

# **Summary of 2017 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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John R. McMillan, Trout Unlimited  
Ray Moses, Lower Elwha Klallam Tribe (LEKT)  
Mike McHenry (LEKT)  
George Pess, NOAA/NWFSC  
Martin Liermann, NOAA/NWFSC

## Summary

2017 represents the sixth consecutive year of steelhead redd surveys in the Elwha River as part of the Elwha River Restoration Project. 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 2017 are significant in that no adult steelhead were relocated from downstream hatcheries and all observations of redds were the result of volitional recolonization. Based on these data we report several important preliminary findings. First, we counted 113 total redds, which accounts for 18%-20% of the total 2017 run size estimated by SONAR. An additional 66 steelhead returned to the LEKT hatchery, increasing the observation rate to approximately 26%. Second, a substantial number of steelhead continue to volitionally colonize and spawn in several tributaries above the former Elwha Dam site. Third, more steelhead were observed spawning in the Upper Elwha (above the former Glines Canyon Dam site) than in any previous year. Fourth, the spatial distribution of redds shifted further upstream within Little River this year compared to previous years, including those years when there were more redds. The combined patterns suggest that the spatial distribution of spawning winter steelhead is likely to expand 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 further expand survey effort in the upper Elwha in future years.

## 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 summer entry timing and half-pounders (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 steelhead 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), the National Oceanic and Atmospheric Administration – Northwest Fisheries Science Center (NOAA-NWFSC), Olympic National Park (ONP), United States Geological Survey (USGS), and Trout Unlimited (TU) have conducted systematic foot surveys to enumerate steelhead redds and estimate spawn timing and spatial distribution in several tributaries and the mainstem Elwha River from the river mouth upstream, beyond the former Glines Canyon Dam to the Dodger Point Bridge (Figure 1). Annual winter steelhead surveys began in 2012 following the removal of Elwha Dam. These surveys were

further expanded above Glines Canyon Dam following its removal in 2014, but have, to date, been limited to the river mouth upstream to the Dodger Pt. Bridge (Rkm 0-29.2). Since the inception of the project, a portion of the adult winter steelhead, which returned to the hatchery facilities have been 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. However, adult steelhead were not relocated in 2017 due to the low numbers of adults that returned to the hatchery (66 total). Hence, all redd survey data in 2017 reflect those steelhead that volunteered to spawn in the tributaries and main-stem Elwha River. Those fish likely represent a mixture of natural origin fish as well as fish from the LEKT captive brood program. 2017 is the first year of volitional recolonization. Within two weeks of the Elwha dam removal steelhead were seen in Indian Creek without any type of floy tag, signifying they were able to swim and locate the area themselves.

In this report we identify : 1) the number of redds observed in each tributary and surveyable sections of the main-stem Elwha River, 2) their locations within the watershed and 3) conduct comparisons of the timing and spatial distribution of redd excavation in tributaries from 2012-2017. In addition we include observation on the location and timing of Pacific Lamprey (*Entosphenus tridentatus*) spawning nests that were observed during the surveys. Pacific Lamprey also appear to be in the early stages of recolonizing the Elwha River and documenting that response is of importance to the overall project.

## **Methods**

### **Redd survey location and timing**

Spawning ground surveys conducted on foot were used to determine the location and timing of adult steelhead spawning (Gallagher et al. 2007). Survey areas (estimated percent of potential steelhead spawning habitat surveyed) included Cat Creek (100%), Long Creek (90%), Hurricane Creek (100%) and Boulder Creek (100%) in the Upper Elwha and six tributaries in the Middle Elwha: Little River (50%) and Indian Creek (25%), Griff (100%), Madison (100%), Campground (Sanders) (100%), and Hughes Creeks (100%) (Figure 1 and Table 1). Limited surveys of the main stem channel were conducted in 2017 due to sustained high flow and low visibility. Those one-time surveys included the Hunt Road Channel (Rkm 1-2.5), former Aldwell Reservoir (Rkm 7-10.8), and the area upstream of the former Glines Canyon Dam to the entrance of the Grand Canyon of the Elwha (Rkm 19.7-27.5). No other surveys of the mainstem were attempted in 2017 because of flow conditions generated by a large snowpack accumulated in the winter of 2016-2017. Redd counts took place from early-February through June or early July and were conducted once

every 7-14 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. Observations of spawning Pacific Lamprey were also made during the 2017 steelhead surveys. Their nests (redds) are distinct from steelhead and are smaller, circular, and resemble a small pit lined with rocks. In 2017 we decided to include our observations on spawning Pacific Lamprey. This species is also recolonizing historic habitats in the Elwha River because documenting their progression is important to the overall project.

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 2017, only data from Indian Creek, Hughes 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 108 redd surveys from early February through late July in the tributaries (Table 1 and Table 2). Most streams had been surveyed in previous years, including Little River, Indian Creek, Hughes Creek, Madison Creek, Campground Creek, Griff Creek, Cat Creek, and Boulder Creek. However, this year we also surveyed Hurricane Creek, a small tributary just above the former Glines Canyon Dam and Long Creek, a tributary located in Geyser Valley (Table 1 and Figure 4a). The most surveys were conducted in Indian Creek and the fewest in Long Creek (Table 1), which is the most remote tributary. This year was unique in that high water reduced visibility to the point where we could not conduct all our regular surveys in some tributaries. The conditions also precluded redd counts in the mainstem Elwha River except for a single survey of the Geyser Valley late in the season.

