THE OREGON PLAN *for Salmon and Watersheds*

Assessment of Western Oregon Adult Winter Steelhead and Lamprey – Redd Surveys 2016

Report Number: OPSW-ODFW-2016-09

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SUMMARY

This report provides a summary of results from winter steelhead spawning ground surveys conducted in Lower Columbia (Oregon side) and Oregon Coast basins in 2016. Also included is a brief summary of lamprey data collected from the same monitoring efforts. Precision goals were met (95% C.I. ± 30% of point estimate) for steelhead estimates in the Oregon Coast (OC) Distinct Population Segment (DPS), the Southwest Washington (SWW) Evolutionarily Significant Unit (ESU), and in the Lower Columbia River (LCR) ESU. Surveys were not conducted in the Klamath Mountains Province (KMP) DPS for 2016. Winter steelhead redd estimates for the 2016 spawning year were very close to both the 5-year and 10-year averages for the Oregon Coast DPS. We do not have long-term data on winter steelhead redd abundance in the Lower Columbia, but 2016 estimates in the SWW ESU were somewhat lower than the three year average, but higher than average in the LCR ESU. Indices for Pacific Lamprey were generally higher in 2016 compared to recent years. Weather and stream flows made for very good survey conditions during the 2016 season. Regional patterns are apparent for redd density, proportion of hatchery origin spawners, and spawn timing.

INTRODUCTION AND METHODS

As part of the Oregon Plan for Salmon and Watersheds, the Oregon Department of Fish and Wildlife (ODFW) initiated a project to monitor spawning winter steelhead (*Oncorhynchus mykiss*) in coastal Oregon streams in 2003 under the Oregon Adult Salmonid Inventory and Sampling (OASIS) project. The project is designed to assess yearly status and trend, abundance, proportion of hatchery fish, and distribution of winter steelhead spawners in four Oregon ESU/DPS units (Figure 1). The Southwest Washington and Lower Columbia ESU's are currently monitored at the population scale, though funding limited efforts in 2016 to only the Clatskanie, Scappoose, Clackamas, and Sandy populations. No monitoring occurred in the Youngs Bay, Big Creek, Gorge, or Hood populations. In the Oregon Coast DPS, monitoring is evaluated at the monitoring area (MA) scale. The KMP DPS was not monitored in 2016.

A spatially balanced probabilistic sampling design (Stevens 2002) was used to randomly select survey sites across a stream network of winter steelhead spawning habitat. The selection frame was developed using professional knowledge of biologists from a variety of private and governmental biologists. Within the sampling frame there are/were dams or fish traps where counts of fish are available, including: River Mill (Clackamas River), Marmot (Sandy River), Winchester (North Umpqua River) and Gold Ray (Rogue River) dams, Bonnie Falls Trap (Scappoose River), and Big Creek Hatchery Weir. Counts of steelhead passed upstream are used for monitoring these areas rather than spawning surveys. This report provides results for surveys outside those areas. In accordance with prior work conducted by ODFW in coastal streams, monitoring of winter steelhead abundance is based on counts of redds, with rearing origin determined from live and dead fish (Susac and Jacobs 1999). Repeat visits to each site from February through May generate a total redd count for each survey. Sites are visited at least once every fourteen days (Susac and Jacobs 1999). Redds are marked with colored rocks and flagging to prevent re-counting during subsequent surveys. Specific descriptions of project protocols can be found in the annual survey procedures manual (ODFW 2016).

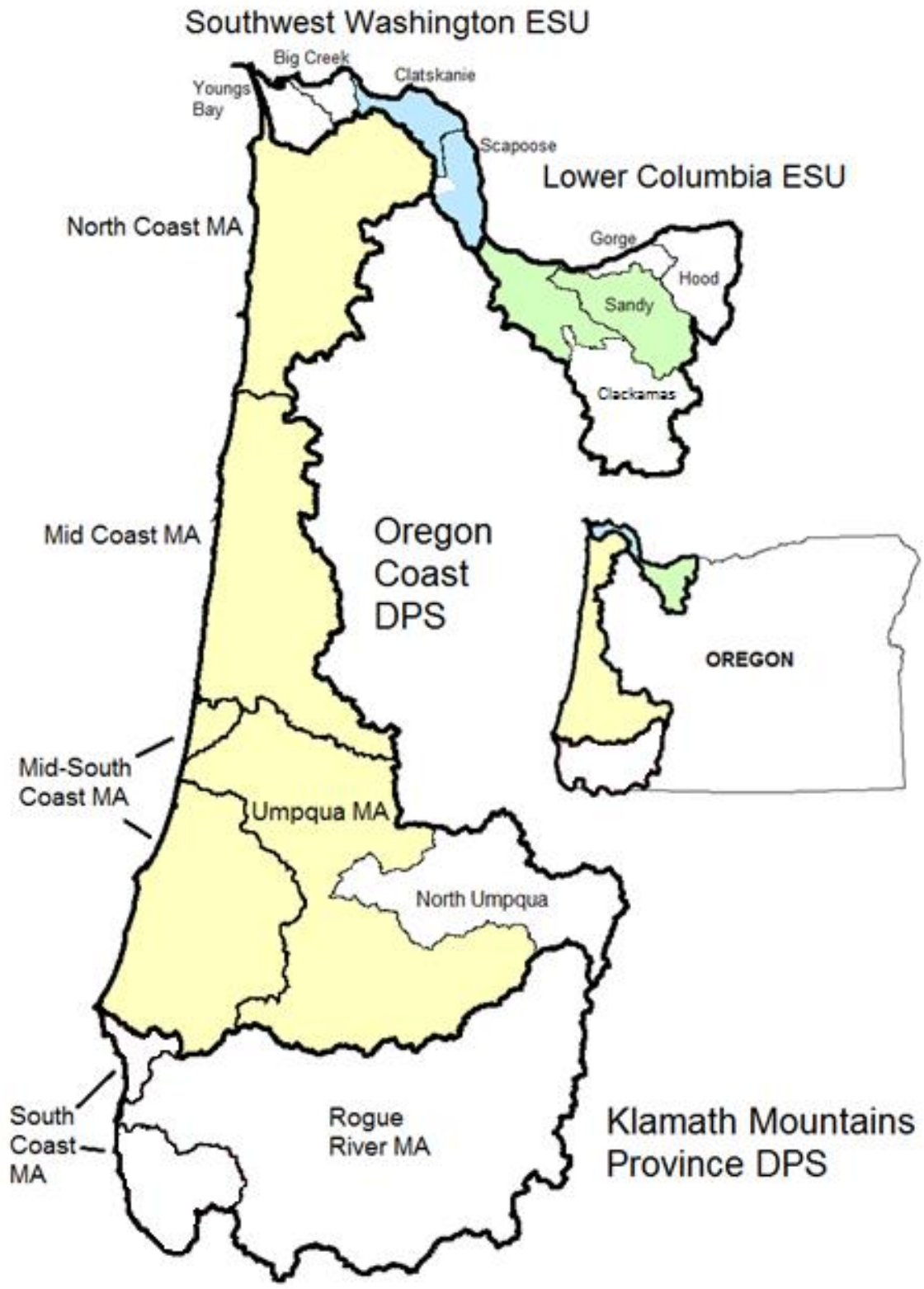

Figure 1. Geographic scope of steelhead spawner monitoring, 2016. Monitoring scales include: Evolutionary Significant Unit (ESU), Dependent Population Segment (DPS), Monitoring Areas (MA), and population. Areas without color were not monitored in 2016.

The geographic scale of monitoring used in this report (Figure 1) is based on a variety of sources. Boundaries for the four ESU/DPS units are as determined by the National Oceanic and Atmospheric Administration (Busby et.al. 1996). Population boundaries are based on Myers et. al. (2006) for the LCR ESU population structure and the 2005 Oregon Native Fish Status Report (ODFW 2005) for other populations. Monitoring area boundaries match those used for coho salmon monitoring by the OASIS project (Lewis et. al. 2009).

Sites adjacent to hatcheries and/or their acclimation areas tend to have a higher proportion of both hatchery fish and redd densities. This uneven distribution of hatchery fish can bias estimates of abundance and pHOS unless accounted for in sampling protocols. In order to reduce bias and increase accuracy within our winter steelhead estimates, we initiated the use of a stratified approach to sampling protocols for steelhead monitoring in 2016. These efforts differ slightly between the Lower Columbia ESU's and Oregon Coast DPS.

In the SWW ESU stratification will be conducted in the Clatskanie population, but will be divided into two strata: Plympton Cr and the remaining Clatskanie basin. There are no hatchery steelhead releases in the Clatskanie population; hatchery fish are typically abundant only in Plympton Creek. In the LCR ESU, in each of the Sandy and Clackamas populations, strata will be defined as migration corridors, areas adjacent to hatchery releases, and the remaining portions of each population (i.e. areas outside of direct hatchery influence). All three strata will initially be calculated individually, but subsequently rolled up into the final population and ESU estimates.

In the OC DPS, the ODFW Coastal Multi-Species Conservation and Management Plan (CMP) allows for higher maximum pHOS rates in areas adjacent to acclimated hatchery release sites (ODFW 2014). These areas are known as hatchery Hot-Spots. Stratification of Hot-Spots aids in reducing estimate bias associated with acclimated hatchery releases within the DPS. It also allows ODFW to assess the management goals for both the DPS and the Hot-Spots separately, as prescribed by the CMP. Implementation of this stratification will result in two abundance and pHOS estimates for each MA, one for sites within Hot-Spots and one for all other areas.

RESULTS AND DISCUSSION

This report contains population level summaries for the SWW and LCR ESU's and a monitoring area level summary for the OC steelhead DPS. Counts of adult lamprey and lamprey redds are recorded during steelhead surveys and the results are included in a brief summary at the end of this report.

A total of 183 sites were successfully surveyed in 2016, split between the three steelhead DPS/ESU areas monitored (Table 1). Successful surveys represent 45% of the 406 total sites selected for 2016. Sites were selected at a rate of 1/24 miles of habitat in the Oregon Coast DPS. Selection densities were greater in the two Lower Columbia ESU's (1/4 in the LCR, and 1/2 in the SWW). Eleven percent of sites in 2016 were not surveyed because of landowner access restrictions. The proportion of sites that were surveyed, but were not used in final estimates due

to turbidity and/or large gaps between survey dates averaged 19%, ranging from 7.9% in the Lower Columbia ESU to 36.2 % in the Mid-South MA. The percentage of sites that were outside of steelhead spawning habitat averaged 5.5 % across the three DPS/ESU areas, ranging from 2.8% in the SWW ESU to 8.9% in the Oregon Coast DPS.

