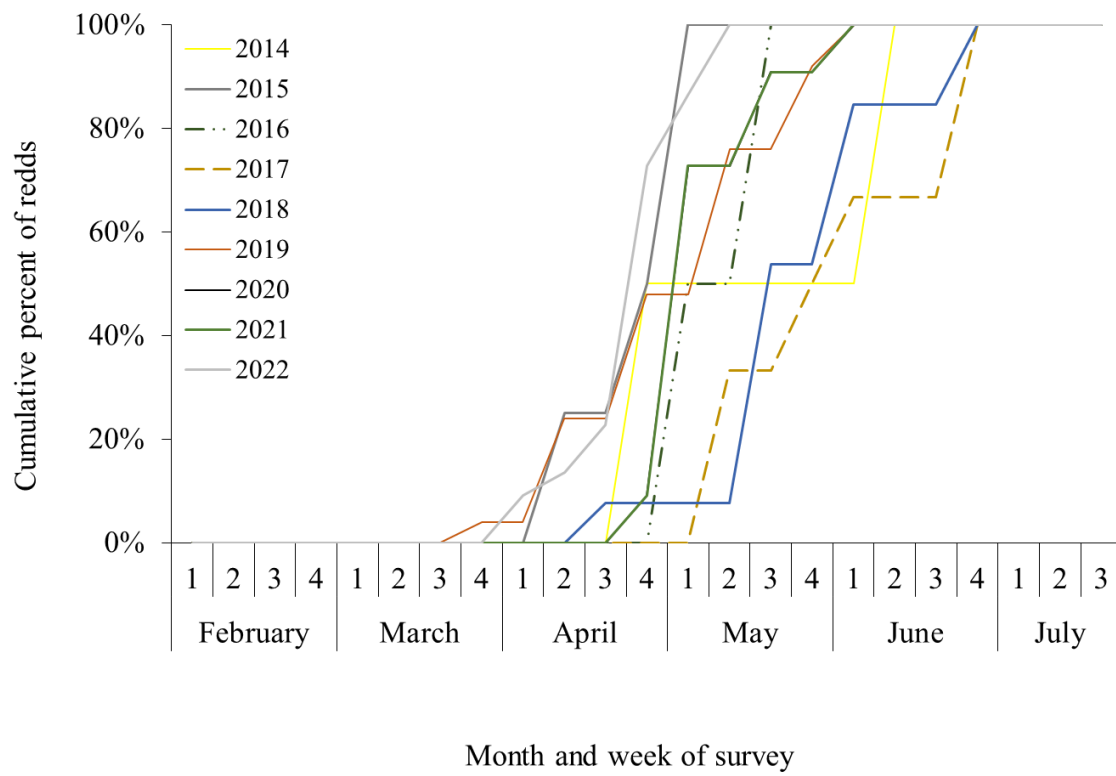
b. Indian Creek



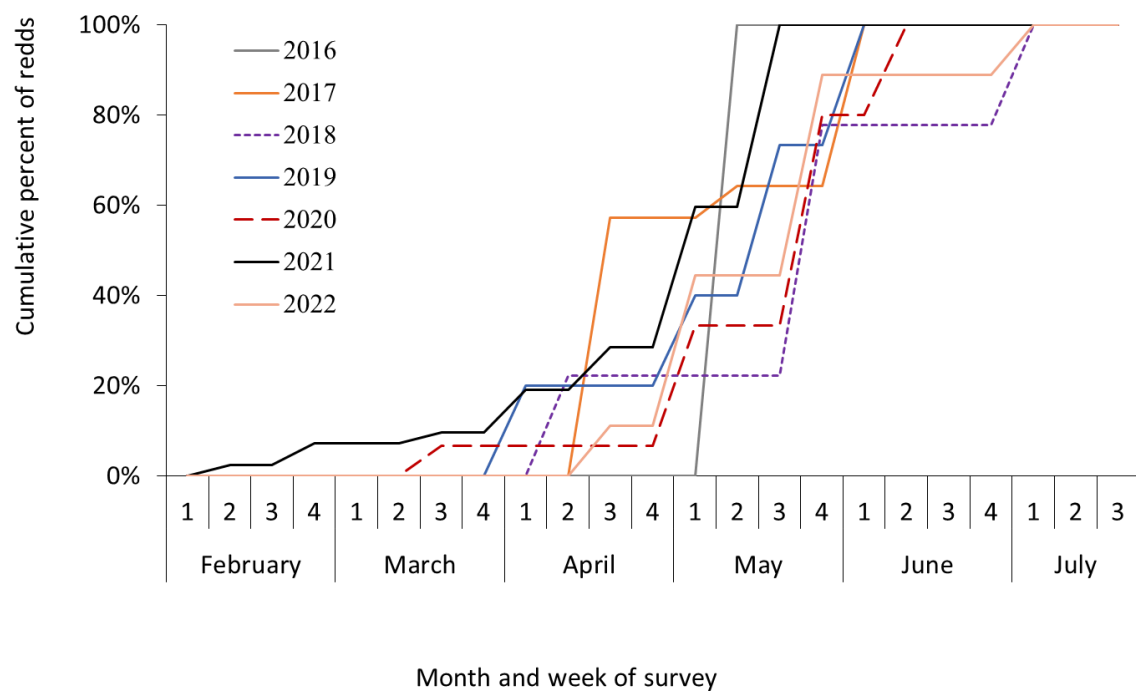
c. Hughes Creek



d. Griff Creek



e. Boulder Creek



f. Cat Creek

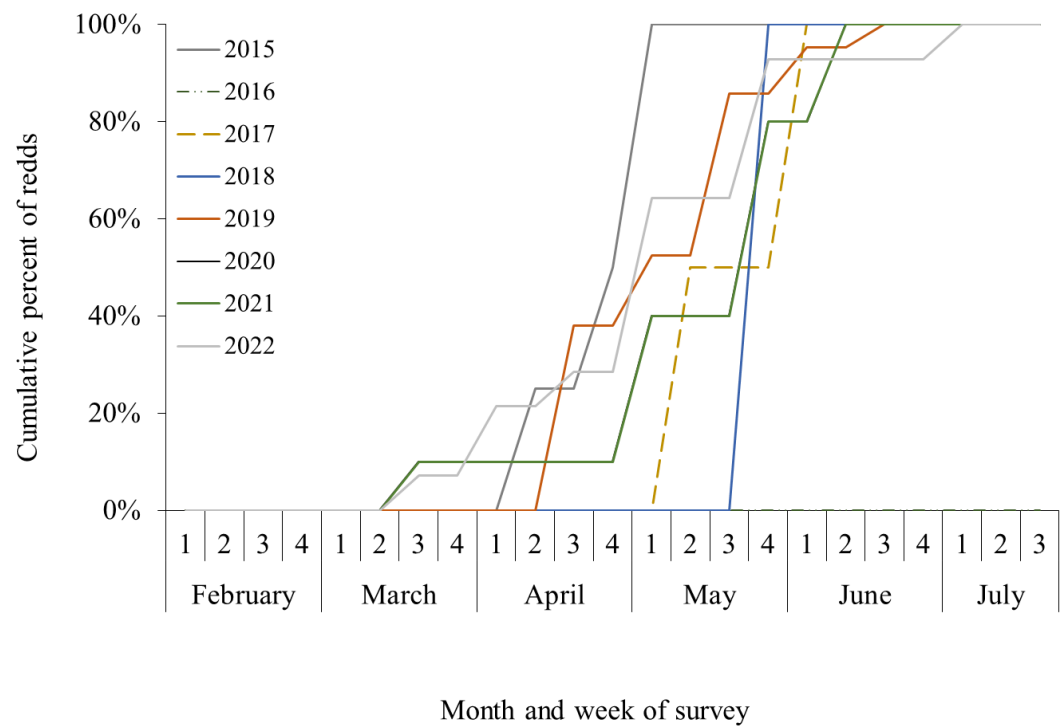


Figure 5. Distribution of steelhead redds in the Elwha River (2005-2022). Black bars are lower Elwha (below Elwha dam site), Gray bars are middle Elwha (Upstream of Elwha dam to Glines Canyon dam site), and red bars are upper Elwha (upstream of Glines Canyon site).