We observed a total of 91 winter steelhead redds in the tributaries and an additional 22 redds were observed in the three surveys of the mainstem conducted in 2017 (Table 1).

Similar to 2016 and previous years, the greatest number of redds were observed in the middle river tributaries. Little River had the greatest number of redds (37) (Figure 2) and we also counted 16 redds in Indian Creek, 15 redds in Hughes and 5 redds in Griff Creek. Campground (Sanders) Creek and Madison Creek were the only two middle Elwha tributaries in which steelhead redds were not observed in 2017 (Table 1). The 2017 survey represents the highest redd count total in Little River since 2014, which was the last year when adult steelhead were relocated to the stream (Table 3 and Figure 2).

Surveys from the upper Elwha indicate that winter steelhead continue to recolonize areas above the former Glines Canyon Dam. Of note this year were 21 redds counted in tributaries or the main stem above the former Glines Canyon Dam, including 5 redds above Rica Canyon. We counted 14 redds in Boulder Creek and an additional 2 redds in Cat Creek. Importantly, we also observed a single redd in Long Creek at Rkm 27.5, which was surveyed for the first time and is located in Geyser Valley (upstream of Rica Canyon) (Table 1 and Figure 4a), as well as 4 redds in the main stem river in Geyser Valley. These observations are the furthest upstream documentation of winter steelhead spawning in the Elwha River to date. In contrast, only four redds were observed upriver of Glines Canyon in 2016 (three in Boulder Creek and one in the mainstem near Windy Arm), and a single redd was observed upriver of Glines in 2015 (in Cat Creek).

### **Temporal and Spatial Redd Distribution**

Temporal patterns indicated a protracted breeding season in 2017, similar to previous years. The earliest redd was observed in the first week of March in Little River, while the latest redd was observed on July 7 in Hurricane Creek. As with the past two to three seasons however, most redds were observed in tributaries from late-March through mid-May. The median spawn timing (time at which 50% of the redds were counted) was similar to the previous two years in Little River, which is the third week of April (Figure 3a). Median spawn timing was the same for Indian Creek, which was similar to the previous three years of surveys (Figure 3b). Median spawn timing was mid-May for Hughes Creek, which was later than the previous seasons (Figure 3c). Comparisons of spawn timing were not possible with other tributaries because of the relatively small number of redds counted in those places.

Spatially, there were several notable results. First, steelhead redds were documented in lower Indian Creek and throughout Little River as with previous years (Figures 4a, 4b, and 4c). However, this year was the first that we observed more redds in the upper section of Little River compared to the lower section. This is reflected in a more continuous distribution of steelhead redds in that section of the tributary (Figure 4a).

Second, a similar observation was made in Indian Creek. However, it is important to remember that we survey a relatively small portion of Indian Creek due to limited access due to private property, so we are uncertain about the full spatial distribution of spawning activity within Indian Creek. Lastly, the number of redds observed above the former Glines Canyon dam was higher than in any previous year.

### **Observations of Pacific Lamprey Spawning**

During the 2017 steelhead surveys, observers encountered small numbers of spawning Pacific Lamprey and/or their nests. Pacific Lamprey typically are spring spawners that construct nests with a unique morphology as compared to Pacific salmon (Beamish 1980; Kostow 2002). Pacific Lamprey quickly recolonized Indian Creek immediately following removal of Elwha Dam in 2012 (McHenry et al. 2016), however they have not been widely observed in other parts of the watershed to date. In 2017 we located a total of 10 lamprey nests during the steelhead survey effort. Six of those redds were found in Campground (Sanders) Creek, 3 nests were observed in Madison Creek and a single nest was observed on the mainstem Elwha in the former Aldwell reservoir.

### **Discussion**

As with previous year's surveys (McMillan et al. 2011-2015; McMillan and Moses 2012; LEKT 2016), tributary flow and visibility conditions in the tributaries generally allowed for enough redd surveys to effectively measure the spatial distribution of spawning by winter steelhead. However, the 2017 surveys were also interrupted by high flows and reduced water clarity, which prohibited systematic surveys of the main-stem Elwha River. Visual counts were not possible in January, for much of February and bi-weekly periods in March and May, which differed from previous years when we were able to conduct weekly surveys in Little River and Indian Creek (McMillan et al. 2011-2016; McMillan and Moses 2012). The reduced temporal resolution in Little River and Indian Creek made it impossible to statistically compare the timing of spawning activity compared to years when surveys were conducted more frequently. Regardless, the 2017 redd surveys still provided information on the general timing of spawning and on the spatial distribution of spawning winter steelhead. The results of the surveys suggest that winter steelhead have continued to volitionally increase their distribution above the former dam sites with an increase in observations above the former Glines Canyon Dam site over 2016.

We counted a total of 113 winter steelhead redds, 91 of which were located in tributaries and 22 in the mainstem. The SONAR monitoring estimated the steelhead run size to be 1,130 steelhead (Denton et al. 2017). If we assume a 50:50 sex ratio and that each female dug only one redd, the 113 redds equates to a total of 226 winter steelhead. Of

course, those assumptions may vary if females excavate more than one redd and the sex ratio is biased. For example, WDFW's assumes 1.8 fish per redd to account for females digging more than one redd, though it still assumes a 50:50 sex ratio. Their method would equate to approximately 203 winter steelhead. This means the total number of redds we observed in tributaries, combined with 66 fish collected from the hatchery rack, accounts for 24% (assuming 1.8 fish/redd) to 26% (assuming 2 fish/redd) of the population, per the Denton et al. (2017) estimate.