Table 1. Site status by monitoring area or population in 2016. Target sites were within and non-target sites were outside of steelhead spawning habitat. Response sites were successfully surveyed. Non-response sites couldn't be surveyed, or were not successfully surveyed.

DPS/ESU	Monitoring Area or Population	Target Response	Target Nonresponse	Nontarget
Southwest Washington	Youngs Bay [a]	-	-	-
	Big Cr [a]	-	-	-
	Clatskanie	24	1	2
	Scappoose	10	20	4
	Total	**34**	**21**	**6**
Lower Columbia River	Clackamas	19	16	18
	Sandy	15	19	5
	Gorge [a]	-	-	-
	Total	**34**	**35**	**23**
Oregon Coast [b]	North Coast	37	13	16
	Mid Coast	32	20	3
	Mid South Coast	21	43	3
	Umpqua	25	32	8
	Total	**115**	**108**	**30**
Klamath Mountains Province [a]	South Coast	-	-	-
	Rogue River	-	-	-
	Total	**-**	**-**	**-**

a = Surveys in the Klamath Mountains Province DPS, and in the Youngs Bay, Big Cr and Gorge populations were not conducted in the 2016 season due to budget constraints.
b = Oregon Coast DPS does not include sites that were within hatchery hotspots.

The target level of precision for steelhead redd estimates is a 95% confidence interval within ±30% of the point estimate. Steelhead spawning survey effort has been dramatically reduced on the Oregon Coast since 2008, resulting in not meeting precision goals at most spatial monitoring scales. In 2016, this goal was achieved for the Oregon Coast DPS, in both the SWW and LCR ESU's, as well as in the North Coast MA and the Clatskanie population (Table 2). Precision goals were not met in Scappoose, Clackamas and Sandy populations. The Mid Coast, Mid-South Coast and Umpqua MA's also did not meet precision goals.

Table 2. Oregon winter steelhead redd abundance estimates, 2016. Wild proportions are derived from fin-mark observation rates on live and dead steelhead.

DPS/ESU	Monitoring Area or Population	Survey Effort		Winter Steelhead Redd Abundance			
				Total		Wild	
		Number of Surveys	Miles	Estimate	95% Confidence Interval	Estimate	95% Confidence Interval
Southwest Washington	Youngs Bay	-	-	-	-	-	-
	Big Cr	-	-	-	-	-	-
	Clatskanie [a]	26	24	504	115	485	115
	Scappoose [b]	10	8	94	122	N.A.S.	
	Total	**36**	**32**	**598**	**163**	**485**	**163**
Lower Columbia River	Clackamas [a]	28	32	1,291	692	1,076	678
	Sandy [a]	23	27	3,428	1,071	3,226	1,056
	Gorge	-	-	-	-	-	-
	Total	**51**	**59**	**4,719**	**1,275**	**4,302**	**1,255**
Oregon Coast [c]	North Coast	38	33	17,455	4,759	15,491	4,224
	Mid Coast	36	25	26,404	9,301	23,776	8,466
	Mid South Coast	21	15	20,070	9,002	14,049	6,302
	Umpqua	25	15	9,292	3,573	9,120	3,507
	Total	**120**	**89**	**73,221**	**14,247**	**62,436**	**11,896**
Klamath Mountains Province	South Coast	-	-	-	-	-	-
	Rogue River	-	-	-	-	-	-
	Total	**-**	**-**	**-**	**-**	**-**	**-**

a = Estimates for these populations are derived from stratified samples. See intro/method section for stratification overview.

b = Not Adequate Sample. No known-fin-clip-status (live or dead) fish were observed, therefore no wild estimate could be derived.

c = Oregon Coast DPS does not include sites that were within hatchery hot-spots.

Southwest Washington ESU

The 2016 estimate of wild winter steelhead redds in the Oregon portion of the SWW ESU was 485, although this total includes only a single population (Clatskanie) due to a combination of no sample in the Scappoose population and lack of funding in the Youngs Bay and Big Cr. populations (Table 2). This is the second lowest result in the five years of record within the Clatskanie population (Figure 2). Redd densities ranged from 1.5 redds per mile in the Scappoose population to 9.9 redds per mile in the Clatskanie population (Table 3 and Figure 8). Average density across the ESU was 5.8 redds per mile, which is just under the ESU average of 6.2 (Table 3). The percentage of sites with at least one redd observed ranged from 38% in the Scappoose population to 70% in the Clatskanie population; just below the respective averages in both cases (Table 3).

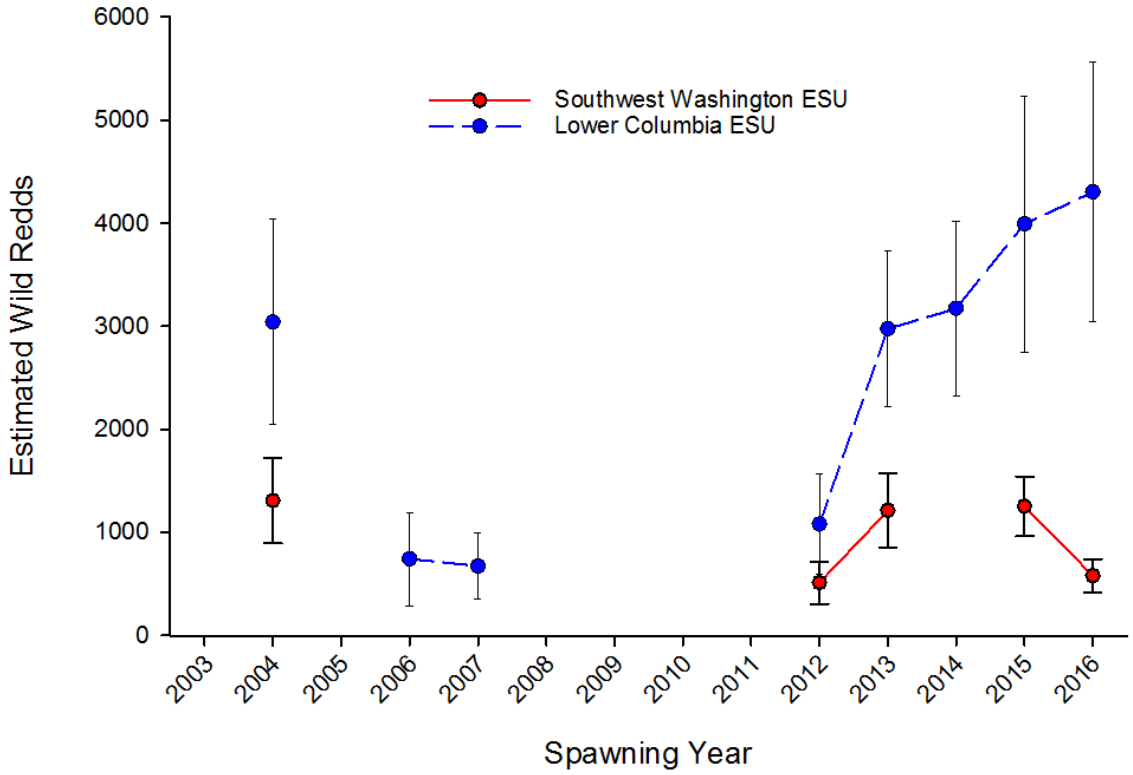

Figure 2. Winter steelhead wild redd estimates in the Oregon portions of the LCR and SWW ESUs based on random surveys, 2004 to 2016. Error bars represent 95% confidence intervals. Inclusion of survey data from specific populations and from above counting stations has varied across years, see Appendix Table A-2.

On average the Scappoose population has only three steelhead observations with known fin-mark status, but none were observed in 2016 (Table 4 and Figure 5). In contrast, the number of known fin-mark observations for calculating hatchery proportion in the Clatskanie population (42) is more than twice the average in that area (Table 4). Excellent stream conditions through much of the season likely contributed to the high sample size of known fish for the ESU. The Clatskanie population had a 4% pHOS rate in 2016, which is just above the average rate of 3% (Table 4 and Figure 5). Plympton Creek was the only site where hatchery fish were observed. As a result, the Clatskanie population outside Plympton Creek accounted for over 95% of the total estimated wild redds in the population while contributing no hatchery origin redds (Table A-4).

Spawn timing was consistent across the SWW ESU populations in 2016, with each population having peak redd deposition in early February (Figure 6). Another much smaller peak was observed in the Clatskanie population in late March. This spawn timing is consistent with years past, however more years of data will be required to explore similarities and differences in winter steelhead spawn timing between these populations, and across years.

Table 3. Oregon winter steelhead redd density and percent occupancy in 2016.

DPS/ESU	Monitoring Area or Population	Redds / Mile		% Sites With Redds	
		2016	Average [a]	2016	Average [a]
Southwest Washington	Young's Bay	-	6.3	-	56%
	Big Creek	-	5.7	-	59%
	Clatskanie	9.9	13.3	70%	73%
	Scappoose	1.5	2.1	38%	42%
	Total	**5.8**	**6.2**	**62%**	**57%**
Lower Columbia River	Clackamas	6.8	6.0	45%	50%
	Sandy	23.2	11.0	71%	71%
	Gorge	-	-	-	-
	Total	**14.2**	**8.5**	**67%**	**61%**
Oregon Coast	North Coast	16.9	18.3	73%	79%
	Mid Coast	15.3	11.3	81%	81%
	Mid-South Coast	20.0	18.1	81%	89%
	Umpqua	5.6	9.1	64%	72%
	Total	**14.5**	**13.3**	**75%**	**80%**
Klamath Mountians Province	South Coast	-	18.0	-	95%
	Rogue River	-	9.6	-	82%
	Total	**-**	**14.2**	**-**	**89%**

a = Average for period of monitoring: Oregon Coast is 2003-2015; SWW and LCR is 2012-2015.

Lower Columbia ESU

The Oregon portion of the Lower Columbia Steelhead ESU includes four populations. However, due to budgetary and logistical issues no surveys were conducted in the Lower Gorge or Hood River populations in 2016. Spawning ground survey effort was limited to the Sandy population, excluding the portion above Sandy Hatchery on Cedar Creek, and the Clackamas population located below River Mill Dam.