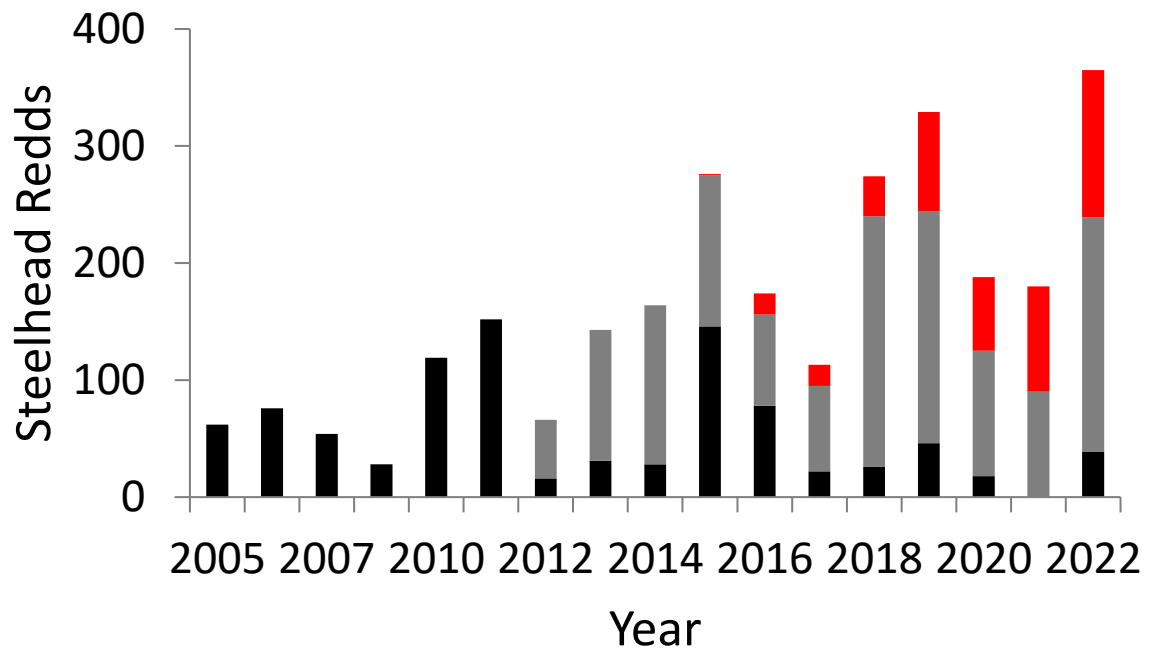
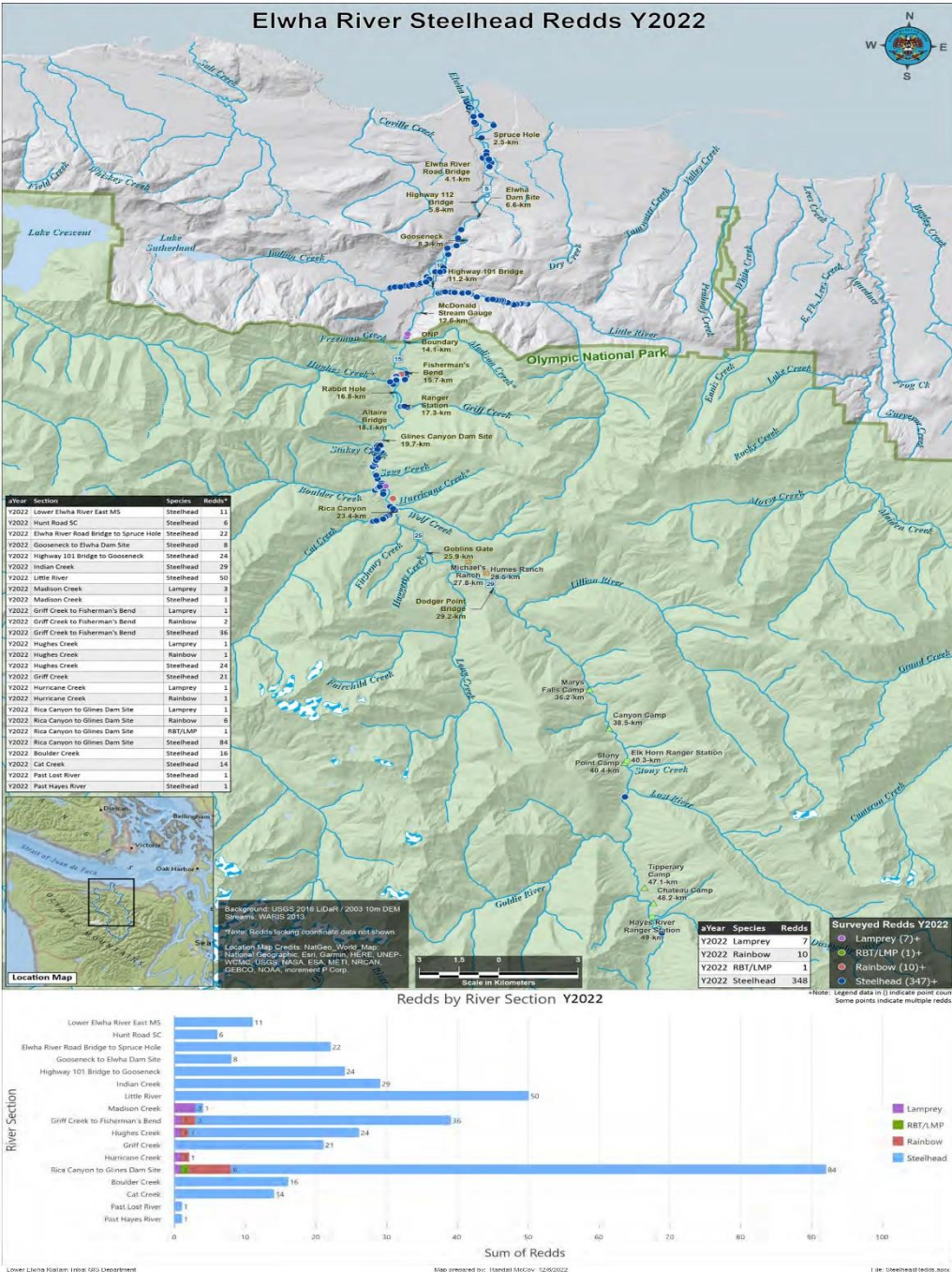