The redd surveys continue to indicate that the middle river tributaries: Little River, Hughes Creek, and Indian Creek are important spawning habitat for winter steelhead. We are also beginning to see increased use of upper Elwha tributaries such as Boulder Creek. The mouth of Boulder Creek is located above Glines Canyon (at rkm 24) and the number of redds increased from three last year to fourteen this year. In addition, 5 steelhead redds were observed in Geyser Valley, about 6 kilometers above Boulder Creek. Given that we observed more redds above Glines Canyon than in any other previous year, it appears that steelhead are passing the former boulder blockage at Glines Canyon (McMillan et al. 2015, 2016) and moving further upstream in the watershed. This is also supported by observations of summer run steelhead in the upper watershed during 2016 and 2017 (Personal Communication, Heidi Huginin, Olympic National Park). These observations suggest that more extensive surveys in the Upper Elwha would improve knowledge about the overall distribution of spawning steelhead. Regardless, the continued upstream distribution is a positive sign for recolonization.

Among tributaries, Little River once again supported the greatest abundance of spawning winter steelhead (McMillan et al. 2011-2016; McMillan and Moses 2012). This year though, for the first time, there were more redds observed in the upper survey reach compared to the lower survey reach. One potential hypothesis is that high stream flows throughout the spawning season improved access to upper parts of the creek. Similarly, improved passage at the Elwha Dam site, coupled with improved water quality conditions, may have stimulated naturally returning fish to move higher into the watershed.

It is also possible there is a genetic or homing component. For example, some returning adults may not be first-time colonizers: they could be 4- or 5-year old progeny of offspring from the initial relocation of steelhead to Little River in 2012 and 2013. Returning adults may have homed back to upper areas if they survived at a higher rate than offspring from lower in the system where redd densities were highest. Understanding what proportion, if any, of juvenile and adult steelhead are from some of those initial colonizers could improve knowledge about recolonization (e.g., Pess et al. 2012), such as: What proportion of the juveniles and adults come from wild or hatchery-origin adults? Which life histories are the most successful during the initial stages of recolonization? Lastly, does spawning location or timing have any effect on colonization success? Answers to those

questions could help better understand natural selection interactions and inform adaptive management on the Elwha and future dam removal projects in other watersheds.

There is another interesting pattern in the spatial distribution of redds in Little River. In the years when adult steelhead were relocated to Little River we observed clusters of redds within the immediate vicinity of the release locations, including near the mouth by the Hot Springs Road bridge and further upstream at the DNR access site (Rkm 1.9) (McMillan et al. 2011-2016; McMillan and Moses 2012). We did not observe clusters of redds in those areas this year or the previous two years when only adult steelhead volitionally colonized Little River. This raises questions about whether the behavior of relocated fish may have reduced the spawning success of relocated fish as opposed to natural colonizers. Did relocated fish spawn in less suitable habitat than natural migrants? Did crowding of redds reduce survival through redd superimposition or early rearing competition upon emergence of fry? This is another reason that it is important to understand how, or if, the spatial distribution of spawners influences recolonization (Pess et al. 2012).

Unlike the last two years, we were not able to conduct extensive redd counts in the main-stem Elwha River. Such information is critical to understanding where and when steelhead are spawning, and in turn, what that means for success of their offspring and recolonization overall. Given the challenges of conducting visual surveys in the Elwha, the partners may need to use alternative methods for estimating abundance and distribution of winter steelhead in the main-stem Elwha. Increasing survey effort in the upper Elwha would be particularly useful. Given the lack of access, which has been exasperated by the road washout on Hot Springs Road, project managers could consider implementing either helicopter redd surveys or installing an additional SONAR camera at an upriver site. Either option would add considerable cost to the overall project monitoring budget.

In summary, we report three important preliminary findings. First, a substantial number of steelhead volitionally recolonized and spawned in several tributaries to the Middle Elwha River. Second, more steelhead were also observed spawning in the Upper Elwha than last year, particularly in Boulder Creek, which means fish are passing the former Glines Canyon Dam site. Third, the spatial distribution of redds in Little River increased in the upper section of the river compared to previous years. 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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## References

