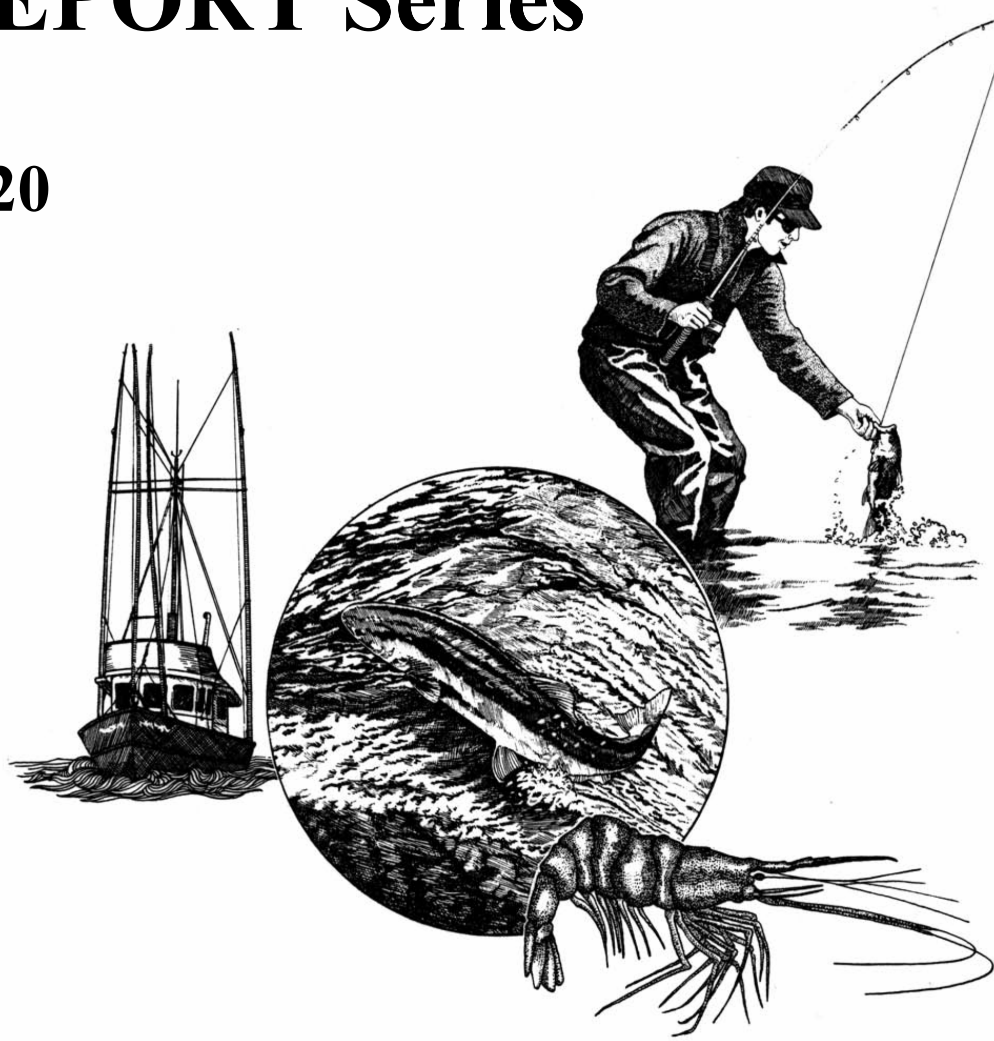
ODFW PROGRESS REPORT Series

2020



Oregon Department of Fish and Wildlife

Juvenile Salmonid Monitoring in Coastal Oregon and Lower Columbia Streams, 2019 Field Season

Annual Monitoring Report No. OPSW-ODFW-2020-1

ANNUAL PROGRESS REPORT
FISH RESEARCH PROJECT
OREGON

PROJECT TITLE: Juvenile Salmonid Monitoring in Coastal Oregon and Lower Columbia Streams, 2019 Field Season

PROJECT NUMBER: OPSW-ODFW-2020-1

PROJECT PERIOD: 2019

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This project was funded by NOAA Pacific Coastal Salmon Recovery Fund (OWEB Contract #216-904 and #218-904), the State of Oregon Lottery Fund, and the State of Oregon General Fund.

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SUMMARY

Monitoring data for juvenile Coho Salmon (*Oncorhynchus kisutch*) in three Evolutionarily Significant Units (ESUs) and juvenile steelhead (*O. mykiss)* in four Distinct Population Segments (DPSs) in western Oregon were analyzed in this report. Results were used to evaluate trends in distribution and abundance of these species from 1998-2019. For previous reports see: https://nrimp.dfw.state.or.us/crl/default.aspx?pn=WORP.

Coho Salmon

Southern Oregon Northern California (SONCC) ESU: The sampling frame was revised in 2019 and analyses were updated based on this revision. The 2019 abundance estimate was 54,890 parr. This was the lowest recorded and 31% of the 1998-2018 average of 173,807 parr. Four of the five lowest abundance estimates in the ESU were in the last five years. Site occupancy was 42% in 2019 and similar to previous years.

Oregon Coast Coho (OCC) ESU: The 2019 abundance estimate was 3.2 million parr. Parr abundance has been between 2.9 and 4.9 million since 2000, after improving from lows averaging 910,000 during 1998-1999. Site occupancy was 78% in 2019. This has been near average since 2000, after improving from low estimates in 1998-1999.

Lower Columbia River (LCR) ESU: The 2019 abundance estimate was 112,044 parr. Parr abundance and site occupancy estimates in 2019 suggest a slight reversal to the declining trend in the ESU observed from 2015-2018.

In the OCC female spawner:parr recruit curves asymptote near current spawner abundances and parr/female spawner rates declined as spawner abundances increased. These data suggest that freshwater productivity rates were regulated by compensatory density dependence at early life stages. This pattern was not observed in the LCR, although the average number of parr per female in the LCR is half of that from the OCC. Adult data were insufficient to perform these analyses in the SONCC.

Steelhead

Klamath Mountains Province (KMP) DPS: The sampling frame was revised in 2019 and analyses were updated based on this revision. The 2019 abundance estimate was 59,402 parr. The five lowest abundance estimates for the DPS were recorded in the last five years. The 2019 site occupancy estimate was 57%. Lower metrics for the DPS have been more pronounced in the Rogue Stratum than in the South Coast Stratum.