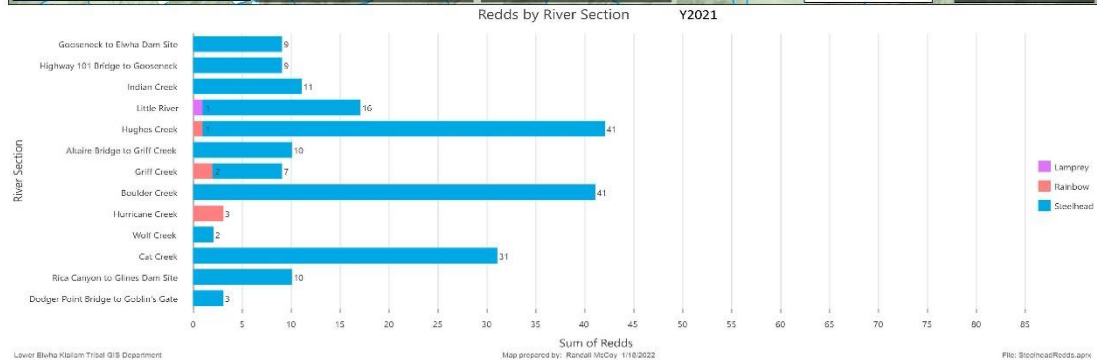
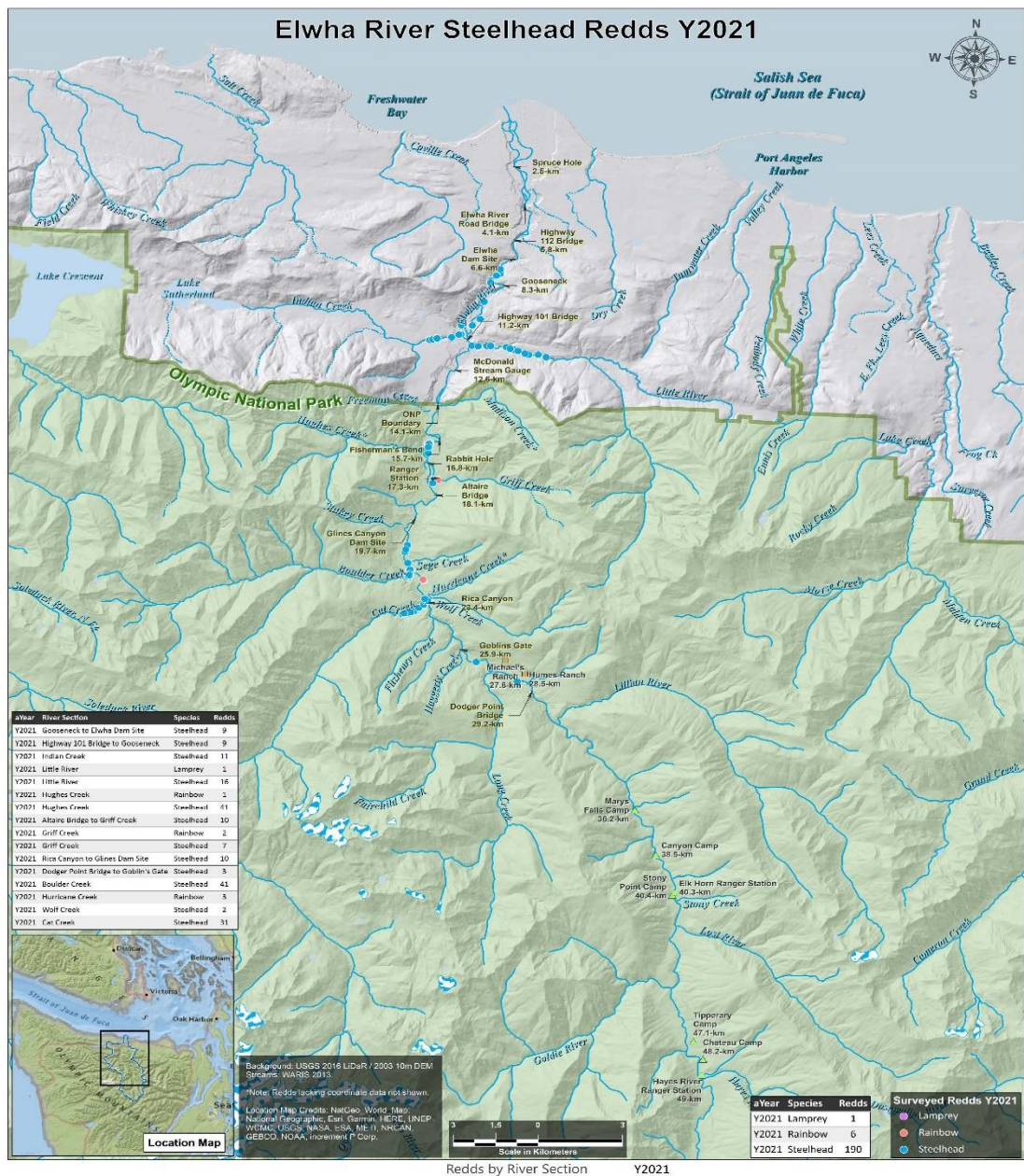