- Beamish, R.J. 1980. Adult biology of the River Lamprey (*Lampetra ayresi*) and the Pacific Lamprey (*Lampetra tridentata*) from the Pacific Coast of Canada. Canadian Journal of Fisheries and Aquatic Science 37:1906-1923.
- Denton, K., M. McHenry, R. Moses, E. Ward, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2016. Elwha River steelhead escapement estimate based on DIDSON/ARIS multi-beam SONAR data. This report is provided to Olympic National Park by the Lower Elwha Klallam Tribe in partial fulfillment of task number 6-1 of contract number P13PC0029.
- Gallagher, S.P., Hahn, P.K., and D.H. Johnson. 2007. Redd counts. Pages 197-234 in D.H. Johnson, B.M. Shrier, J.S. O'Neal, J.A. Knutzen, X. Augerot, T.A. O'Neil, and T.N. Pearsons. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.
- Kostow, K. 2002. Oregon lampreys: Natural history status and problem analysis. Oregon Department of Fish and Wildlife, Salem, Oregon.
- McHenry, M.L., M. Elofson, M. Lehrman, T. Bennett, S. Corbett, and G. Pess. 2016. Elwha River smolt enumeration report. Report to Olympic National Park, Port Angeles, WA 98363.
- McMillan, J. R., S. L. Katz, and G. R. Pess. 2007. Observational evidence of spatial and temporal structure in a sympatric anadromous (winter steelhead) and resident *Oncorhynchus mykiss* mating system on the Olympic Peninsula, Washington State. Transactions of the American Fisheries Society **136**:736-748.
- McMillan, J.R., Moses, R., and McHenry, M., Pess, G.R., Denton, K., and Liermann, M. 2011. Winter steelhead redd enumeration report for lower Elwha River 2010/2011. Elwha River Annual Reports for NOAA/NWFSC, Lower Elwha Klallam Tribe, and Olympic National Park.
- McMillan, J.R., and R. Moses. 2012. Winter Steelhead (*Oncorhynchus mykiss*) Redd Survey Summary for Middle Elwha River 2011/2012. Elwha River Annual Reports for NOAA/NWFSC, Lower Elwha Klallam Tribe, and Olympic National Park.
- McMillan, J.R., Moses, R., McHenry, M., Denton, K., Pess, G., Hugunin, H., and A. Geffre. 2013. Winter Steelhead (*Oncorhynchus mykiss*) Redd Survey Summary for Elwha River 2012/2013. Elwha River Annual Reports for NOAA/NWFSC, Lower Elwha Klallam Tribe, and Olympic National Park.

- McMillan, J.R., Moses, R., McHenry, M., Denton, K., Pess, G., Hugunin, H., and A. Geffre. 2014. Winter Steelhead (*Oncorhynchus mykiss*) Redd Survey Summary for Elwha River 2013/2014. Elwha River Annual Reports for NOAA/NWFSC, Lower Elwha Klallam Tribe, and Olympic National Park.
- McMillan, J.R., Moses, R., McHenry, M., Denton, K., Pess, G., Hugunin, H., and A. Geffre. 2015. Winter Steelhead (*Oncorhynchus mykiss*) Redd Survey Summary for Elwha River 2014/2015. Elwha River Annual Reports for NOAA/NWFSC, Lower Elwha Klallam Tribe, and Olympic National Park.
- Pess, G. R., R. Hilborn, K. Kloehn, T. P. Quinn. 2012. The influence of population dynamics and environmental conditions on pink salmon recolonization after barrier removal. Canadian Journal of Fisheries and Aquatic Sciences, 69:970-982. doi:10.1139/F2012-030

## TABLES

**Table 1.** Description of survey locations, reach (all - indicates entire stream was surveyed), number of surveys conducted, number of steelhead relocated, and the total number of redds counted.

| Site           | Reach location (km) | # Surveys | Steelhead relocated | Redds (#/km) | % Surveyed       |
|----------------|---------------------|-----------|---------------------|--------------|------------------|
| Little R.      | 0.0 - 4.7           | 14        | None                | 37 (7.8)     | 50% <sup>1</sup> |
| Indian Ck.     | 0.0 – 2.4           | 15        | None                | 16 (6.7)     | 25%              |
| Mainstem Elwha | various             | 3         | None                | 22           | <5%              |
| Madison Ck.    | 0.0 - 0.2           | 11        | None                | 0 (0)        | 100%             |
| Griff Ck.      | 0.0 - 0.4           | 11        | None                | 5 (12.5)     | 100%             |
| Campground Ck. | 0.0 - 0.6           | 11        | None                | 0 (0)        | 100%             |
| Hughes Ck.     | 0.0 - 1.2           | 11        | None                | 15 (12.5)    | 100%             |
| Boulder Ck.    | 0.0 - 1.0           | 8         | None                | 14 (14)      | 100%             |
| Cat Ck.        | 0.0-1.1             | 8         | None                | 2 (1.8)      | 100%             |
| Hurricane Ck.  | 0.0 - 1.1           | 5         | None                | 1 (0.9)      | 100%             |
| Long Ck.       | 0.0 - 1.1           | 1         | None                | 1 (0.9)      | 90%              |
| Totals         | 16.9                | 108       | 0                   | 113          |                  |

<sup>1</sup> Estimated proportion of usable habitat – total available habitat for steelhead is unknown for this tributary