Oregon Coast (OC) DPS: The 2019 abundance estimate was 185,529 parr. Abundance from 2018-2019 was lower than in 2010-2017, but similar to 2002-2009. The 2019 site occupancy estimate was 72%, which was lower than the average estimate from 2010-2013 but similar to other years.

Lower Columbia River (LCR) DPS: The 2019 abundance estimate was 4,441 parr, 33% of the 2006-2018 average. The five lowest abundances estimates in the DPS were recorded in the last 5 years. The 2019 site occupancy estimate was 60%, which was similar to previous years.

South West Washington (SWW) DPS: The 2019 abundance estimate was 3,524 parr; well below the 2006-2018 average of 12,011 parr. The four lowest abundances estimates in the DPS were recorded in the last 5 years, but the high degree of variation in these estimates prevented detection of a trend. The 2019 site occupancy estimate was 54%. Site occupancy estimates from 2014-2019 have been low, relative to those from 2010-2013 and similar to those from 2006-2009.

BACKGROUND AND METHODS

Background

This project was initiated by the Oregon Department of Fish and Wildlife (ODFW) in 1998 as one of the Oregon Plan for Salmon and Watersheds (OPSW) monitoring programs (State of Oregon 1997). Its primary objective is to monitor status and trends of Coho Salmon (*Oncorhynchus kisutch*) parr distribution and abundance in Western Oregon. Monitoring status and trends of steelhead (*Oncorhynchus mykiss)* parr distribution and abundance was added in 2002. This monitoring informs related conservation and recovery decisions. Snorkel surveys at selected sites were used to meet these objectives.

Sites were selected using a Generalized Random Tessellation Stratified (GRTS, Stevens 2002) design which produced a random, spatially balanced sample from within Coho Salmon and steelhead rearing distribution. To asses both status and trend, site selection was incorporated with a rotating panel design. The rotating panel design emulated the Coho Salmon three year life cycle (reviewed by Weitkamp et. al 1995); a quarter of selected sites were placed on an annual survey rotation, a quarter were placed on a three year survey rotation, a quarter were placed on a nine year survey rotation, and a quarter were surveyed only once (Stevens 2002). Sites on an annual rotation provided trend detection capability and contributed to the representation of the area needed to estimate status. Sites on three and nine year rotations augmented trend detection capability over time and contributed to the sample size for status. Sites that were visited only once contributed to sample size for status and improved the representation of the rearing distribution. Using GRTS and the rotating panel designs, sites were selected, assigned to a panel, and apportioned among the three Coho Salmon Evolutionarily Significant Units (ESUs, Figure 1) and the four steelhead Distinct Population Segments (DPSs, Figure 2) in Western Oregon. Both the spatial scope and the scale of digital stream distribution network (sampling frame) employed in the site selection process have changed since 1998. These changes differed among the ESUs/DPSs:

Southern Oregon Northern California Coast Coho ESU and Klamath Mountains Province DPS sampling frames

In the Oregon portion of the Southern Oregon Northern California Coast Coho ESU (SONCC), sites were originally selected from a 1:100,000 (100k) scale sampling frame of 1^{st}-3^{rd} order streams that were within the presumed higher quality Coho Salmon rearing habitat distribution, as designated by profession judgement. In 2002, the scope was expanded to include the presumed steelhead rearing distribution in 1^{st}-3^{rd} and 4^{th}-6^{th} order streams within the Oregon portion of the Klamath Mountains Province DPS (KMP). At this time, the rearing distributions of Coho Salmon and steelhead were considered more distinct (less overlapping) relative to the other ESUs/DPSs, and were thought to require independent frames and site selection (Jepsen and Rodgers, 2004). Steelhead sites were selected proportionately within their frame from 1^{st}-3^{rd} and 4^{th}-6^{th} order streams, based on stream kilometers in each. Steelhead sites were also partitioned between streams within the Rogue River watershed (Rogue) and those that were not (non-Rogue). Coho Salmon sites were selected from the 1st-3rd order streams in the coho frame, and a proportionate selection was also made in 4th-6th order streams from the steelhead frame. In the years following the development of these initial frames, ancillary steelhead data were collected in sites exclusive to the coho frame and, likewise, ancillary Coho Salmon data were collected in sites exclusive to the steelhead frame. These data were presumed to be from sites that were spatially unbalanced for the ancillary species and were not used in comparative analyses (Jepsen and Rodgers 2004). However, the presence of these species in streams outside of their respective frames amended stream kilometers used in respective population estimate expansions.

In 2012, the coho and steelhead frames were revised and converted to a 1:24,000 (24k) scale. The revision departed from the chosen, high quality areas of the initial frames and endeavored to include all coho and steelhead habitat upstream of tidal areas. This tripled the number of stream kilometers in the coho frame and increased the number of stream kilometers in the steelhead frame by 70 percent. The revised steelhead frame encompassed the entire coho frame and included an additional 1090 kilometers of steelhead distribution. Revised frame configurations were combined with spatial balance in a single site selection process for both species, which allowed >99% of steelhead and Coho Salmon data to be used in analyses and comparisons; only Coho Salmon data that was collected from outside of the coho frame was exclude from analysis, but this data was retained for future frame revisions. The 2012 revision retained the Rogue and non-Rogue steelhead strata within the KMP, but renamed them to KMP Rogue and KMP South Coast, respectively, for consistency with federal management plans. The revision also partitioned the coho frame into two strata, the Interior Rogue and North Coast Basins to align with federal management plans. Surveys in 4th-6th order streams were phased out in 2012 due to funding constraints.

The 2012 revision was necessary in order to monitor these species across the entirety of their rearing habitat and not solely in presumed high quality areas. A major impact of this revision was that the habitat quality of sites in the 2012 Coho Salmon frame (which was 21% high quality habitat) was consistently biased low compared to that of the initial frame (which was 68% high quality habitats). This bias prevented Coho Salmon data from frame years 1998-2011 from being directly comparable to Coho Salmon data based on the 2012 revised frame (2012-present). Comparability of the 1998-2011 data to that of future years was also complicated by the lack of strata in the earlier frames. Analyses did not show a bias in the habitat quality of sites between the two frames for steelhead.