Figure 6. Map of steelhead redd locations in the mainstem Elwha River and tributaries in (a.) 2022, (b.) 2021, (c.) 2020, (d.) 2019, (e.) 2018, (f.) 2017, (g.) 2016, (h.) 2015, (i) 2014, and (j) 2013. Extensive surveys in the mainstem Elwha were not conducted in 2017 due to poor visibility and high flows.

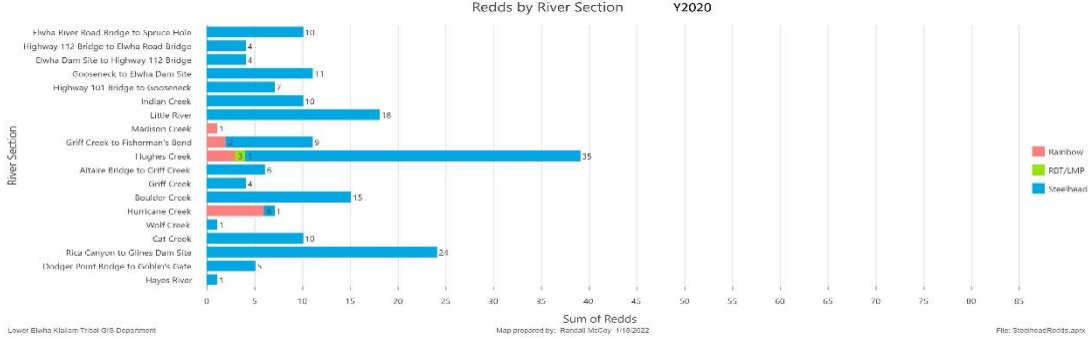
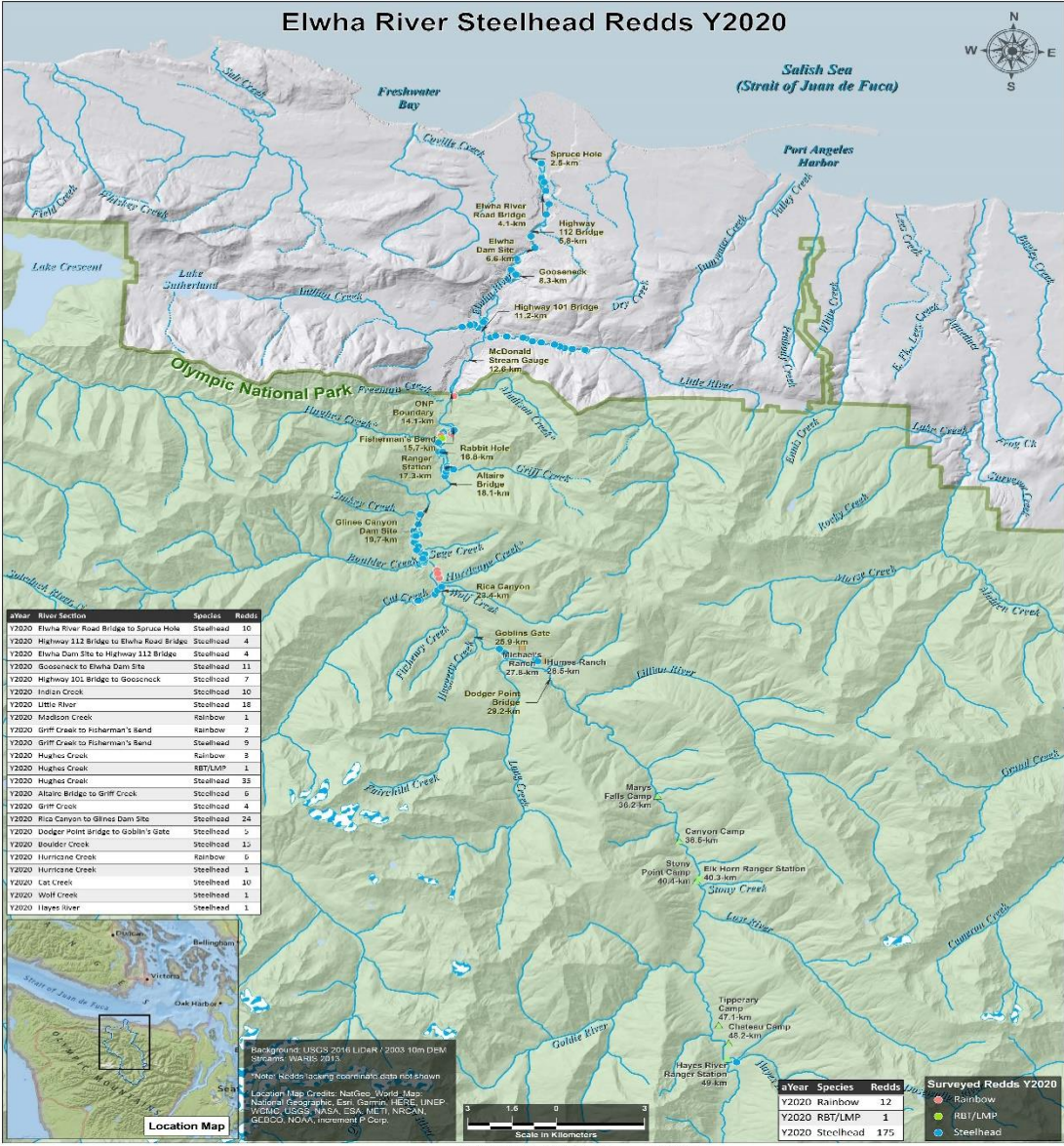
a. 2022