The 2016 estimate of wild winter steelhead redds in the LCR ESU was 4,303 (Table 2). This is the highest LCR ESU redd estimate in the eight years of monitoring that include both the Sandy and Clackamas populations (Appendix Table A-2). However, trend analysis is not possible considering the lack of a long continuous time series. The 2016 Clackamas estimate of 1,076 wild redds is similar to recent estimates, though much lower than the 2004 estimate (Figure 3). Part of this difference is that the 2004 estimate is for the entire Clackamas population and all subsequent estimates are only for the area below River Mill Dam. For comparison, areas above the dam have provided an average of 43% of the estimated winter steelhead in the Clackamas basin during the seven years of record available for comparison. The 2016 Sandy population estimate of 3,227 wild redds is the highest estimate observed since monitoring began

(Figure 3). However, the 2004 through 2007 estimates in the Sandy are only for the area below Marmot Dam, while all subsequent estimates are for the whole Sandy population. Survey conditions in both the Clackamas and Sandy populations were excellent in 2016, particularly for the latter half of the season, and these conditions may have contributed to these relatively high results.

Table 4. Number of known fin-mark status steelhead observed on spawning grounds, and resulting percent hatchery fish in 2016. Hatchery percentage based on adipose fin clip observations of live and dead steelhead in successfully conducted surveys.

DPS/ESU	Monitoring Area or Population	Number Known Fish		Percent Hatchery	
		2016	Average [a]	2016	Average [a]
Southwest Washington	Young's Bay	-	-	-	-
	Big Cr	-	-	-	-
	Clatskanie	16	21[c]	0% (4%)[d]	-
	Plympton	26	-	46%	-
	Scappoose	0	3	-	0%
	Total	**42**	**3**	**-**	**-**
Lower Columbia River	Clackamas Population	72	28	17%	8%
	Clackamas	6	-	0%	-
	Migration Corridor	7	-	43%	-
	Eagle Creek	59	-	71%	-
	Sandy Population	108	33	6%	5%
	Sandy	17	-	0%	-
	Migration Corridor	17	-	30%	-
	Cedar Creek	74	-	60%	-
	Gorge	-	0	-	-
	Total	**288**	**-**	**9%**	**5%**
Oregon Coast [b]	North Coast	80	101	11%	11%
	Mid Coast	70	74	9%	22%
	Mid South Coast	60	102	30%	17%
	Umpqua	54	54	2%	6%
	Total	**264**	**331**	**15%**	**14.0%**
Klamath Mountains Province	South Coast	-	65	-	6%
	Rogue River	-	50	-	7%
	Total	**-**	**88**	**-**	**6%**

a = Average for period of monitoring: Oregon Coast is 2003-2015; SWW and LCR is 2012-2015.

b = Oregon Coast DPS does not include sites that were within hatchery hotspots.

c = Average includes samples from whole population including Plympton Cr.

d = Perentheses show actual percent hatchery for the population, including results for Plympton Cr .

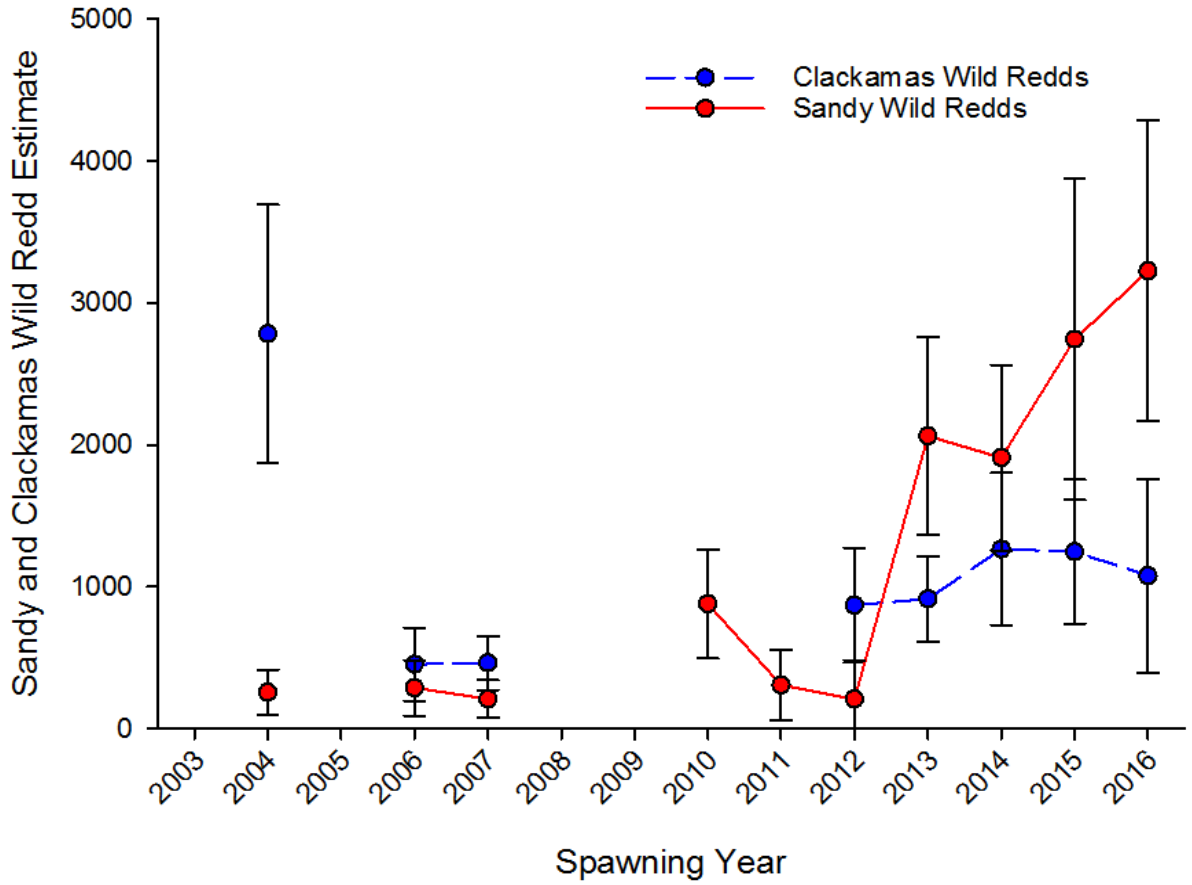

Figure 3. Winter steelhead wild redd estimates in the Clackamas and Sandy River populations based on random surveys, 2004 to 2016. Error bars represent 95% confidence intervals.

Survey frequency in the Sandy population in 2013 through 2016 differed from all other populations reported, in that surveys were conducted weekly rather than bi-weekly. This was done primarily to improve the sample size of known fin-marked adults in the basin, but also to maintain a higher number of successfully surveyed sites because of chronically high/turbid water issues. In the Sandy population, 82% of the sites surveyed in 2016 met protocols for inclusion in the estimate calculation. This is the highest proportion of successful sites observed in this population since monitoring began. Increased survey visits during the spawning season were a likely factor in the high proportion of valid surveys completed in 2016. The combination of increased survey frequency and excellent survey conditions may be a factor in the higher abundance estimates (i.e. increased rate of redd observation) in recent years.

Redd density for the LCR ESU was 12.2 redds per mile; ranging from 6.8 redds per mile in the Clackamas to 23.2 redds per mile in the Sandy (Table 3 and Figure 4). Both the Clackamas and Sandy redd densities are above their respective averages (Table 3). The percentage of sites having at least one redd varied between the two populations, with 45% of

sites occupied in the Clackamas and 71% of sites occupied in the Sandy population (Table 3). Site occupancy was average in the Sandy, and slightly below average in the Clackamas in 2016.

The proportion of naturally spawning hatchery steelhead in the LCR ESU was 9% in 2016. The 2016 pHOS rate of 6% in the Sandy population is slightly above average. Increased survey frequency in the Sandy continues to improve the number of known fin-clip status steelhead from three in 2012 to an average of over fifty in the four subsequent years (72 in 2016).

In the Clackamas population the pHOS for the population estimate for areas below River Mill Dam is 17%, which is above the average of 8% for this area (Table 4). It should be noted that the pHOS for the entire Clackamas population (including fish passed above River Mill Dam) is much lower (6%).

The Sandy and Clackamas Rivers contains hatchery summer steelhead programs. Differentiating summer and winter steelhead on the spawning grounds is difficult. The two runs differ somewhat in spawn timing, with most summer-run fish spawning from late December into February, and winter runs spawning February through May. Management plans for wild winter steelhead in the Sandy and Clackamas Rivers set different maximum allowable pHOS rates for the two steelhead runs. When the Sandy total hatchery steelhead pHOS rate is less than the lower of the two run specific pHOS limits, both are in compliance. If the total exceeds the lower limit (5% for summer steelhead), then a separate pHOS calculation is made for the period of spawning overlap between wild winter and hatchery summer steelhead runs. This calculation is based on redds and known fin clip status steelhead observed before March 1st. The 6% estimated pHOS in the Sandy population for 2016 triggered the calculation of a summer steelhead pHOS. The estimated pHOS for the period before March 1st, 2016 in the Sandy population is 0.1%. The estimated pHOS in the Clackamas population in 2016 is 6%, triggering the calculation of a summer steelhead pHOS. The estimated pHOS for the period before March 1st, 2016 in the Clackamas population is 0.2%.

Peak spawn timing in the Clackamas population occurred in Late March, which is typical of this population. Peak spawn timing in the Sandy population was also within that population's normal range, peaking in early April (Figure 6). Spawning activity decreased relatively rapidly after peaks in both populations. Survey conditions were good throughout most of the 2016 spawning season in the LCR ESU, and there was no indication that these timing signatures were the product of survey conditions or any other surveying affect.