In 2019, the 2012 coho and steelhead frames were revised based on the previous 7 years of survey work. The revision reduced the coho frame size by 8% and the steelhead frame size by 14%. In order to address the lack of comparability of Coho Salmon data from the original frame to that of the 2012 frame, the 2019 revised frame was also stratified into high quality and low quality habitats. Analyses demonstrated that data from sites in the original frames (1998 and 2002) should be comparable and unbiased relative to data collected from sites in the more current frames (2012 and 2019), provided that such data were correctly classified and weighted as originating from a high quality or low quality habitat. The stratification was accomplished using the Rogue South Coast Multi-Species Plan Species Distribution Modeling (SDM) (Julie Firman, ODFW, personal communication). SDM applied a probability of occurrence for Coho

Salmon to stream reaches. Those with a probability of occurrence >0.5 were identified as high quality habitat, and those with a probability of occurrence ≤0.5 were identified as low quality habitat. In areas where high and low quality habitats were mixed, minority designations were changed to agree with those in the majority. Local experts reviewed the designations and updates were made in the rare cases were empirical data did not match SDM. Data in this report, including previous years, were analyzed and presented to reflect the 2019 revision. Coho Salmon annual metrics were comparable for all years on the ESU scale (provided sites are assigned to and weighted by a high quality or low quality designation). Due to very small (<5 sites per year) sample sizes in low quality habitat in the years previous to 2002 at the Coho Salmon strata scale, annual metrics that include both habitat types for the strata were only comparable for the years 2002 to present. Metrics based only on high quality habitats were comparable for all years in the Interior Rogue, but since the North Coast basins contain <6km of high quality habitat, such metrics were not available for the stratum. Steelhead annual metrics were comparable from 2002-present in both strata and for the DPS.

Oregon Coast Coho ESU and DPS

In the Oregon Coast Coho ESU (OCC), sites were originally selected from a 100k sampling frame of 1st-3rd order streams that were within the putative Coho Salmon summer rearing distribution. This original sampling frame was designed to include all Coho Salmon rearing habitat in these lower order streams and upstream of tidal areas. In 2002, for juvenile steelhead monitoring, the scope was expanded to include 4th-6th order streams within steelhead distribution. The scope was only slightly expanded for steelhead in 1st -3rd order streams because, unlike the SONCC/KMP, there was a high degree (~94%) of overlap between the distributions of the two species in this region. For both species sites were selected proportionally from the same frame from 1st-3rd and 4th-6th order streams within the four strata (which had the same boundaries for the two species) within the ESU/DPS. In 2007 the sampling frame was revised, based primarily on 1998-2006 field work, and converted to a 24k scale. The revision resulted in a ~33% increase in stream kilometers within the frame. The increase was disproportionately higher (~50%) in the Umpqua stratum. There was no bias in habitat quality between the original and 2007 revised frame. Annual distribution and abundance metrics for both species were comparable for all years, beginning in 1998 for Coho Salmon and 2002 for steelhead. In 2009, due to funding constraints, surveys in 4th-6th order streams were discontinued. In 2012 the frame was again revised and resulted in a less than a 1% change in stream kilometers. Annual distribution and abundance metrics for both species were comparable for all years, beginning in 1998 for Coho Salmon and 2002 for steelhead. Data in this report were analyzed and presented based on the revised 2012 frame.

Lower Columbia River ESU and DPS

The Oregon portion of the Lower Columbia River (LCR), which includes LCR ESU, the LCR DPS, and the South West Washington DPS (SWW), were added to the scope of the project in 2006. Site selection in this area was similar to the OCC. In 2006 sites were selected from a 100k sampling frame for 1st-3rd order streams within the putative Coho Salmon rearing distribution and for 4th-6th orders streams within the putative steelhead rearing distribution. This original sampling frame included putative

Coho Salmon and steelhead rearing habitat upstream of tidal areas and within the aforementioned stream orders. Similar to the OCC there was a high degree (~91%) of overlap between the steelhead and Coho Salmon rearing distributions in 1^{st}-3^{rd} order streams. For both species, sites were selected proportionally from the same frame, from 1^{st}-3^{rd} and 4^{th}-6^{th} order streams within the two strata in the ESU and within the two steelhead DPSs. The ESU strata and the two DPSs have the same boundaries. In 2007 the sampling frame was revised and converted to a 24k digital stream network scale. This revision resulted a 6% reduction in stream kilometers within the original frame, with the LCR Coast stratum / SWW DPS decreasing by 15% and the LCR Cascades/Gorge stratum / LCR DPS increasing by 2%. There was no detectable bias in habitat quality between the original and 2007 revised frame; annual distribution and abundance metrics for both species were comparable for all years. In 2012, due to budget restrictions, surveys in 4^{th}-6^{th} order streams were discontinued in the region. Similar to the OCC, the frame was again revised in 2012, resulting in a less than a 1% change in stream kilometers. Annual distribution and abundance metrics for both species in the region were comparable for all years, beginning in 2006 to the present year. Data in this report were analyzed and presented based on the revised 2012 frame. Sampling frame and survey design processes previous to 2007 for all ESUs/DPSs are described in detail by Jepsen and Rodgers (2004) and Jepsen and Leader (2007).

Field Sampling

Selected sites were surveyed by field crews using daytime snorkeling during the base flow period (mid-July to mid-October). Sites were 1 kilometer in length and encompassed the GRTS point (x, y coordinates) provided by the selection process. Field crews were trained in fish identification and snorkel survey protocols described by Rodgers (2000). Surveys began at the downstream end of the site and proceeded upstream (Thurow 1994). Site length, pool length, and average pool width were measured with either a hip chain, open reel tape, depth staff, or range finder. Pool depth was measured using a depth staff. All pools ≥6m^2 in surface area and ≥20cm in maximum depth were snorkeled with a single pass to identify and count juvenile salmonids. Dive lights were used to improve visibility. Visibility was rated by considering factors that could impede the ability to observe fish (Rodgers 2000; Crawford 2011). Counts were made of Coho Salmon parr regardless of length, juvenile steelhead ≥90 mm in fork length (FL, visually estimated), and cutthroat trout (*O. clarki*) ≥90 mm FL. Due to difficulties distinguishing O. *mykiss* and *O. clarki* when under 90mm FL, all trout in this range were assumed to be age 0 and were not identified to species or used in analysis (Hawkins 1997, Roni and Fayram 2000). Fish presence was noted for dace, shiners, and trout <90 mm FL. Freshwater mussel relative abundance and beaver activity were also noted. As a part of surveyor training and to evaluate observational differences among snorkelers 10-15% of sites were resurveyed by supervisory staff.