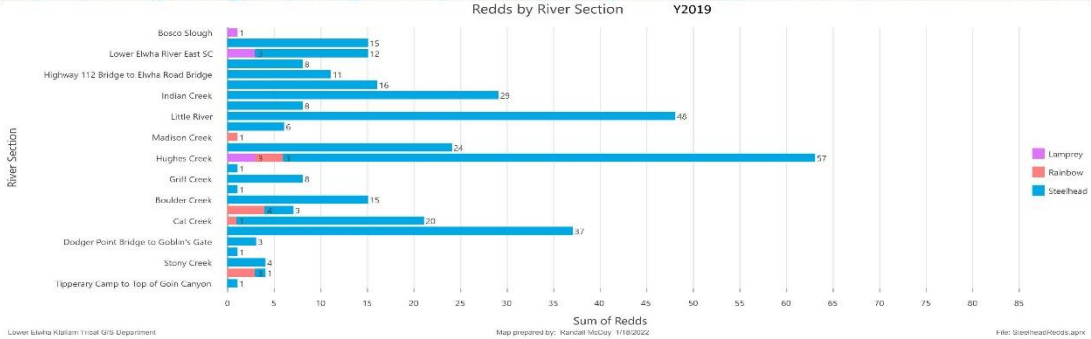
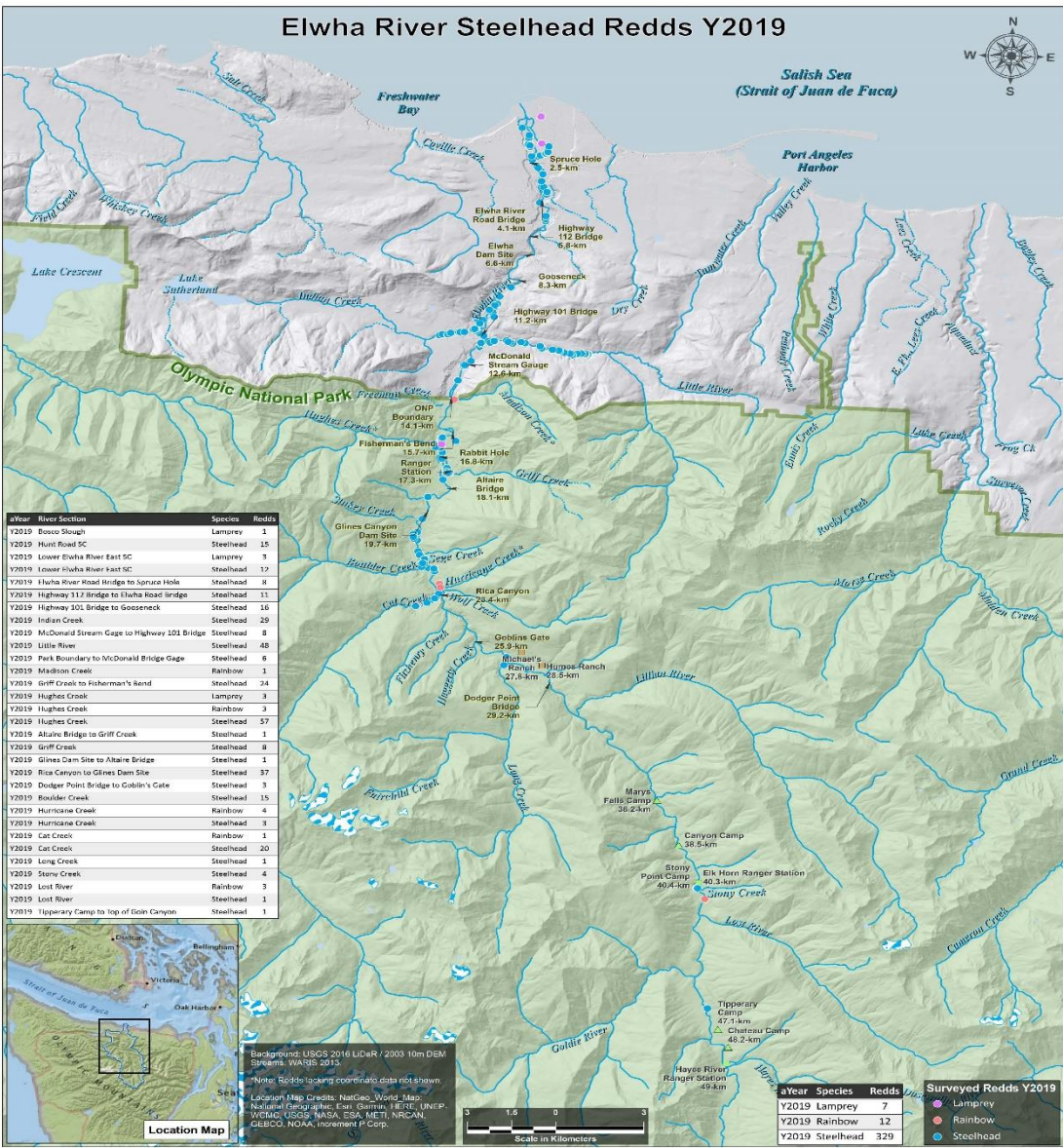
b. 2021