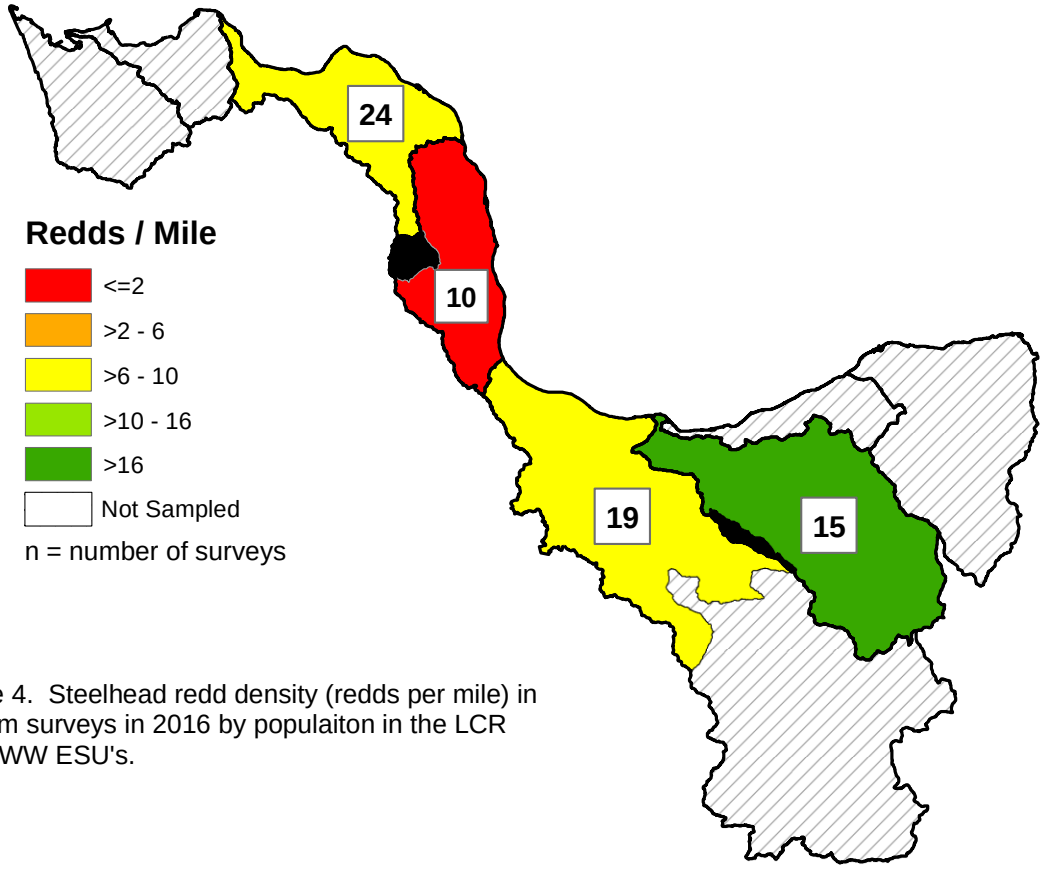

Figure 4. Steelhead redd density (redds per mile) in random surveys in 2016 by populaiton in the LCR and SWW ESU's.

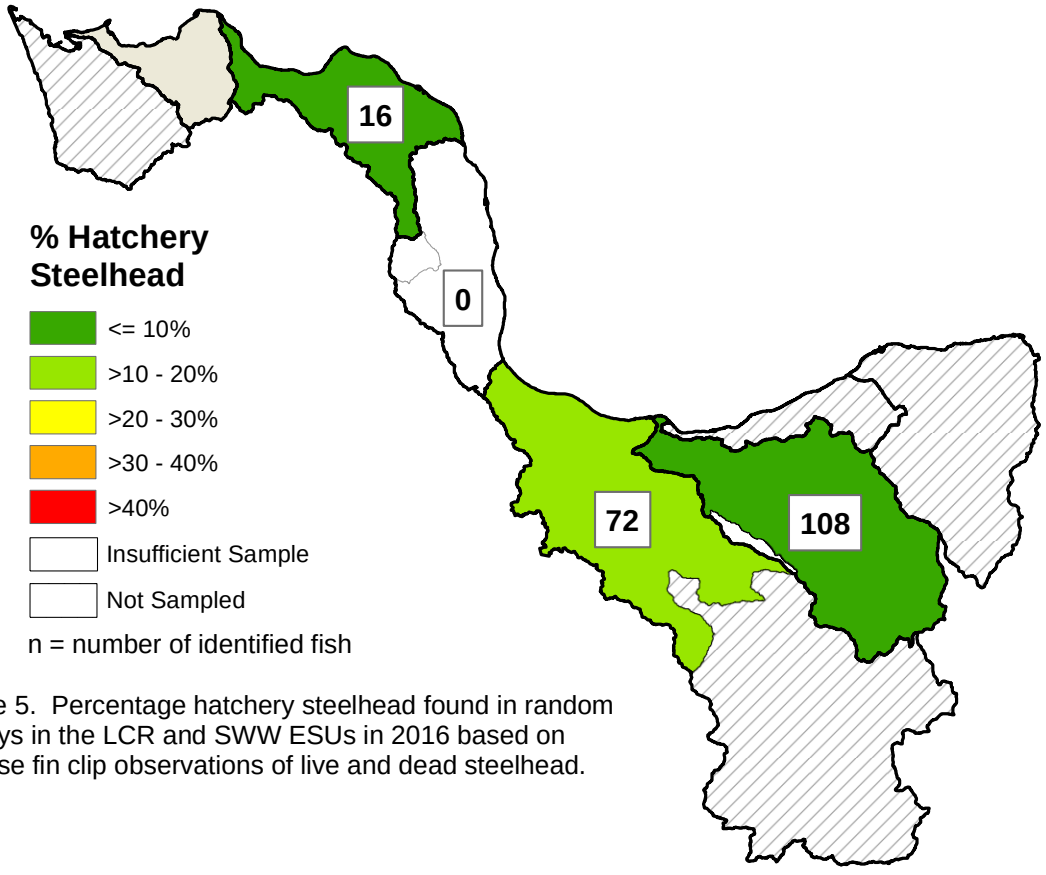

Figure 5. Percentage hatchery steelhead found in random surveys in the LCR and SWW ESUs in 2016 based on adipose fin clip observations of live and dead steelhead.

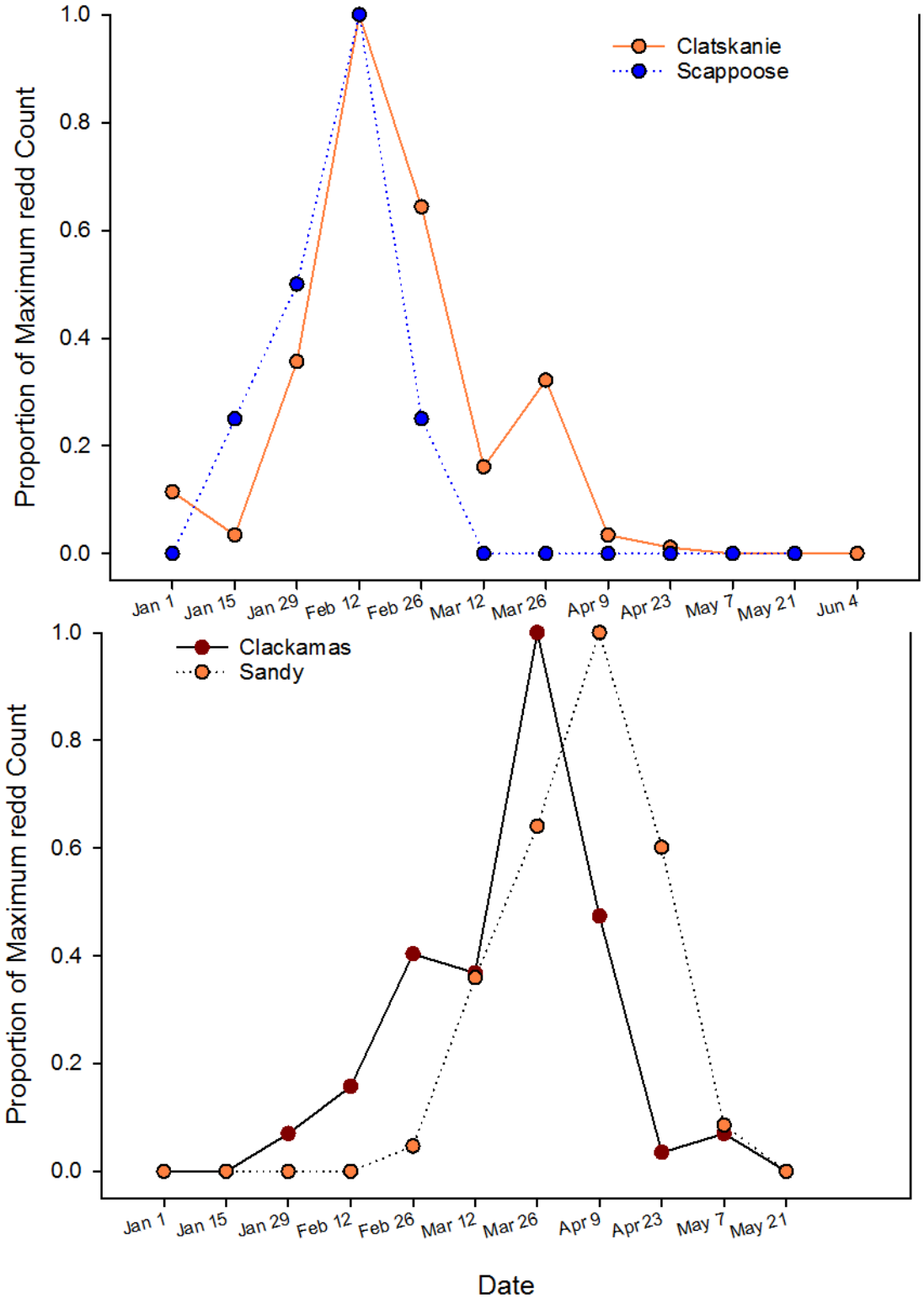

Figure 6. Proportion of the maximum winter steelhead redd count in each of the Lower Columbia populations by week of the year in 2016.

Oregon Coast DPS

The 2016 estimate of 62,436 wild winter steelhead redds in the Oregon Coast DPS approximates the long term average, and for the second consecutive year is within 1% of both the 5-year average and the average since this monitoring began in 2003 (Figure 7). While the 2016 redd estimate for the whole DPS was about average, results in individual MA's vary, with the Mid Coast being 151% of the long term average, but the North Coast (80%), Mid-South (95%) and Umpqua (67%) all being below average (Appendix Table A-1). While the estimated abundance of wild steelhead redds in the Oregon Coast DPS has ranged from about 41,000 to 95,000 across the 13 years of monitoring (2003 through 2016), there does not appear to be any clear trend in abundance over this time period. The relatively short time period of monitoring and the reduced effort in recent years (and thus larger 95% confidence intervals) currently limit the ability to detect long-term trends in abundance.