**Table 2.** Months and weeks (1-4) when redd surveys were conducted (grey cells) for each location.

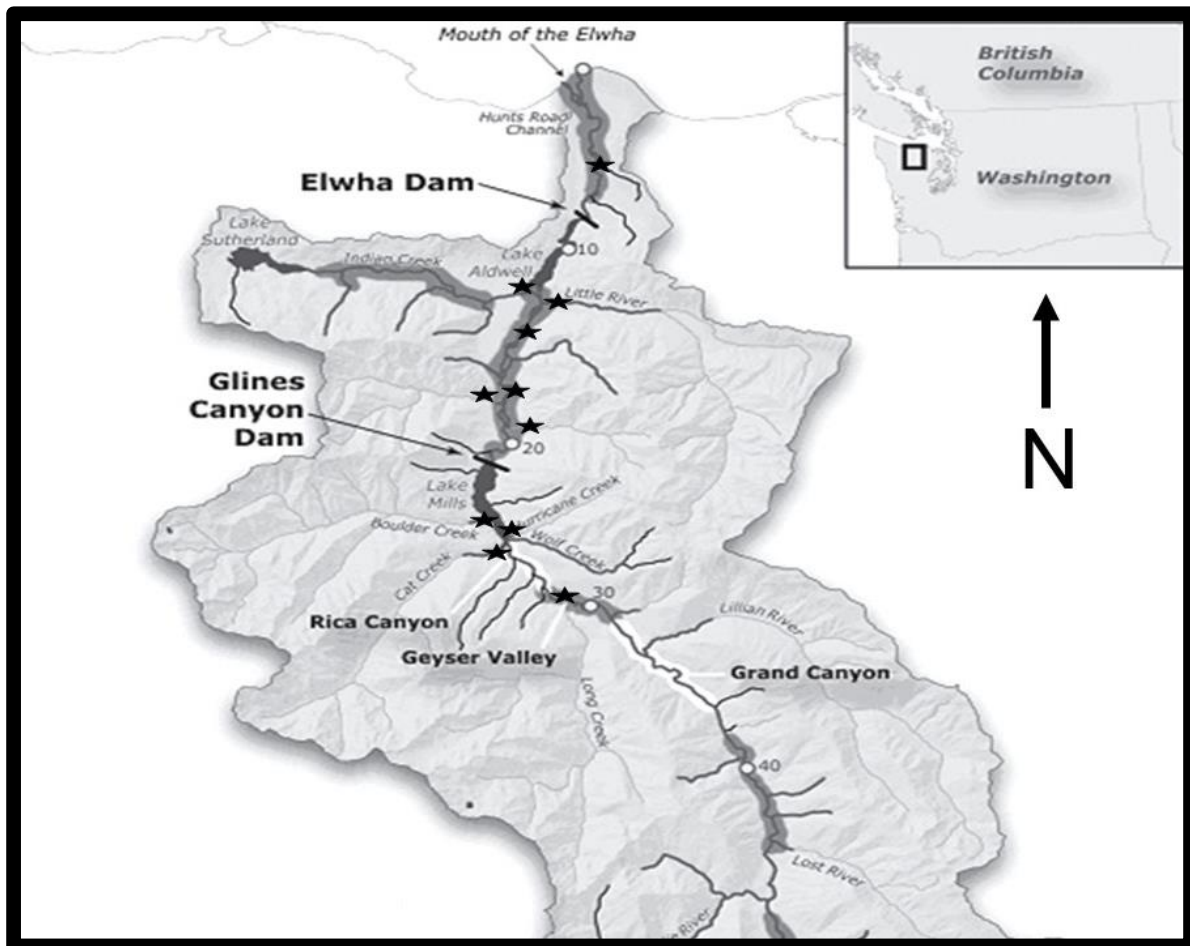
| Site           | February |   |      |   | March |      |      |      | April |      |      |      | May  |      |      |      | June |      |      |      | July |
|----------------|----------|---|------|---|-------|------|------|------|-------|------|------|------|------|------|------|------|------|------|------|------|------|
|                | 1        | 2 | 3    | 4 | 1     | 2    | 3    | 4    | 1     | 2    | 3    | 4    | 1    | 2    | 3    | 4    | 1    | 2    | 3    | 4    | 1    |
| Little R.      |          |   |      |   |       |      |      |      |       |      |      |      |      |      |      |      |      |      |      |      |      |
| Lower          | Grey     |   |      |   | Grey  | Grey |      | Grey | Grey  |      | Grey | Grey |      | Grey | Grey | Grey | Grey | Grey |      | Grey |      |
| Upper          |          |   |      |   |       |      |      |      |       |      |      | Grey |      |      |      |      |      | Grey | Grey |      |      |
| Indian Ck.     |          |   |      |   |       |      |      |      |       |      |      |      |      |      |      |      |      |      |      |      |      |
| Lower          | Grey     |   |      |   | Grey  |      | Grey | Grey | Grey  | Grey |      | Grey | Grey |      | Grey | Grey | Grey | Grey |      | Grey |      |
| Middle         |          |   |      |   |       |      |      |      |       |      |      |      |      |      |      |      |      |      |      |      |      |
| Madison Ck.    | Grey     |   | Grey |   |       | Grey | Grey | Grey | Grey  | Grey | Grey |      |      | Grey | Grey | Grey | Grey | Grey |      | Grey |      |
| Hughes Ck.     | Grey     |   |      |   | Grey  |      | Grey | Grey |       |      |      | Grey |      |      |      |      |      |      |      |      |      |
| Campground Ck. | Grey     |   | Grey |   |       | Grey |      | Grey | Grey  | Grey | Grey |      | Grey |      | Grey | Grey | Grey | Grey |      |      |      |
| Griff Ck.      | Grey     |   | Grey |   |       | Grey | Grey | Grey | Grey  | Grey | Grey |      | Grey |      | Grey | Grey | Grey | Grey |      | Grey |      |
| Boulder Ck.    |          |   |      |   |       |      |      |      |       | Grey |      | Grey |      | Grey |      |      |      |      | Grey |      | Grey |
| Cat Ck.        |          |   |      |   |       | Grey | Grey | Grey |       | Grey |      | Grey |      | Grey |      |      |      |      |      |      |      |
| Hurricane Ck.  |          |   |      |   |       |      |      |      |       |      |      |      |      | Grey |      |      | Grey | Grey | Grey |      | Grey |
| Long Ck.       |          |   |      |   |       |      |      |      |       |      |      | Grey |      |      |      |      |      |      |      |      |      |