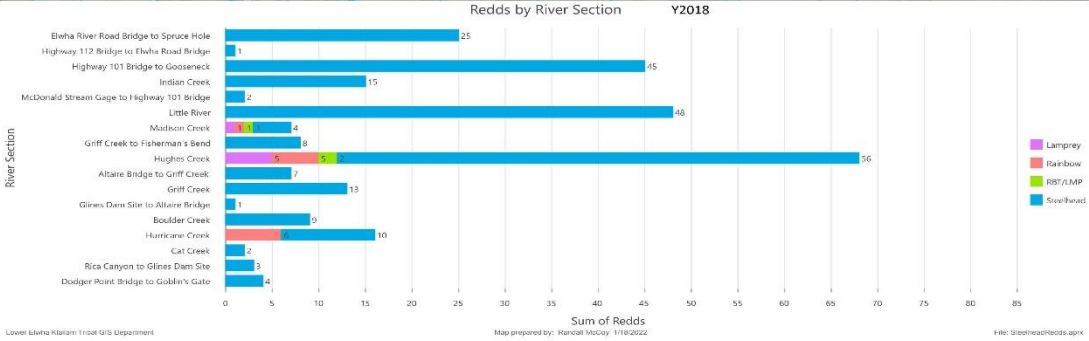
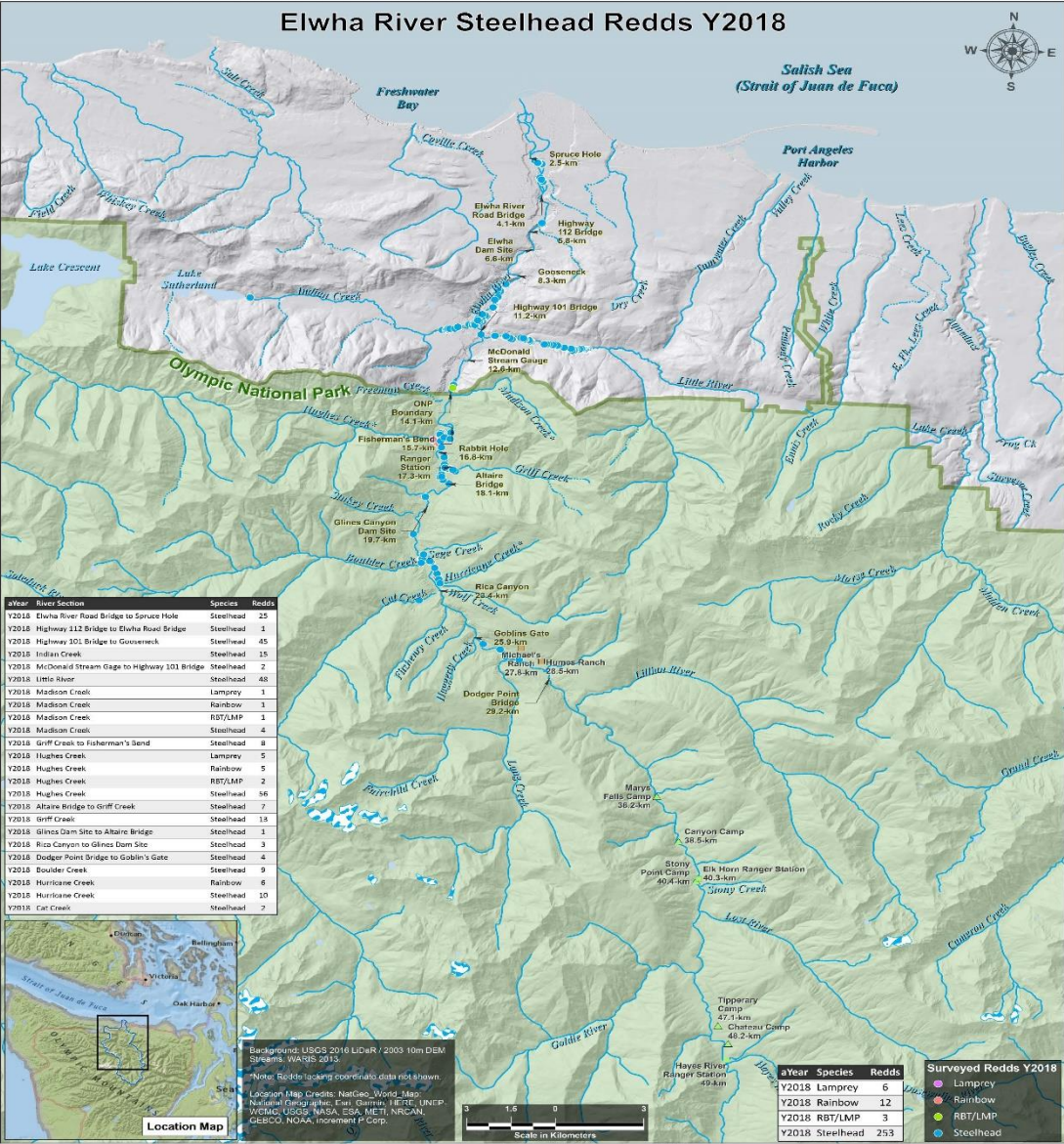
c. 2020