Initially only pools that were ≥40cm in maximum depth were snorkeled. In 2010, this criterion was expanded to include pools ≥20cm in maximum depth based on results from the Smith River Verification Study (Constable and Suring, unpublished data). The Smith River Verification Study suggested the lower criterion would allow surveyors to sample larger and more consistent portions of Coho Salmon and steelhead summer rearing abundances. In order to compare current data to that from previous years, reports following the 2010 field season primarily provide an analysis of data based on pools meeting the ≥40cm maximum depth criterion and a secondary analysis of data based on pools meeting the ≥20cm maximum depth criterion.

From 1998-2016, most sites that could not be snorkeled due to poor water clarity or quality were surveyed via single-pass electrofishing effort without block nets to determine occupancy in each pool for Coho Salmon and occupancy at the site for steelhead and cutthroat. Abundance was not estimated at these sites. In 2017, electroshocking was discontinued due to limitations with the data and small percent of sites (<6%) electroshocked.

Our sampling objective for Coho Salmon is to produce abundance estimates with 95% confidence intervals ≤30% of the estimate and to be able to detect a 15% change in occupancy with 80% certainty (Crawford and Rumsey, 2011). Analysis of our data has shown that completing 40 sites per stratum is typically sufficient to reach this objective and remain within project budgets.

Data Analysis

Data are summarized by ESU or DPS and stratum. Cumulative Distribution Function (CDF) graphs (based on density), variances, and confidence intervals were created using tools developed by the EMAP Design and Analysis Team (EPA 2009). In comparison tests a p-value ≤ 0.05 was considered to indicate a significant difference. The following metrics of fish distribution and abundance were estimated for each of the two target species:

- Site occupancy: The percent of sites where at least one individual of the target species was observed; calculated by dividing the number of sites where the target species was observed by the number of sites that were surveyed for each stratum, ESU, or DPS.

- Pool frequency: The average percent of pools in a site that contain at least one individual of the target species. Pool frequency was first calculated at each site by dividing the number of pools where the target species was observed by the total number of surveyed pools. The resulting percent at each site was then averaged to obtain the pool frequency estimate within the stratum, ESU, or DPS.

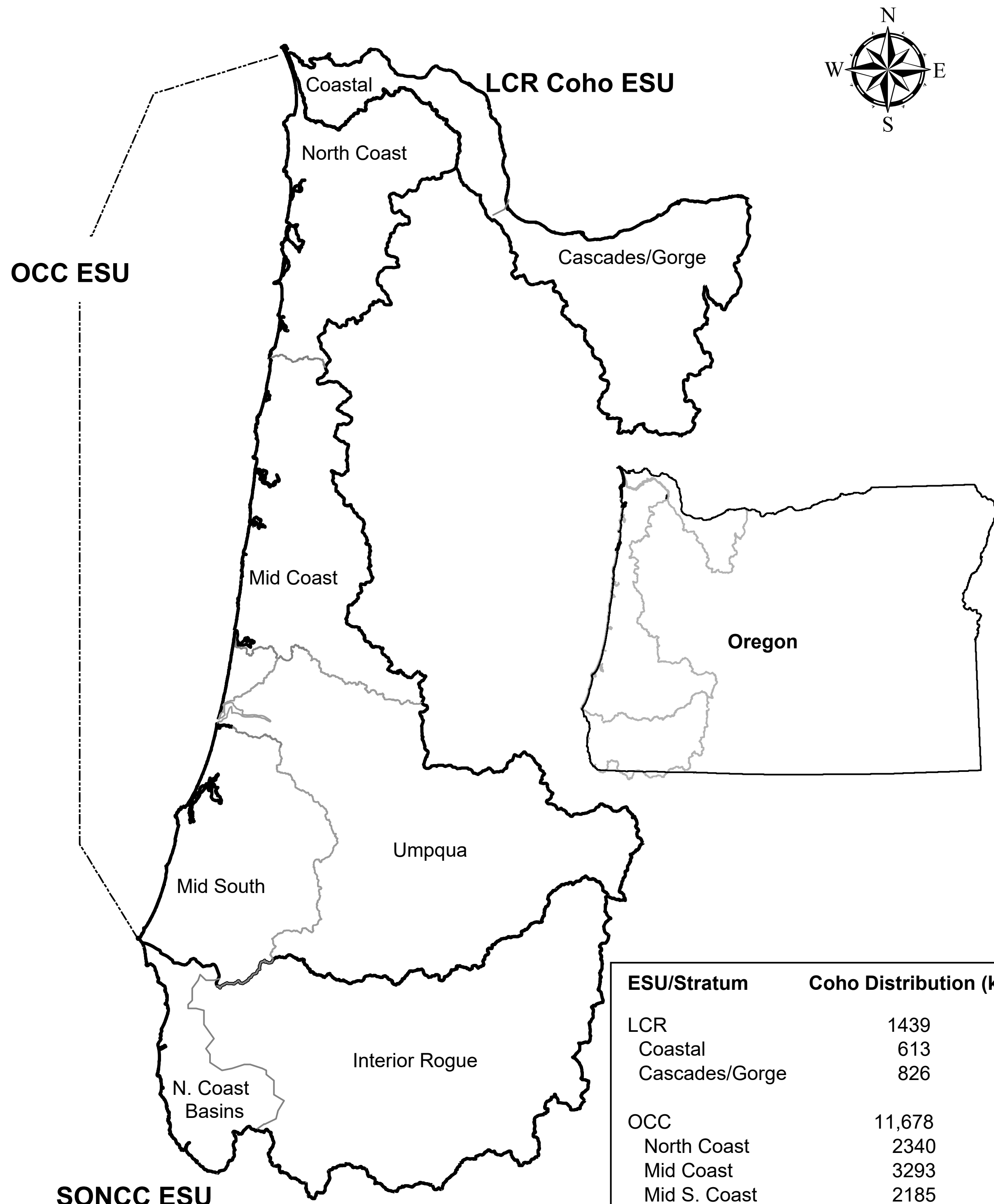
- Density: The number of target species individuals divided by the surface area of the pool in which they were observed. Density was first calculated in each pool. Second, a site density was calculated for each site by averaging the pool densities within the site. Lastly, density was estimated for each stratum, ESU, and DPS by averaging the site densities within each respective region.