**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.

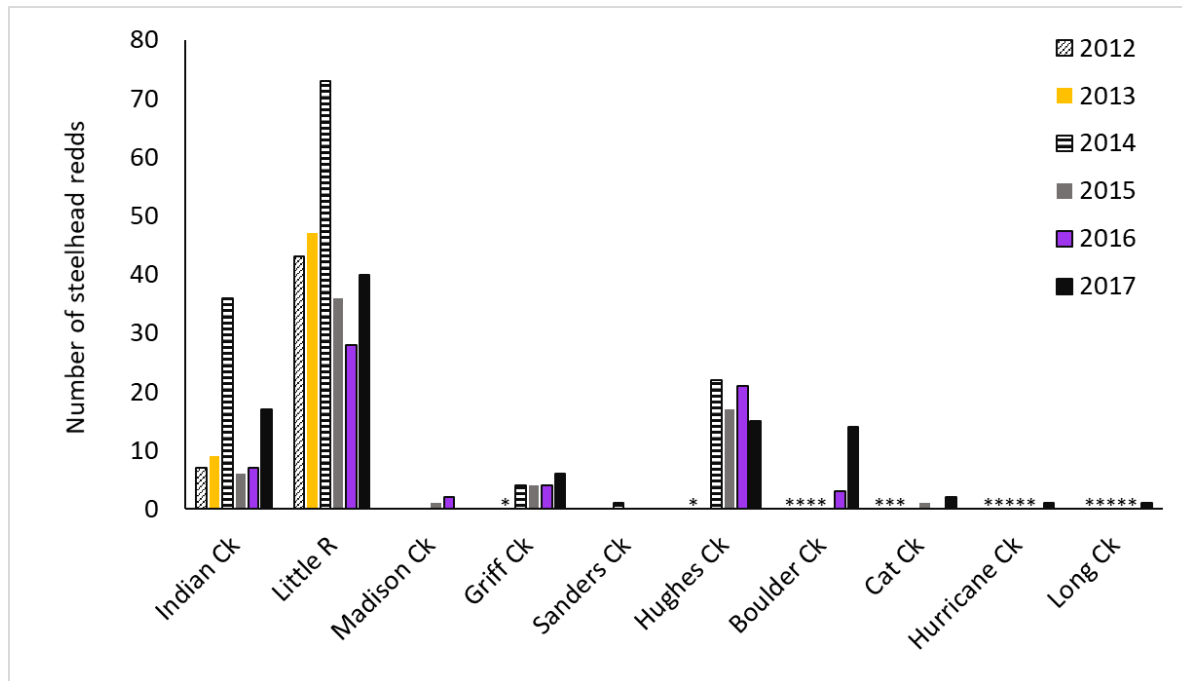
| Stream       | 2012 |   |      | 2013 |    |      | 2014 |    |      | 2015 |   |      | 2016 |    |      | 2017 |   |      |
|--------------|------|---|------|------|----|------|------|----|------|------|---|------|------|----|------|------|---|------|
|              | W    | H | Redd | W    | H  | Redd | W    | H  | Redd | W    | H | Redd | W    | H  | Redd | W    | H | Redd |
| Indian Creek | 11   | 0 | 9    | 0    | 0  | 24   | 0    | 0  | 36   | 0    | 0 | 6    | 3    | 32 | 7    | 0    | 0 | 17   |
| Little River | 35   | 0 | 43   | 53   | 35 | 47   | 1    | 58 | 73   | 0    | 0 | 36   | 0    | 0  | 28   | 0    | 0 | 40   |

## FIGURES

**Figure 1.** Map of Elwha River basin and location of streams where redd surveys were conducted for winter steelhead from February-July 2017. Stars indicate locations of (working south to north) Long Creek, Cat Creek, Hurricane Creek, Boulder Creek, Griff Creek, Hughes Creek, Campground Creek, Madison Creek, Little River, Indian Creek, and the WDFW Hatchery outflow (no longer surveyed).