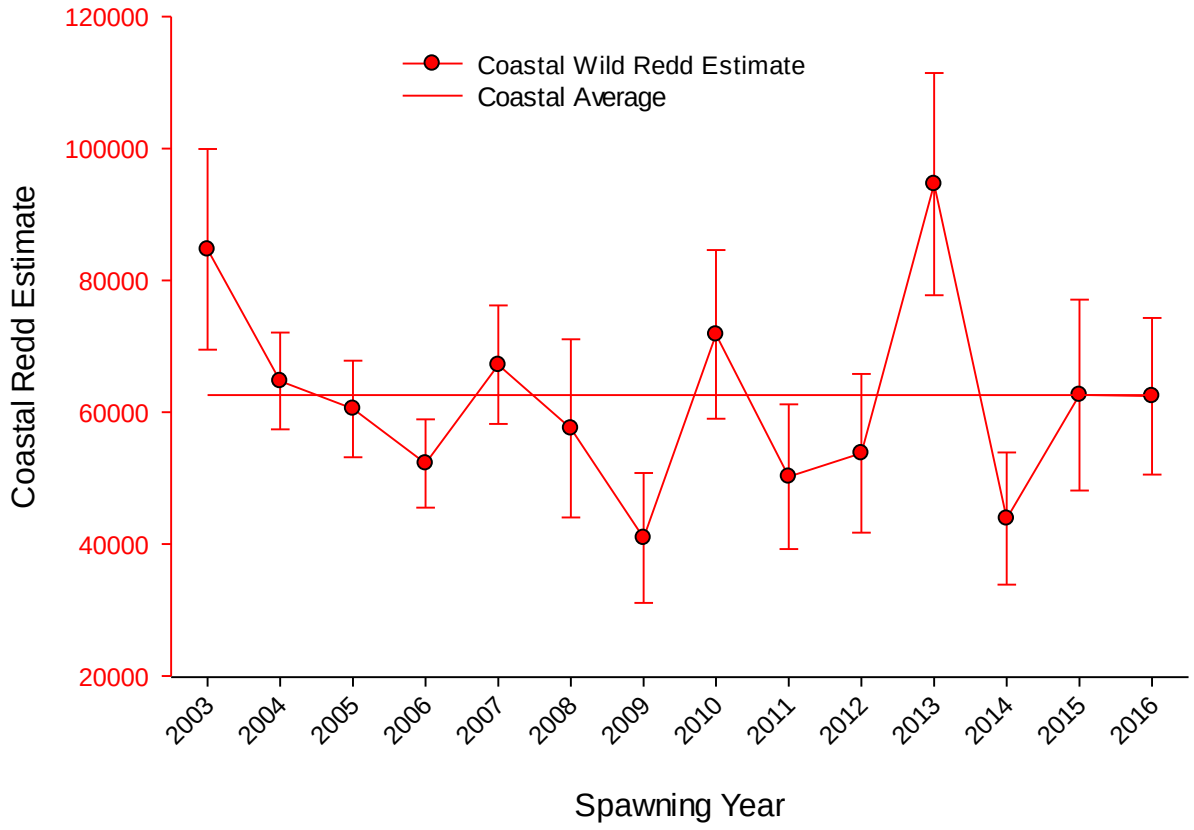

Figure 7. Estimated number of wild winter steelhead redds in the Oregon Coast DPS, 2003 to 2016. Error bars represent 95% confidence intervals, and horizontal lines show the previous 12-year average.

Density of redds (steelhead redds/mile of spawning habitat) also varied across monitoring areas, ranging from 5.6 redds/mile in the Umpqua MA to the 22.0 redds/mile in the Mid-South Coast MA (Table 3 and Figure 8). Geographic patterns in redd density were similar to that of the redd abundance estimates; Mid Coast and Mid-South Coast MAs were above average while North Coast and Umpqua MAs were below average.

An occupied site is defined as having at least one steelhead redd recorded during the season. The proportion of occupied sites in 2016 in the Oregon Coast DPS was 5 percent lower than the previous 13-year average (Table 3). In a pattern similar to redd abundance, occupancy in individual MA's was consistently about 90% of average, with the exception of the Mid Coast, which performed near its 13-year mean. Geographic patterns in occupancy rates for 2016 were consistent with the 13 year average, being highest in the Mid and Mid-South Coast MA's and lowest in the Umpqua MA (Table 3). It is worth noting that low stream flow conditions can reduce occupancy, and that stream flows in 2016 were generally lower than normal during much of the primary spawning season.

The proportion of hatchery origin spawners (pHOS) in the naturally spawning steelhead population of the Oregon Coast DPS was 15% in 2016, which is near the 2003-2015 average of 14% (Table 4). The proportion of hatchery origin spawners varied among the monitoring areas in 2016 (Figure 9), ranging from 2% in the Umpqua MA to nearly 0% in the Mid-South Coast MA. All MA's excepting the Mid-South had 2016 pHOS rates below their respective 13 year averages (Table 4). Geographic patterns in pHOS rates for 2016 were generally similar to the previous 13 year averages. The exception was the Mid Coast, where pHOS was greater than half of the average, and the second lowest figure on record since 2003 (Table 4). In part, this outcome is the result of Hot-Spot stratification efforts new to steelhead monitoring for 2016, which more accurately describe the risk of introgression in the Oregon Coast (and its MA's). However, inclusion of Hot-Spot sites would have raised the pHOS to only 11%, which is still among the lowest recorded (Table A-3).

Oregon Coast DPS peak spawning time (defined as maximum number of new redds observed) was generally comparable to previous years, though activity at the start of the spawning season was higher than normal in all areas excepting the Umpqua MA (Figure 10). Over the 14 years of monitoring, typical peak spawning time for the four monitoring areas are: early April in the North Coast MA; a bi-modal peak in late February and early April in the Mid Coast MA; and late February for both the Mid-South Coast MA and Umpqua MA (Figure 10). Spawn timing differences between the monitoring areas suggest differences between the steelhead populations, but may also be impacted by weather and stream flow events. The pattern of moderately high flow events present from mid-January through March were typical of the Oregon Coast during that time of year, but the continuously low stream discharge levels present for all of April and May were unusual (Figure 11). Survey conditions throughout the spawning season were amenable to survey methods; however, the low flows of the latter half of the season may have contributed to higher than normal rates of redd observation.

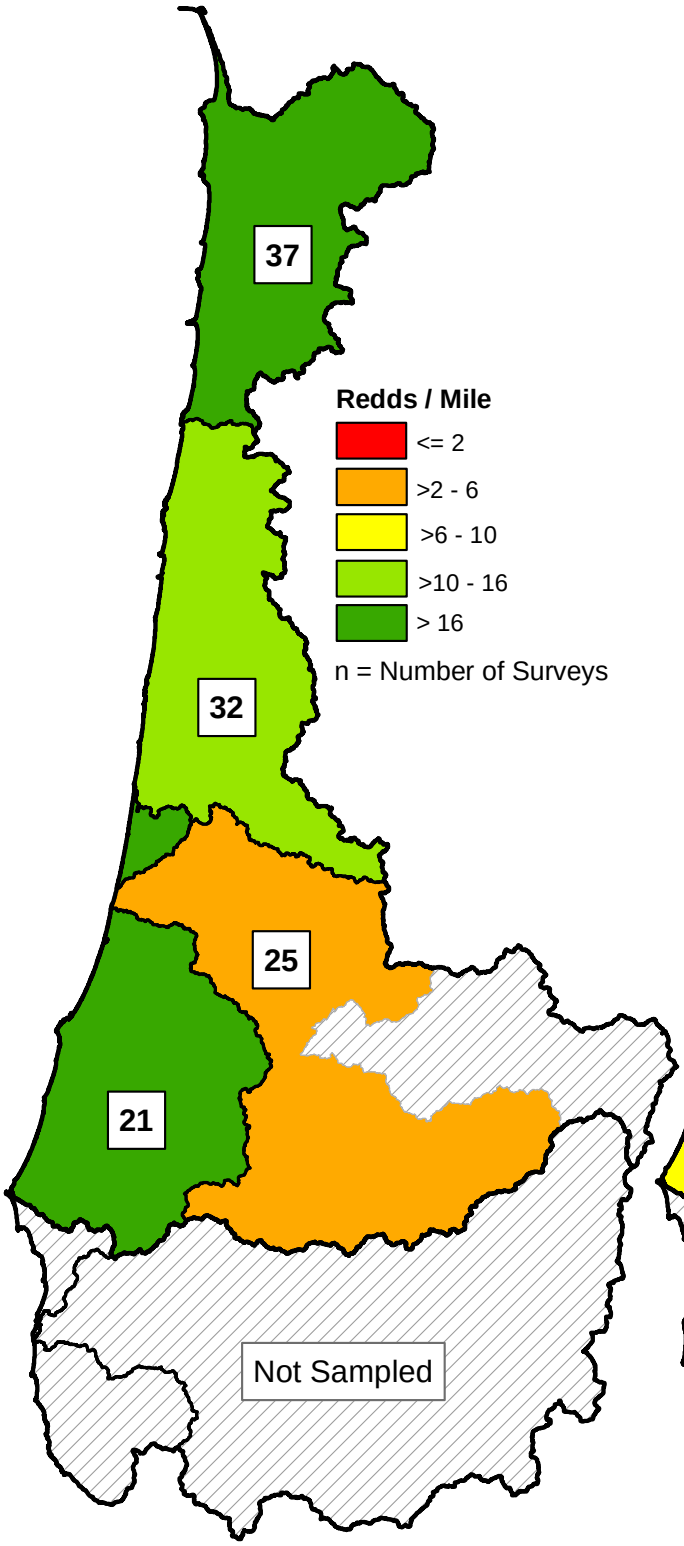

Figure 8. Steelhead redd density (redds per mile) in random surveys in 2016 by monitoring area in the Coastal and KMP DPS's.