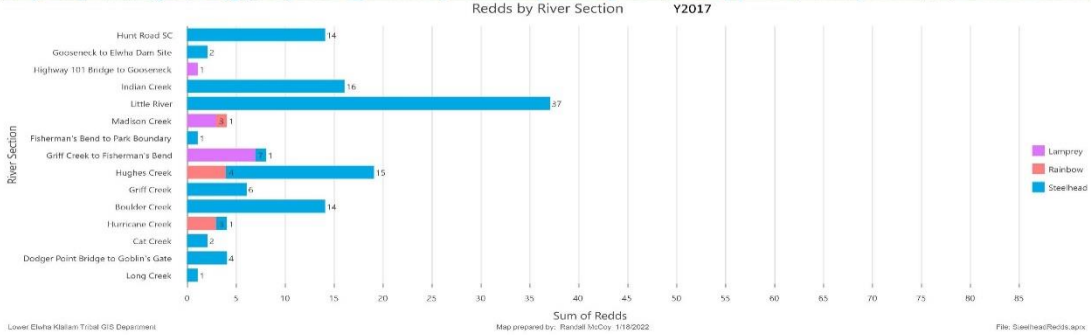
d. 2019



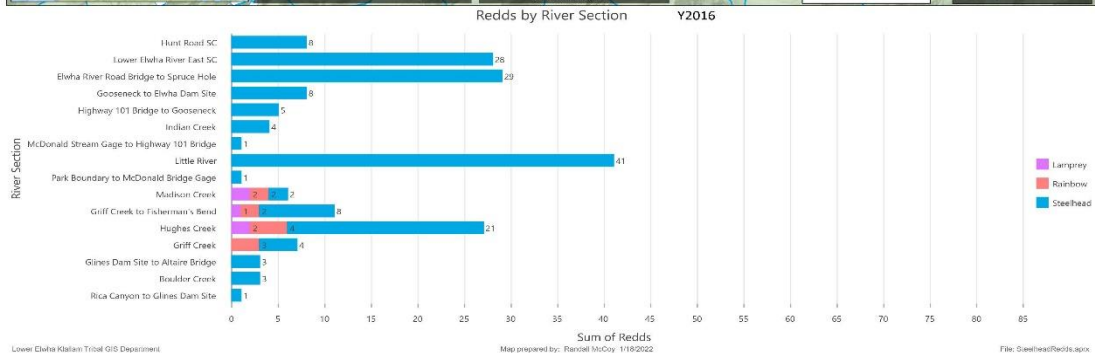
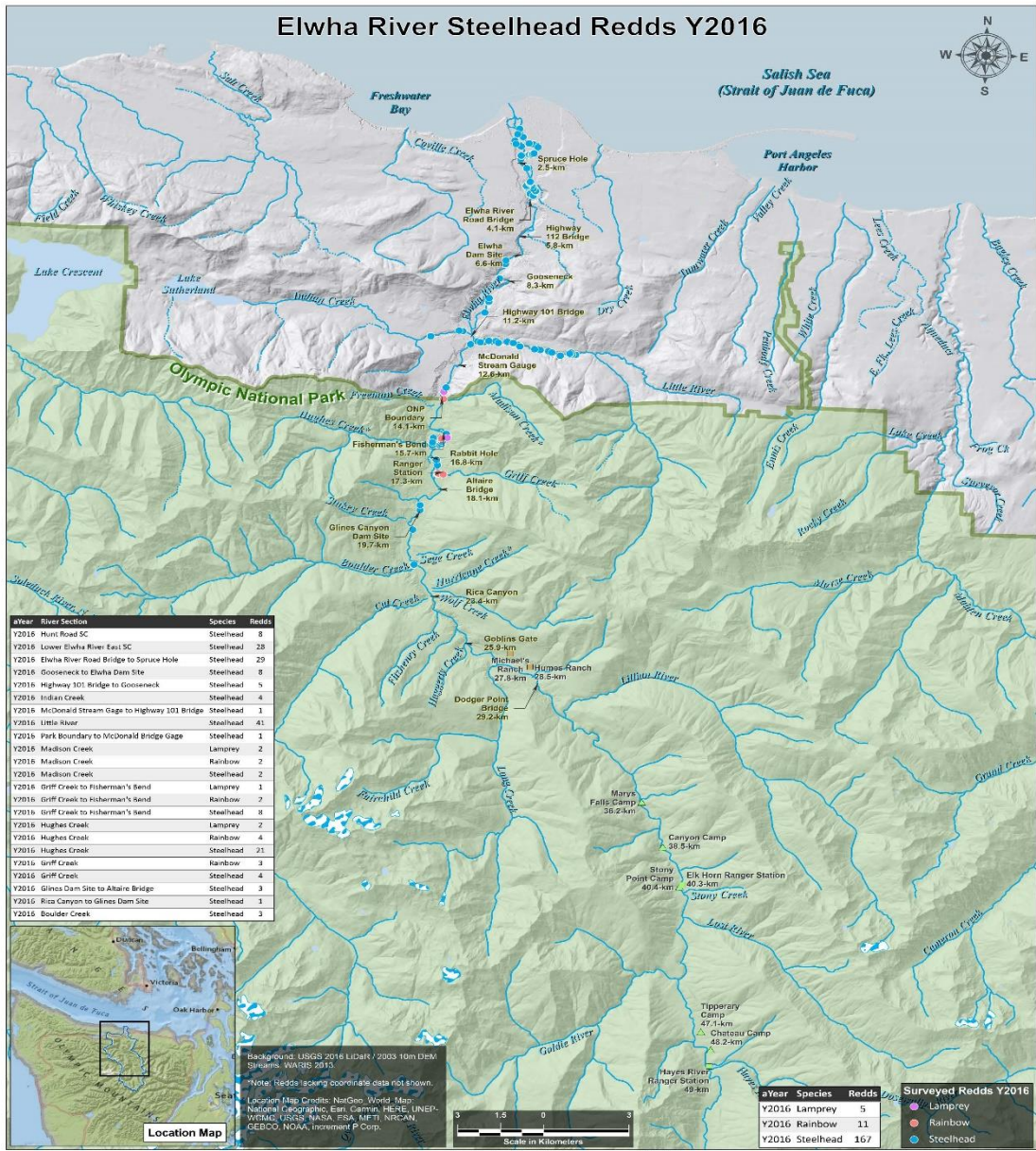
e. 2018