- Abundance: The estimate of the number of individuals of each target species in pools that met sampling criteria for each stratum, ESU, or DPS. Abundance was calculated by multiplying the count of target species individuals per kilometer at each site by the site weight. Target species individuals per kilometer is the sum of the snorkel count at the site divided by the length (in km) of the site. Site weight is the total length of the rearing distribution in the stratum, ESU, or DPS divided by the number of surveyed sites in the area. The site weight is adjusted for sites that were non-target, i.e. sites that were dry, in tidal zones, or above fish passage barriers, (Stevens 2002). Abundance estimates provided in this report were based on un-calibrated snorkel counts in pools that meet size criteria. As such they did not represent total abundance estimates, but were appropriate for assessing trends.

- Percent full seeding: This metric is the percent of sites within a stratum or ESU with a site density $\geq$0.7 Coho Salmon/m^2. This value is regarded as full seeding following Nickelson et al. (1992) and Rodgers et al. (1992). Nickelson et al. estimate full seeding to be 1.0 coho/m^2 from electrofishing removal estimates and Rodgers et al. report that snorkelers observed 70% of the Coho Salmon in electrofishing removal estimates.

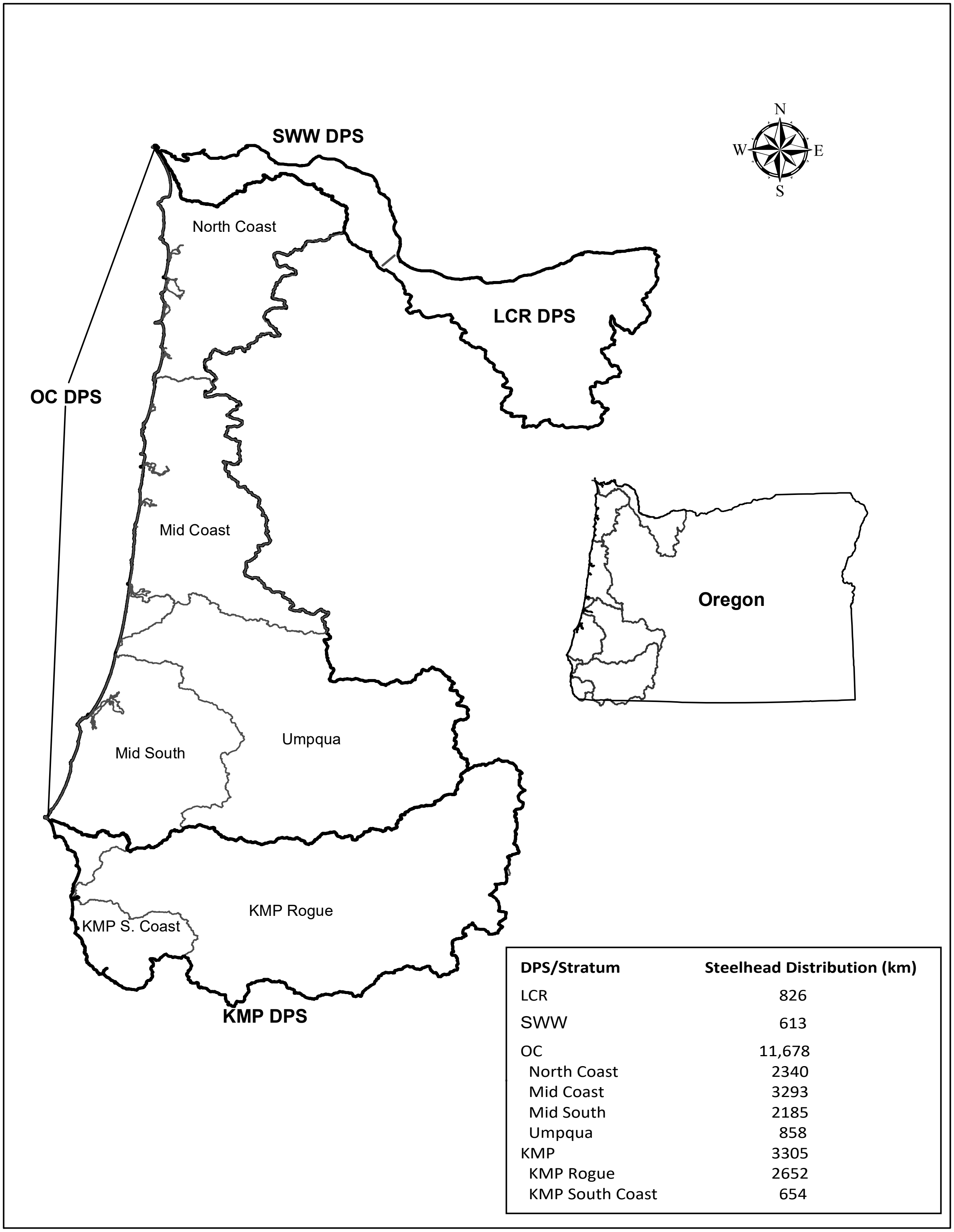
With the completion of the 2019 field season, there are now 22 years of monitoring data for juvenile Coho Salmon in the OCC and SONCC. To compare metrics across this time span, we partitioned these 22 years of the data into three-year intervals, based on the conventional three-year Coho Salmon life cycle (reviewed by Weitkamp et al., 1995). This resulted in seven successive brood groups from 1998-2018 and an eighth partial brood group for 2019. Juvenile steelhead data were partitioned into brood groups based on a presumptive four-year life cycle (reviewed by Busby et al., 1996). This resulted in four successive brood groups from 2002-2017. Data from the 2018 and 2019 field season is presented as a fifth partial brood group. The LCR Coho Salmon data were partitioned following the 2015 field season, resulting in four successive brood groups from 2007-2018 and a fifth partial brood group for 2019. Steelhead data in the LCR and SWW were partitioned into three successive brood groups from 2006-2017. Steelhead data from the 2018 and 2019 field seasons are presented as a fourth partial brood group. A brood group contains one iteration of each of the three Coho Salmon brood lines (likewise, a brood group for steelhead contains one iteration of each of the four brood lines), and thus is one complete cycle of the summer rearing segment of the Coho Salmon population. The application of brood groups as an analysis unit, in addition to individual cohorts or years, can provide a useful way to monitor trends in distribution and abundance. Estimates of site occupancy and fish abundance were analyzed and compared for Coho Salmon and steelhead brood groups within strata and ESUs/DPSs.