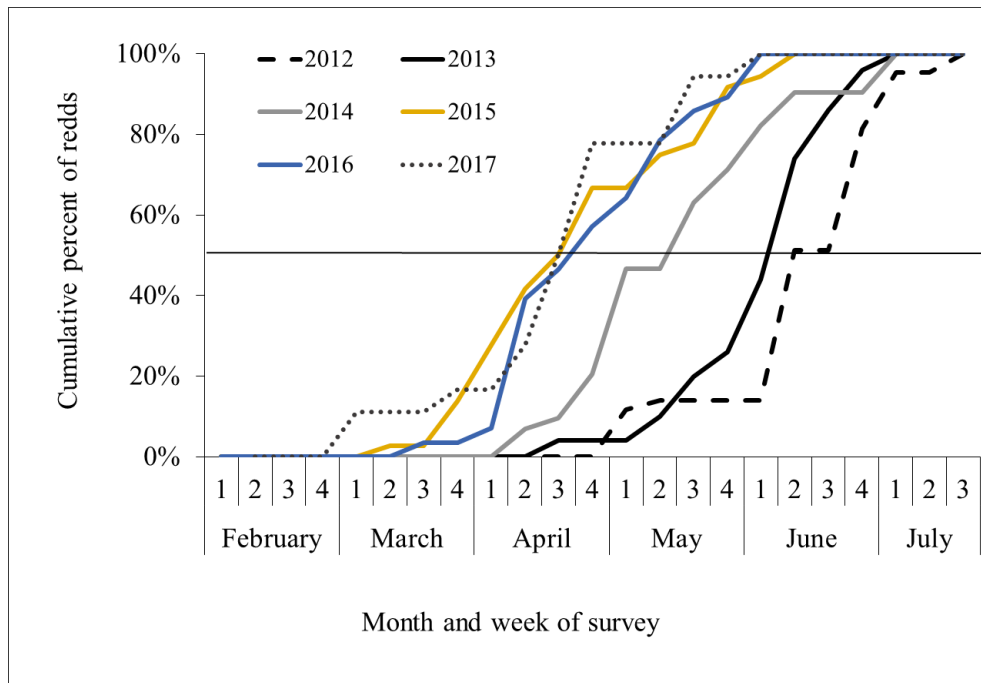


**Figure 2.** Number of winter steelhead redds counted in tributary by year in the Elwha River basin since steelhead were first reintroduced to habitat above the former Elwha Dam site. Location of stream confluence with main-stem Elwha River works upstream from left to right based on Figure 1, with Indian 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.

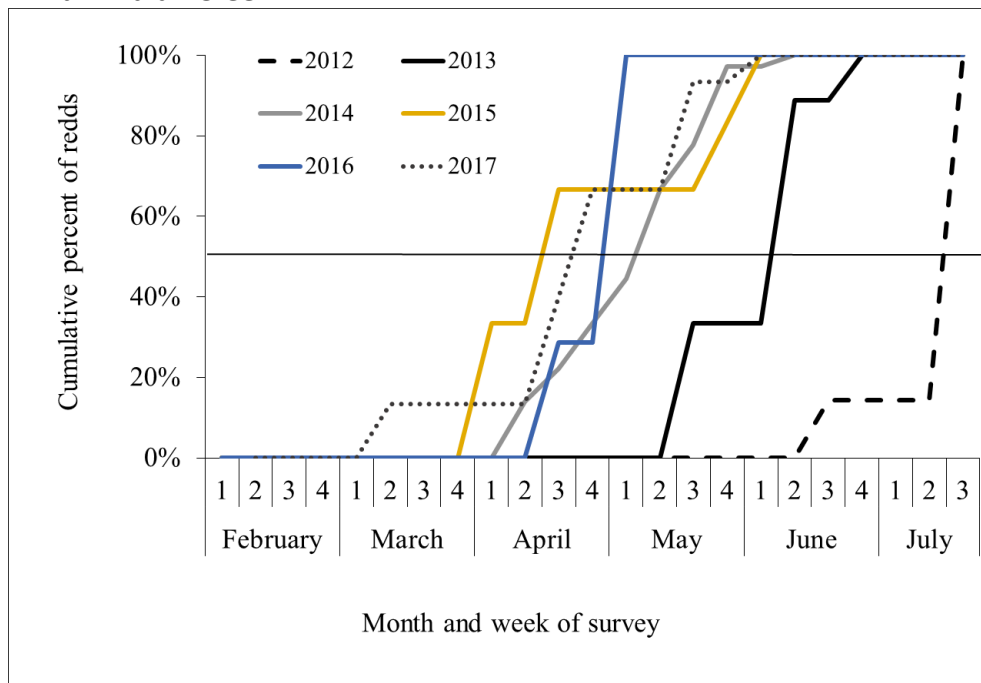


**Figure 3.** Cumulative distribution of winter steelhead redds counted during weekly redd surveys in (a.) Little River, (b.) Indian Creek, and (c.) Hughes Creek by year. Horizontal line indicates 50% threshold for cumulative distribution.