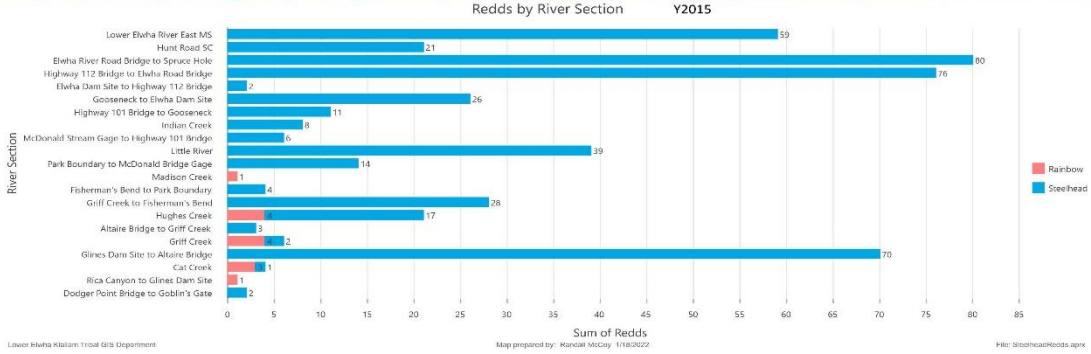
f. 2017



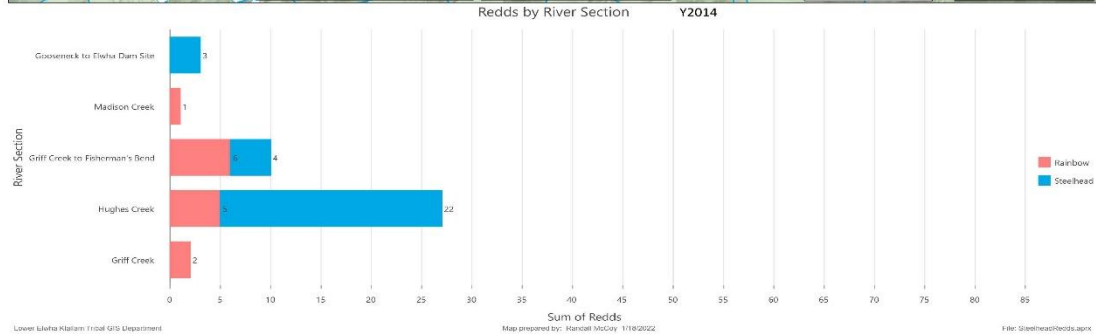
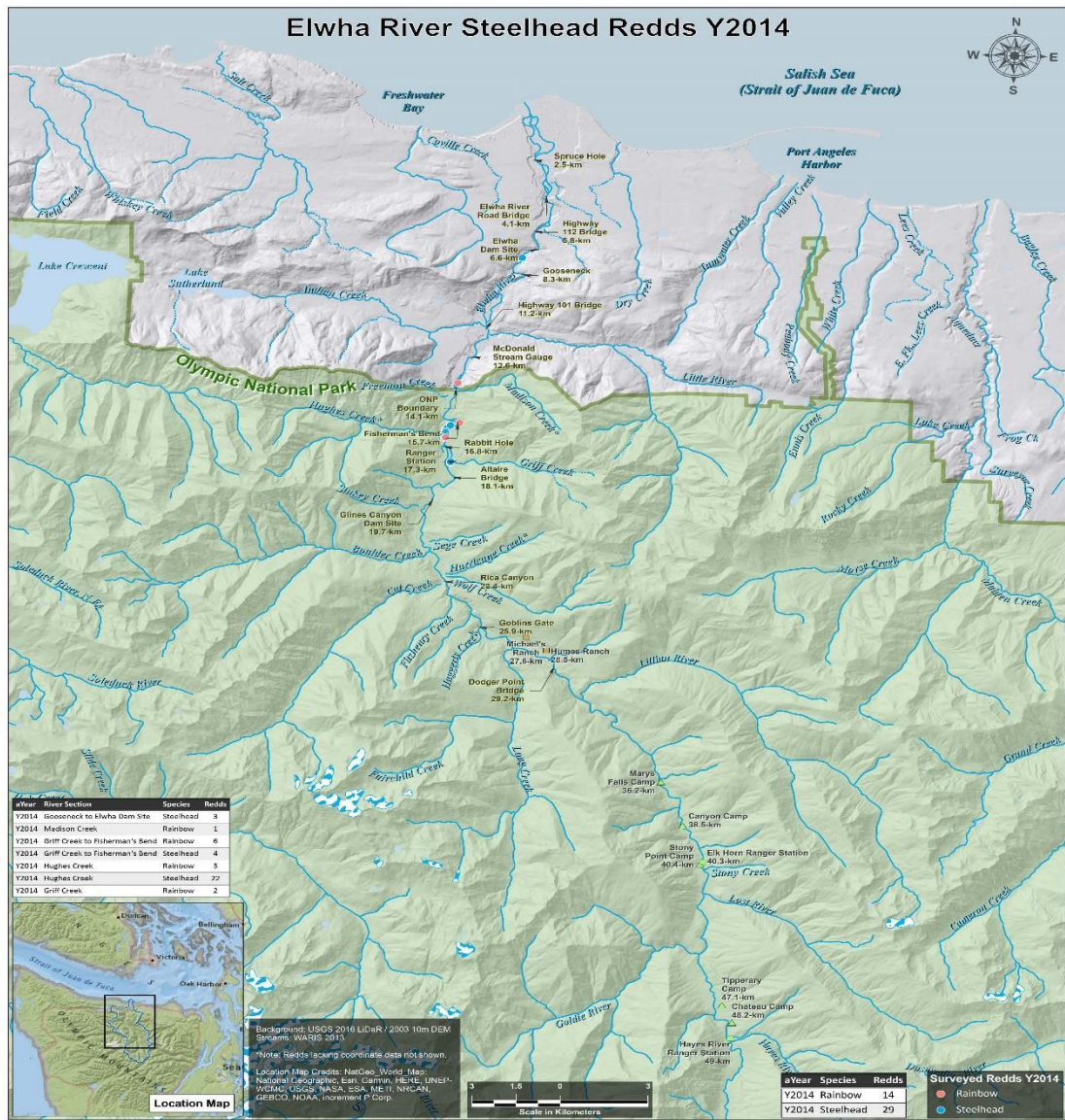
g. 2016



h. 2015



i. 2014



j. 2013