Female spawner-parr recruit plots were produced using Beverton-Holt models in R version 3.4.0 (2017). AICs from models using a single line to fit all data and models with strata-specific asymptotes were compared to select the best model. Residuals were plotted to determine trend. Female spawner data used in these plots were from the ODFW Oregon Adult Salmonid Inventory and Sampling (OASIS) project (available at http://odfw.forestry.oregonstate.edu/spawn/cohoabund.htm).



ESU/Stratum	Coho Distribution (km)
LCR	1439
Coastal	613
Cascades/Gorge	826
OCC	11,678
North Coast	2340
Mid Coast	3293
Mid S. Coast	2185
Umpqua	3858
SONCC	2122
N. Coast Basins	362
Interior Rogue	1760

Figure 1. Coho Salmon ESUs and strata within the Western Oregon project area. The table gives the length of rearing distribution in 1st-3rd order streams in each area.



DPS/Stratum	Steelhead Distribution (km)
LCR	826
SWW	613
OC	11,678
North Coast	2340
Mid Coast	3293
Mid South	2185
Umpqua	858
KMP	3305
KMP Rogue	2652
KMP South Coast	654

Figure 2. Steelhead DPSs and strata within the Western Oregon project area. The table gives the length of steelhead rearing distribution in 1st-3rd order streams in each area.

RESULTS

2019 Survey Effort and Resurveys

In 2019, 644 sites were selected by the GRTS process within the coho and steelhead sampling frames. Forty-one sites were determined to be non-target (beyond the potential rearing distribution of Coho Salmon and steelhead). Of the remaining 603 sites, 260 were not surveyed because of landowner access restrictions (n=160), visibility or water quality issues (n=22), unsafe or difficult access (n=8), or time restrictions (n=70). Sites that were not surveyed were defined as target, non-response. A total of 343 sites were snorkeled, comprising 4,592 pools in 338.8 km of streams. This was the largest number of sites snorkeled since the sampling frame were revised in 2012.

We met our goals for survey effort in all but 2 of the 8 strata (Table 1). Landowner denials and lack of visibility accounted for the high number of sites that could not be surveyed in the LCR and Interior Rogue. The absence of large wildfires in the Umpqua and the SONCC allowed us to reach survey goals in these areas for the first time in several years.

Table 1. Survey effort goals and status of sites for 2019.

ESU	Stratum	Survey Goal	Snorkeled	Target -Non response	Non-Target
OCC	North Coast	40	40	23	1
	Mid Coast	40	44	19	3
	Mid-South Coast	40	39	26	2
	Umpqua	40	41	25	1
LCR	Coast	40	37	50	10
	Cascades/Gorge	40	42	37	10
SONCC	Interior Rogue	60	60	58	12
	N. Coast Basins	40	40	22	2

As in 2018, the goal of a 95% confidence interval ≤30% of the density estimate was met only in the North Coast and Mid Coast strata for 2019 (Table 2). Variance partitioning has indicated low precision in most years was due to the high variation of Coho Salmon abundance among the survey sites (Anlauf-Dunn, ODFW, unpublished data).

Resurveys were conducted by supervisory staff in thirty five (10%) sites across the sampling area. Coho salmon counts in snorkel sites had a significant relationship to counts from resurveys (Figure 3, top left panel, R^2 = 0.996). These results were similar to previous years (bottom left panel, R^2 = 0.970) and indicated our snorkel counts of Coho Salmon were precise and repeatable. Resurvey counts of steelhead in 2019 showed increased precision and repeatability (top right panel, R^2 = 0.874) relative to previous years (bottom right panel, R^2 = 0.795).

Table 2. Distribution and density estimates of Coho Salmon parr in the four strata of the Oregon Coast Coho ESU and in the LCR and SONCC. Estimates are from snorkel surveys in 1st-3rd order streams from 2019.

	Distribution			Density		
Stratum or ESU	Site Occupancy	Mean Pool Frequency	95% CI	Percent Sites > 0.7 coho/m^2	Mean Average Pool Density (coho/m^2)	95% CI
North Coast	78%	65%	± 17%	15%	0.290	± 28%
Mid Coast	84%	77%	±12%	18%	0.389	± 22%
Mid-South Coast	82%	68%	± 15%	5%	0.171	± 31%
Umpqua	70%	57%	± 16%	5%	0.128	± 38%
SONCC	42%	22%	± 34%	0%	0.040	± 47%
LCR	46%	28%	± 25%	3%	0.090	± 57%