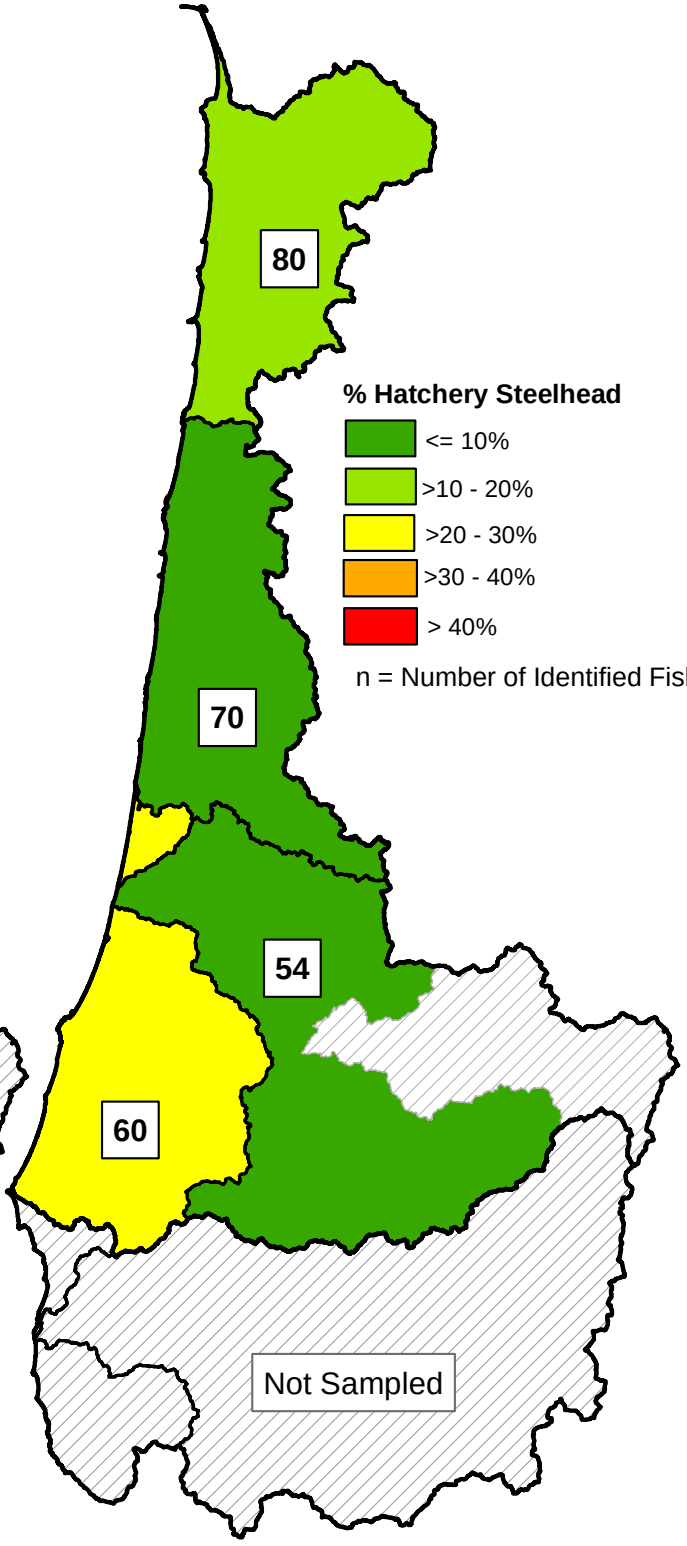

Figure 9. Percentage hatchery steelhead found in random surveys in each of the six Coastal and KMP monitoring areas in 2016 based on adipose fin clip observations of live and dead steelhead.

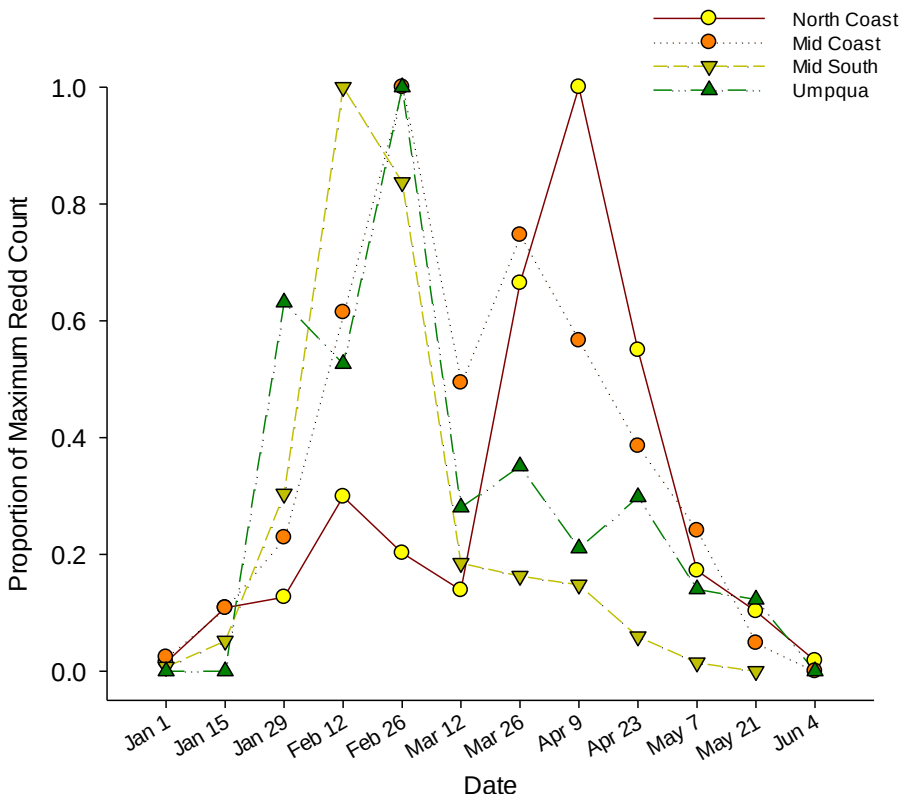

Figure 10. Proportions of the maximum winter steelhead redd count in each of the four Coastal areas by two-week period in 2016.

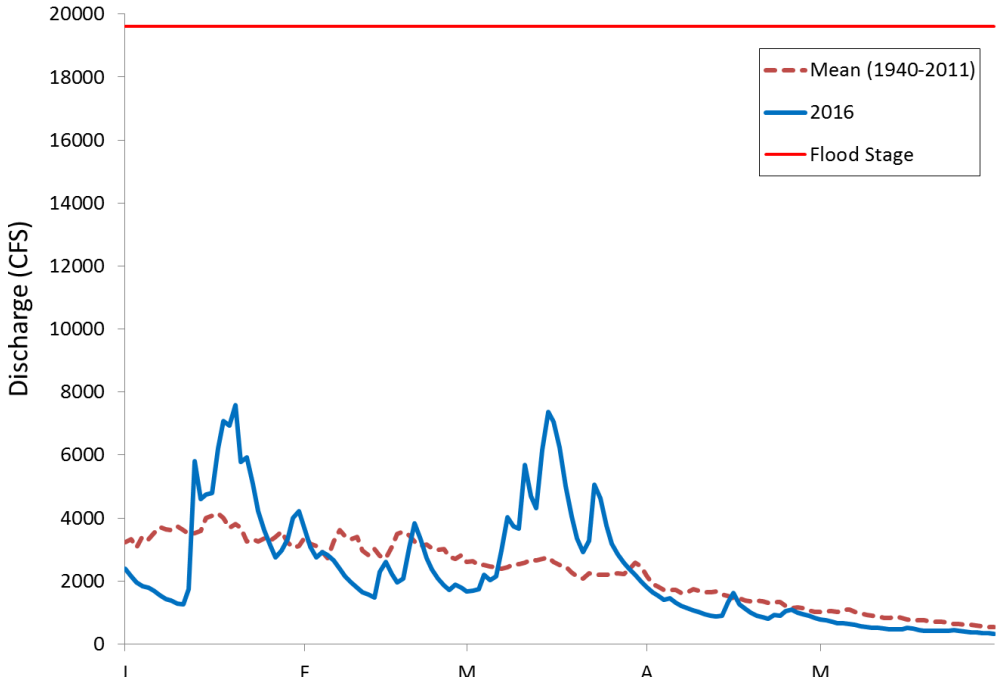

Figure 11. Stream discharge at Alsea River near Tidewater during 2016, compared to mean discharge from 1940 to 2011. (Flood stage = 19,500 CFS)

Steelhead Escapement

In recent years there has been an increased emphasis on a redd-to-fish conversion so that estimates can be reported in terms of fish rather than redds. In 2013 a re-analysis of previous year's redd-to-fish regression efforts was conducted, based on four calibration sites over a five-year time span (1998-2002). This re-analysis resulted in a conversion rate which is intended to be used across all of the monitoring areas and populations included in this report (ODFW 2013).

Total steelhead = (1.70 * Redds) + 3.74

Estimates of winter steelhead escapement in 2016, derived from redd counts and then converted with the above equation are reported in Table 5. Starting in 2014, we began exploring additional calibration sites using similar methods and a mix of new and repeated calibration sites. However, those results are not yet reported nor used for conversions. These calibration efforts are intended to be an ongoing, annual component of these monitoring efforts. Some variation does exist between sites and between years, so the goal is to build on previous calibration work by exploring the feasibility of producing a redd-to-fish conversion on an annual basis.

LAMPREY MONITORING

Over the course of steelhead monitoring, ancillary data recorded on each survey include the counts of Pacific Lamprey (*Entosphenus tridentatus*) redds, as well as counts of observed live and dead lamprey. In addition, Western Brook Lamprey (*Lampetra richardsoni*) are observed and data recorded, but that data is not summarized in this report. While these data do provide information for lamprey coast-wide and in the Lower Columbia, it is worth noting that survey sites are selected from the known distribution of steelhead spawning habitat, which does not necessarily cover lamprey spawning distribution. Furthermore, while live lamprey are observed spawning on surveys, we do not survey often enough nor when lamprey are most active (at night) to use live lamprey counts for abundance estimates. As a result, lamprey density on spawning surveys is summarized in this report by peak redds per mile. The peak redd count is the highest number of lamprey redds visible during any one survey date within a given spawning season. Abundance estimates for lamprey are not available because the cumulative number of redds deposited over a spawning season is not accounted for and because there is no reliable information on the ratio of redds to fish. However, peak redd counts do provide information on the distribution and timing of lamprey spawning activity, as well as some indication of relative density (and by proxy, relative abundance). Lamprey redd counts also provide occupancy information, though survey methods have not been precision tested. So, while a lamprey redd likely proves lamprey presence in a given survey, the lack of recorded redds does not necessarily mean lamprey were absent. Despite the many caveats, this lamprey data set has grown quite large, and contains some information that may begin to provide a method of tracking Pacific Lamprey trends and relative abundance.

Table 5. Oregon winter steelhead fish abundance estimates in 2016. Estimates do not include steelhead above counting stations and are thus not complete population estimates in all areas, see Appendix Tables A-1 and A-2.