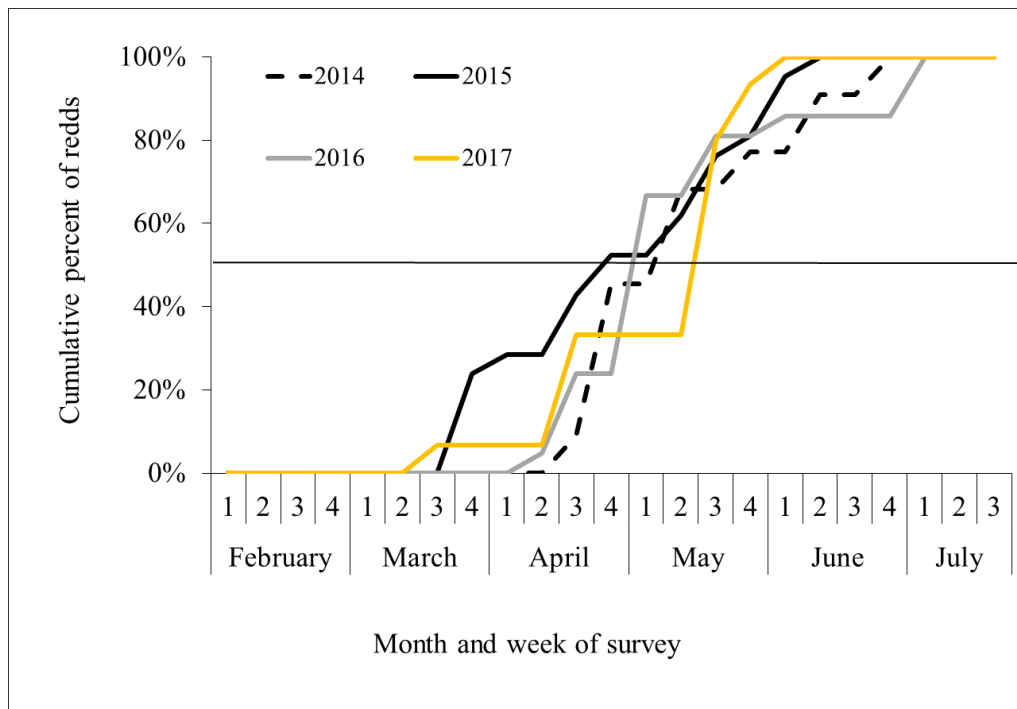
**a. Little River**



**b. Indian Creek**

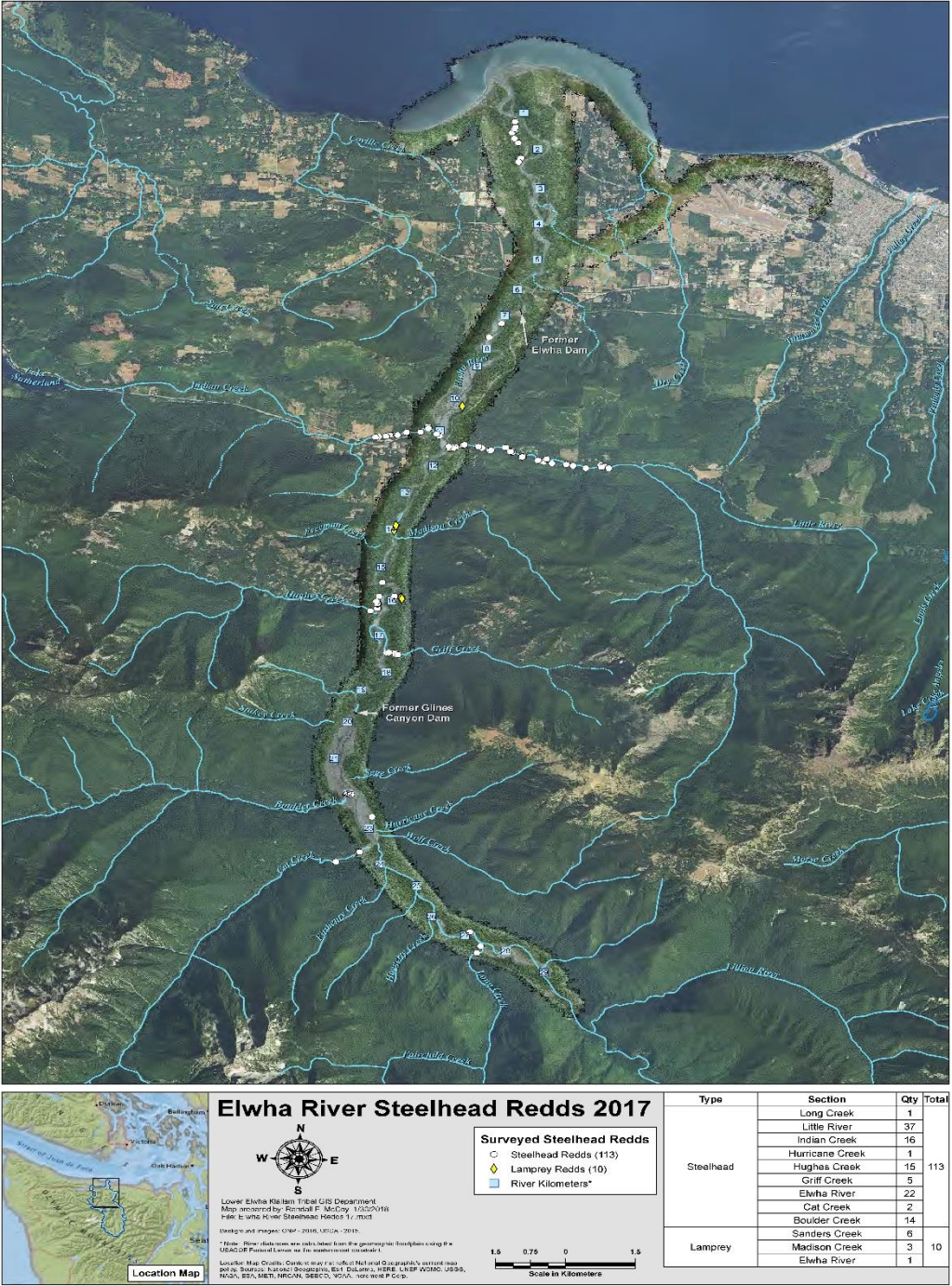


**c. Hughes Creek**



**Figure 4.** Map of steelhead redd locations in (a.) the mainstem Elwha River in 2017 (a), 2016 (b), and 2015 (c). Extensive surveys in the mainstem Elwha were not conducted in 2017 due to poor visibility and high flows.

**A. 2017**



B. 2016



C. 2015