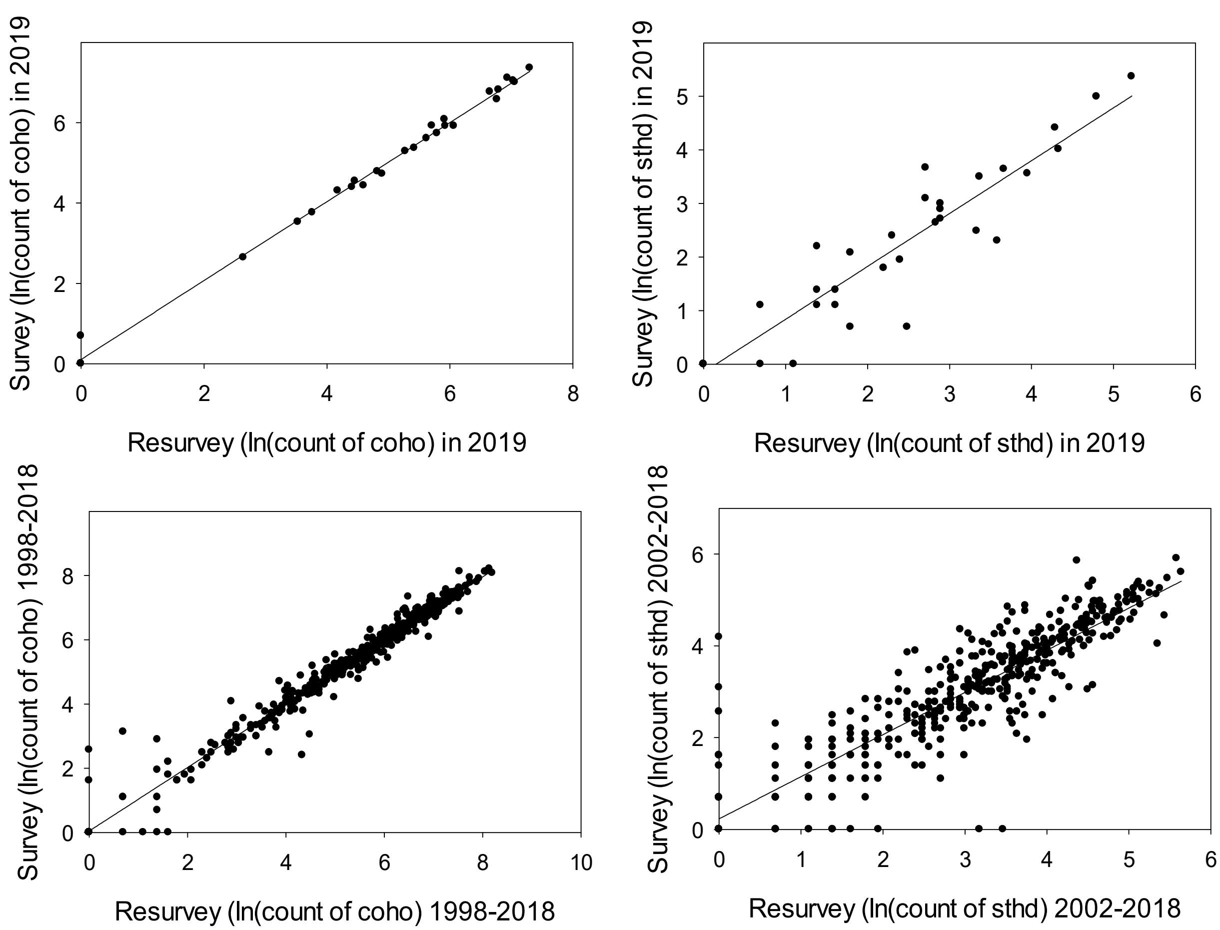


Figure 3. The relationship of Coho Salmon parr and steelhead (≥90mm in fork length) parr counts from surveys and resurveys of the same sampling sites for 2019 (top panels, n = 35) and for all previous years (bottom panels, n = 531 for Coho Salmon and n= 477 for steelhead, respectively). Data are log transformed to satisfy regression assumptions.

Trends in Salmonid Distribution and Abundance

Coho Salmon

Southern Oregon Northern California Coast

The SONCC frame underwent a revision and stratification in 2019 which resulted in a correction of metrics from previous years. These are presented in Appendix I. The 2019 abundance estimate was 54,890 parr, which was the lowest on record. Abundance estimates for the brood groups from 2013 to present were similar to the 1998-2000 brood group, but low relative to the 2007-2009 group (Figure 4). The 2019 density estimate was 0.04 fish/m², the second lowest recorded, and no sites in the SONCC were fully seeded for the year. Site occupancy in 2019 was 42%, which was similar to that of the previous brood groups (Figure 5).

Oregon Coast Coho

The 2019 abundance estimate was 3.2 million parr. Parr abundance has remained between 2.9 and 4.9 million since 2000, after improving from an average of 910,000 for 1998 and 1999. The abundance estimate for the 2016-2018 brood group was lower than those for the 2007-2015 brood groups and higher than the estimate for the 1998-2000 brood group. Density in the ESU and the number of sites fully seeded were similar from 2018 to 2019. Site occupancy was 78% for 2019, which was one of only two years this decade where the metric did not meet the National Marine Fishery Service recovery criterion (Wainwright et al., 2008) of ≥80% of sites occupied. Site occupancy for the 2016-2018 brood group was low relative to estimate for the 2010-2012 brood group and high relative to the estimates for the 1998-2003 brood groups. Yearly metrics for the ESU and its strata are presented in Appendix I.

In the Mid-South Coast and Umpqua strata of the OCC, the 2019 CDF curve was low relative to the 1998-2018 average CDF curve (Figure 6). In the North Coast and Mid Coast the 2019 CDF curves were similar to the 1998-2018 average. Abundance estimates in 2019 were similar to those in 2018 and to the 2016-2018 brood groups, respectively, within the four strata. Abundance estimates in the 2016-2018 brood groups were high in the North Coast, similar in the Mid Coast and Umpqua, and low in the Mid-South Coast when compared to 2013-2015 brood groups (Figure 7). Density estimates in 2019 were similar to those in 2018 for the four strata. Site occupancy estimates in the strata for the 2016-2018 brood groups were similar to those for the 2013-2015 brood groups, and the 2019 estimates were similar to those in 2018 (Figure 8). Site occupancy in the Umpqua continues to be low, on average, relative to the three other strata.

Female spawner:parr recruit plots for the OCC strata suggested parr production began to asymptote near current spawner abundances, indicating a density-dependent effect on rearing capacity at this early life stage (Figure 9). Data suggest the rearing capacity may be slightly higher in the Mid-South Coast relative to the other strata. The 5 highest (and 12 of the 20 highest) parr abundance estimates were in the Mid-South Coast. Plots of residuals also suggested the Mid-South Coast had a positive trend ($P=0.05$), while a trend was not observed in other strata. In the OCC, the number of parr produced per female increased when female spawner abundance decreased and, conversely, decreased when female spawner abundance increased, suggesting a compensatory effect (Figures 10 and 11). The average number of parr per female was 66 and ranged from 14 (in the Umpqua, when female spawner abundance was at its highest) to 221 (in the Umpqua when, female spawner abundance was at its 2nd lowest). Density-dependent effects on recruits per spawner in the OCC have been described by Nickelson and Lawson (1998) and Wainwright (2008).