DPS/ESU	Monitoring Area or Population	Winter Steelhead Abundance			
		Total		Wild	
		Estimate	95% Confidence Interval	Estimate	95% Confidence Interval
Southwest Washington	Youngs Bay	-	-	-	-
	Big Cr	-	-	-	-
	Clatskanie [a]	861	199	828	199
	Scappoose [b]	164	211	N.A.S.	
	Total	**1,020**	**281**	**1,020**	**281**
Lower Columbia River	Clackamas [a]	2,198	N.A	1,833	N.A
	Sandy [a]	5,831	N.A	5,488	N.A
	Gorge	-	-	-	-
	Total	**8,026**	**2,171**	**7,317**	**2,137**
Oregon Coast [c]	North Coast	29,677	8,094	26,338	7,185
	Mid Coast	44,891	15,815	40,423	14,396
	Mid South Coast	34,123	15,307	23,887	10,717
	Umpqua	15,800	6,078	15,508	5,966
	Total	**124,479**	**24,157**	**106,145**	**5,966**
Klamath Mountains Province	South Coast	-	-	-	-
	Rogue River	-	-	-	-
	Total	**-**	**-**	**-**	**-**

a = Estimates for these populations are derived from stratified samples. See intro/method section for stratification overview.

b = Not Adequate Sample. No known-fin-clip-status (live or dead) fish were observed, therefore no wild estimate could be derived.

c = Oregon Coast DPS does not include sites that were within hatchery hot-spots.

Lower Columbia Pacific Lamprey

The available time series for Pacific Lamprey in the Lower Columbia is more limited than in the Oregon Coast, but many populations now have at least five consecutive years of effort available for analysis. Redd densities during the 2016 monitoring season equaled or exceeded previous records in each of the monitored populations (Figure 12), and were generally more than twice the previous four-year population averages. Pacific Lamprey redds were identified in 45% of random steelhead surveys sampled in the Lower Columbia River ESU in

2016. Pacific Lamprey redd occupancy varied in 2016 by population; 68% in the Clatskanie, 54% in the Scappoose, 35% in the Clackamas and 36% in the Sandy.

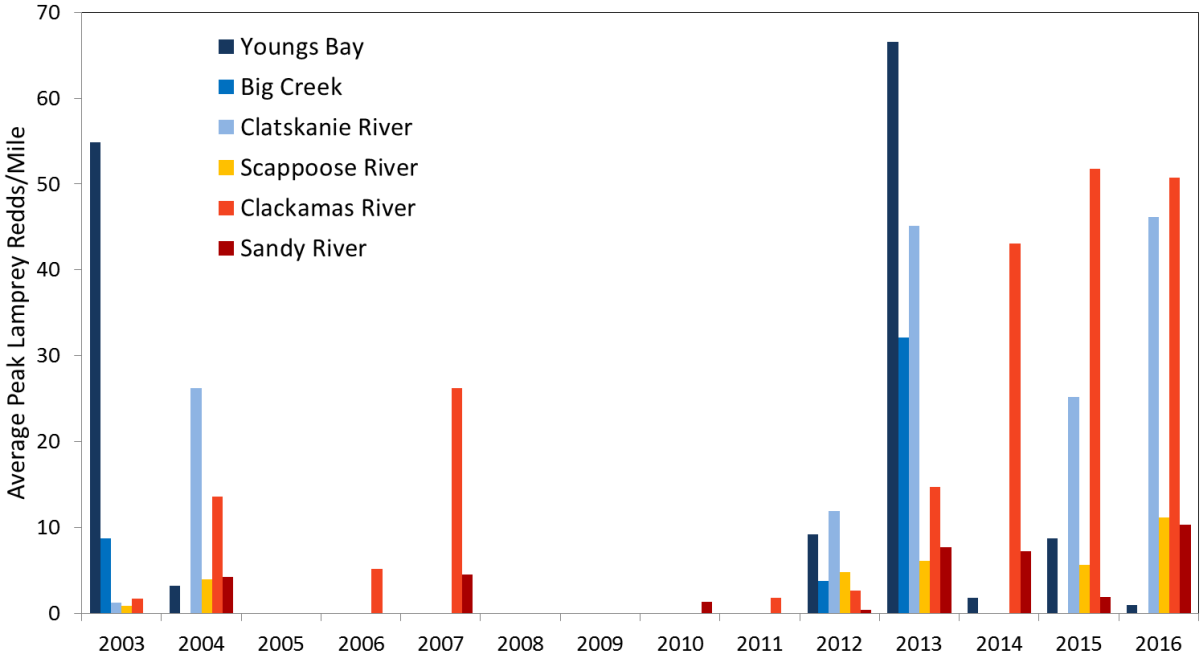

Figure 12. Lower Columbia Pacific Lamprey Peak Redd Density in Random Steelhead Spawning Surveys, 2003-2016. Note that not all populations were monitored in all years.

Pacific Lamprey redds were first observed across the Lower Columbia in late March, which is slightly earlier than typical. Peak spawning activity occurred in mid to late April in all populations but the Clackamas, which recorded a peak in the last week of May. No surveys were conducted in the Clackamas after that date, so the full extent of spawn timing is not clear for Pacific Lamprey in this population for 2016. The Clatskanie population showed a similar pattern, with the last surveys of the year occurring in mid-June resulting in counts of redds which are relatively high (Figure 13). Lamprey redd counts are conducted as peak counts, and thus these patterns may reflect observation of redds that are many weeks old, as opposed to counting new redds deposited at this late time of the spawning season.

Oregon Coast Pacific Lamprey

Over the past 13 years, Pacific Lamprey peak redd density on the Oregon Coast has fluctuated from 1 to 9 redds/mile in random steelhead surveys, averaging about 4.3 redds/mile (Figure 14). The proportion of sites occupied by Pacific Lamprey (sites with at least one Pacific Lamprey redd) has ranged from about 25% to 54% (mean = 39%); with increases and decreases in occupancy often tracking similar increases and decreases in peak redd density (Figure 14).

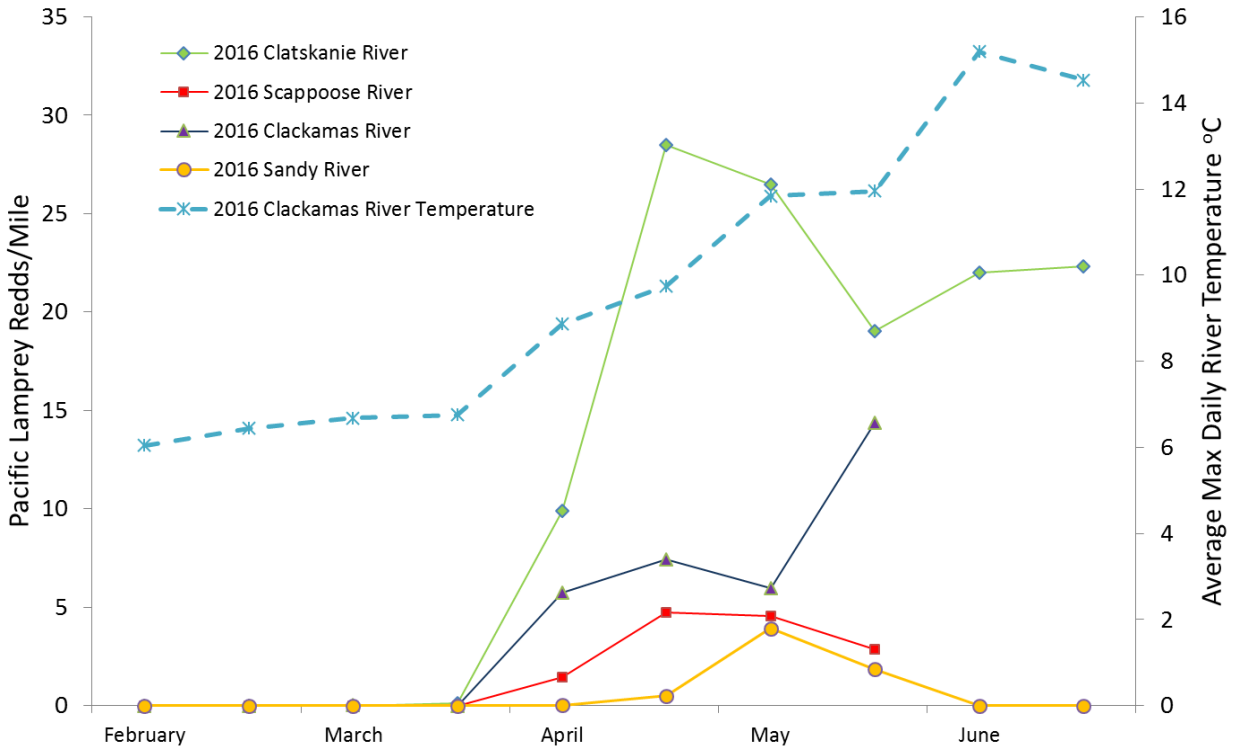

Figure 13. Lower Columbia Pacific Lamprey spawn timing in random steelhead surveys in 2016 and average daily max water temperature in the Clackamas River.

Beginning in 2010, thirteen annual steelhead surveys across the Oregon Coast were selected to be index surveys for the monitoring of Pacific Lamprey through their full spawn timing. These index surveys were picked with consideration to the following: (a) consistent presence of lamprey spawning activity across years; (b) a mix of smaller and larger streams in each steelhead monitoring area; and (c) the feasibility of conducting these surveys with limited staff availability. Index surveys are visited during each steelhead spawning season (February-May), and while steelhead surveys are primarily discontinued by the end of May, lamprey index surveys continue through late June (some years even into early July) in an attempt to capture the full lamprey spawn timing. The average spawn timing among index sites over the past five years peaked in mid-May, with the earliest peak occurring in late April (2014), and the latest occurring in early-June (2011) (Figure 15). Pacific Lamprey spawn timing in 2016 was similar to the 5-year average timing in terms of both the peak date, and the dates that the spawning season began and ended, but differed somewhat in that a smaller peak was recorded mid-June. It should also be noted that the density of redds observed in 2016 index surveys is more than twice any previously recorded. The density of redds in 2016 among randomly selected sites was above average, but much lower on a relative scale than seen in the index sites. This suggests that index sites (which are selected for consistently high abundance) may track overall abundance differently than randomly selected sites, possibly due in part to factors related to stream flows. Results so far from the index sites suggest surveys should be continued through mid-to-late June to encompass the entire Pacific Lamprey spawning period.

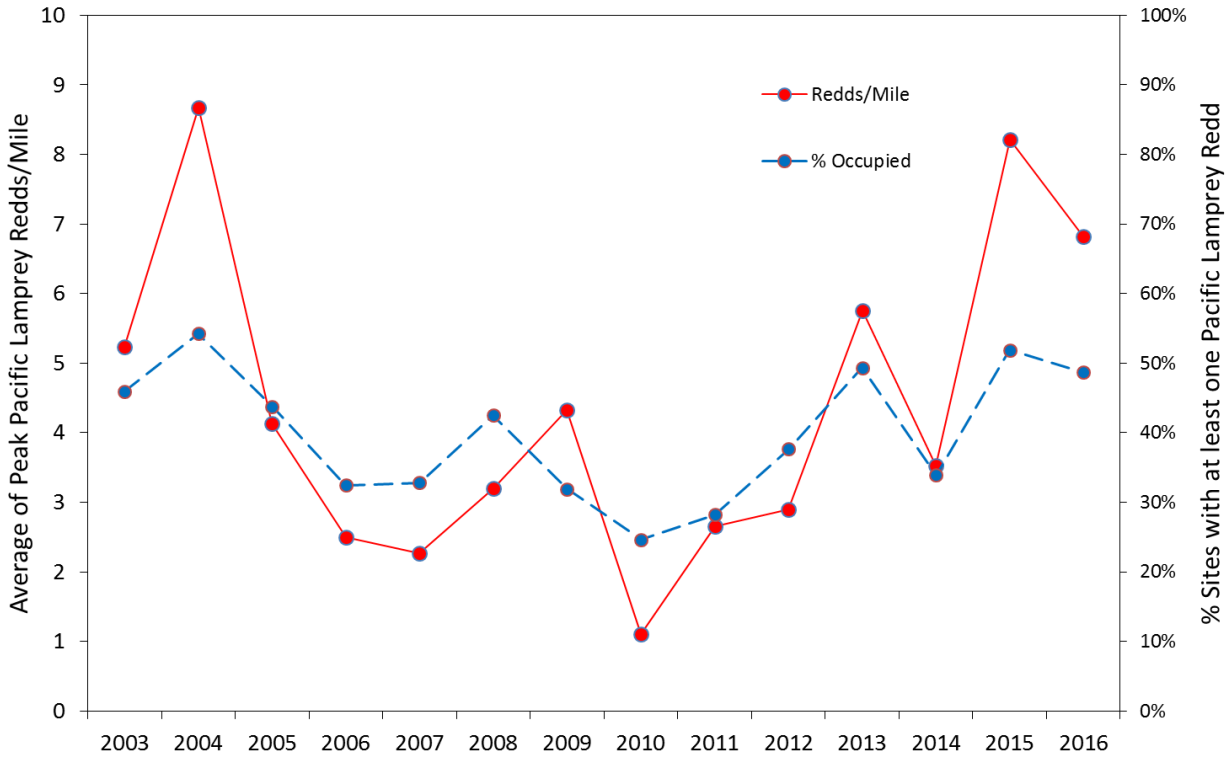

Figure 14. Oregon coast Pacific Lamprey peak redd density and percent of sites occupied in random steelhead spawning surveys, 2003 to 2016.

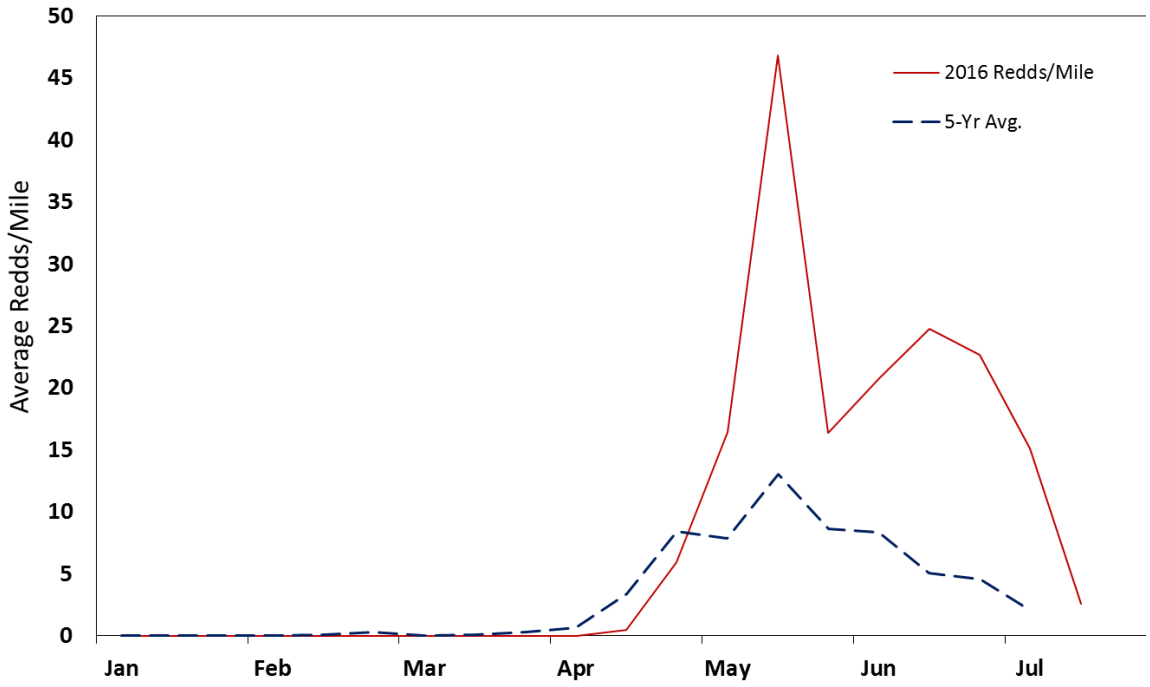

Figure 15. Oregon coast Pacific Lamprey spawn timing in index surveys.

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APPENDIX

Table A-1. Annual redd abundance estimates of naturally spawning wild steelhead by Monitoring Area (MA), in Oregon Coast Steelhead DPSs, run years 2003 to 2016. n.a. = not available. Highlighted cells do not include estimates for areas above counting stations.

Year	Oregon Coast DPS				Klamath Mountains Province DPS	
	North Coast MA	Mid Coast MA	Mid-South Coast MA	Umpqua MA	South Coast MA	Rogue River MA
2003	28,726	18,092	11,853	26,044	4,852	7,105
2004	28,599	14,043	10,195	11,922	9,093	n.a.
2005	19,125	7,890	22,871	10,628	10,035	4,995
2006	21,065	13,496	19,550	8,786	5,667	7,372
2007	20,592	10,133	24,312	13,900	6,917	6,986
2008	11,859	12,628	18,806	15,556	5,520	5,822
2009	10,433	12,080	9,136	9,282	14,268	12,352
2010	18,928	16,684	19,927	16,266	4,430	n.a.
2011	9,961	19,347	9,504	11,394	1,808	n.a.
2012	15,864	19,074	7,414	11,416	2,738	n.a.
2013	29,371	27,927	15,423	21,895	8,961	n.a.
2014	14,185	9,012	10,877	9,791	4,449	n.a.
2015	24,641	15,443	11,548	10,975	1,682	n.a.
2016	15,491	23,776	14,049	9,120	n.a.	n.a.

Table A-2. Annual redd abundance estimates of naturally spawning wild steelhead by Population, in Lower Columbia Steelhead ESUs, run years 2003 to 2016. n.a. = not available. Highlighted cells do not include estimates for areas above counting stations.

	Southwest Washington ESU				Lower Columbia ESU	
Year	Youngs Bay	Big Creek	Clatskanie	Scappoose	Clackamas	Sandy
2003	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2004 *					2,784	257
2005	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2006	n.a.	n.a.	n.a.	n.a.	453	288
2007	n.a.	n.a.	n.a.	n.a.	463	210
2008	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2009	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2010	n.a.	n.a.	n.a.	n.a.	n.a.	879
2011	n.a.	n.a.	n.a.	n.a.	n.a.	308
2012	197	0	242	72	871	208
2013	94	14	898	205	914	2,062
2014	n.a.	n.a.	n.a.	n.a.	1,265	1,909
2015	n.a.	n.a.	1,145	107	1,247	2,745
2016	n.a.	n.a.	485	94	1,076	3,227

* = Random surveys were conducted in 2004, but population scale estimates have not be

Table A-3. Oregon winter steelhead redd abundance estimates within Oregon Coast Hotspot areas. Hotspots are areas located within 4 stream miles of acclimated hatchery release sites, and are not included within population, monitoring area, DPS or ESU estimates. Wild proportions are derived from fin-mark observation rates on live and dead steelhead.

		Survey Effort			Winter Steelhead Redd Abundance			
					Total		Wild	
DPS/ESU	Monitoring Area or Population	Number of Surveys	Miles	Spawning Miles within Hotspots	Estimate	95% Confidence Interval	Estimate	95% Confidence Interval
Oregon Coast [a]	North Coast Hotspots	1	1	49	NA	NA	NA	NA
	Mid Coast	4	4	89	881	1,054	440	527
	Mid South Coast	0	NA	61	NA	NA	NA	NA
	Umpqua	0	NA	42	NA	NA	NA	NA
	Total	**5**	**NA**	**241**	**NA**	**NA**	**NA**	**NA**

Table A-4. Oregon winter steelhead redd abundance estimates within strata in 2016. Strata estimates are components of monitoring area and/or population estimates shown in Table 2. Wild proportions are derived from fin-mark observation rates on live and dead steelhead.

DPS/ESU	Monitoring Area or Population	Survey Effort		Aproximate Spawning Miles	Winter Steelhead Redd Abundance			
					Total		Wild	
		Number of Surveys	Miles		Estimate	95% Confidence Interval	Estimate	95% Confidence Interval
	Clatskanie Strata	24	22	53	462	114	462	114
	Plympton Cr.Strata	2	2	1	42	0	22	0
Southwest Washington	Clatskanie Total	26	24	54	504	115	485	115
Lower Columbia River	*Clackamas Strata*	19	18	141	958	676	958	676
	Clackamas Migration Strata	4	7	32	79	63	45	36
	Eagle Cr. Hatchery	5	6	10	254	134	73	39
	Lower Clackamas Total	28	32	183	1,291	692	1,076	678
	Sandy Strata	15	15	125	2,915	1,041	2,915	1,041
	Sandy MigrationStrata	6	11	22	350	254	246	179
	Cedar Cr. HatcheryStrata	2	1	1	163	0	65	0
	Sandy Total	23	27	148	3,428	1,071	3,227	1,056
	Cascade DPS Total	**51**	**59**		**4,719**	**1,275**	**4,303**	**1,255**

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