As stated in the Methods section, the parr numbers given here were from un-calibrated visual estimates conducted only in pools meeting protocol criteria. Actual parr abundance was likely ~185% higher (Constable and Suring, 2018.). We assumed that the lack of a corresponding linear increase in parr abundance with increased female spawner abundance was not an effect of parr “spilling over” into less optimal habitats, such as riffles, where they would not be observed with our protocols. Supporting this assumption are data that indicate pool densities have been relatively low to moderate (<0.7 Coho Salmon/m^2) in the majority of sites in high spawner abundance years. We also assume that the bias of snorkeler counts of parr in pools is similar across the range of parr abundances we have observed. Initial work of testing these assumptions began in the 2016 field season and continued in 2017-2019.

Lower Columbia River

The 2019 abundance estimate was 112,044 parr. Although this nearly doubled the average for the 2016-2018 brood group, the large confidence interval for 2019 confounded comparisons between the year and the brood groups. Density estimates and the number of sites fully seeded were similar in 2018-2019. In both of these years only two of the sites in the ESU were fully seeded. The 2019 site occupancy estimate was similar to the estimate in 2018 and was higher than the average occupancy for the 2016-2018 brood group. Site occupancy for the 2016-2018 brood group was low relative to the estimates for the preceding brood groups.

Unlike the OCC, the plot of female spawner and parr recruits for the LCR did not suggest an asymptote in parr production at current spawner abundances, and there was a much weaker indication of a density-dependent effect on parr production (Figure 12). A plot of residuals did not suggest a trend. The number of parr produced per female spawner was an average of 50% lower than in the OCC and appeared to be less influenced by female spawner abundance (Figures 13 and 14). The number of parr per female ranged from 7, when female spawner abundance was highest, to 66, when female spawner abundance was the 2nd lowest, but any compensatory effect in the LCR seems weaker than this effect in the OCC (Figure 14). These differences between the ESUs are perhaps due to a later start of monitoring in the LCR (fewer data points) and spawner densities (female spawners/km) in the LCR that average 36% of those in the OCC strata for the 2005-2018 brood years. In 2019 an average of 51 parr were produced per female spawner. This relatively high production rate for the ESU may have contributed to the average abundance and occupancy metrics in a brood year when the number of spawners was below average.

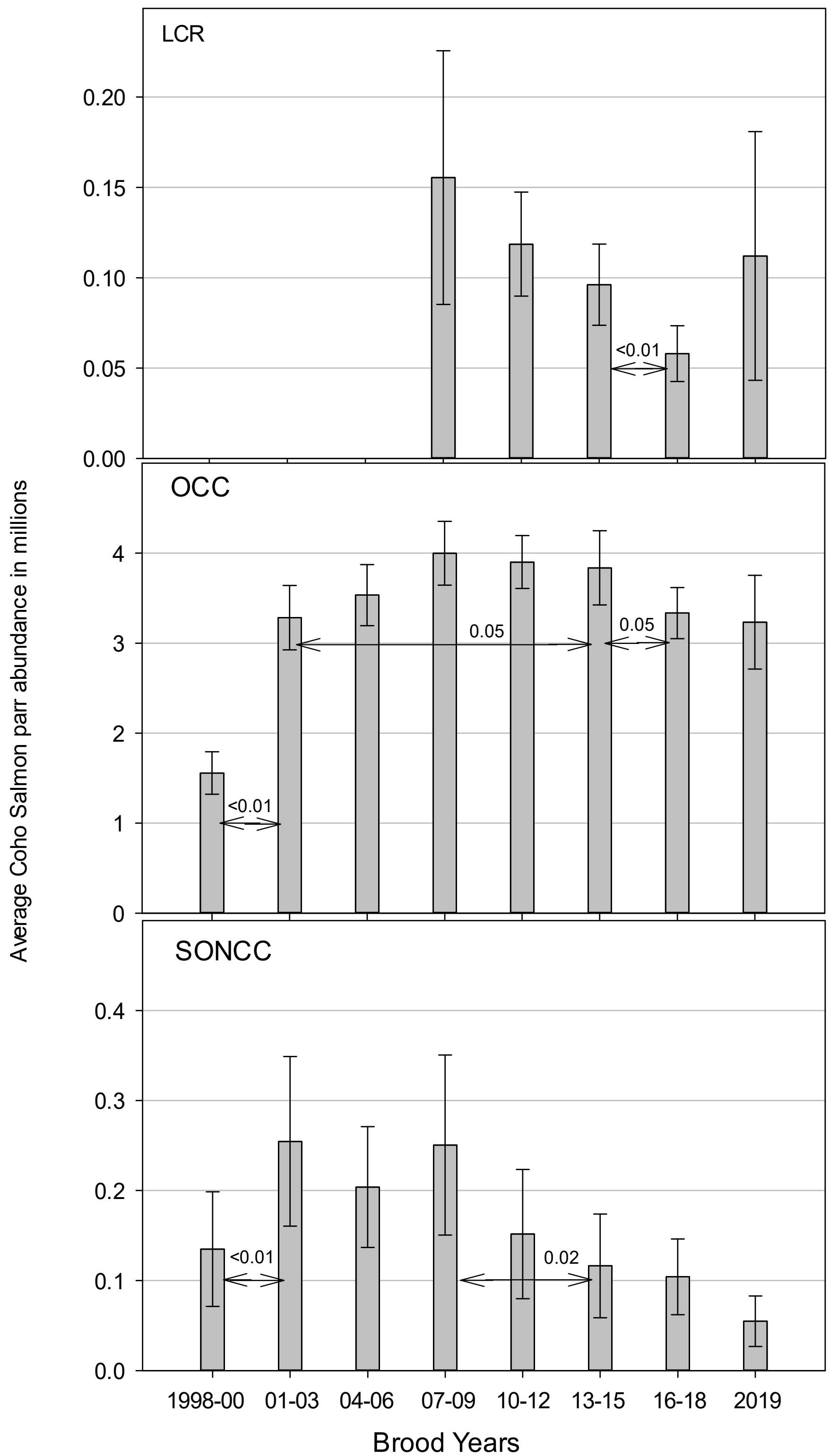


Figure 4. Three year (brood group) trends of Coho Salmon parr abundance estimates in the three western Oregon Coho ESUs, based on snorkel surveys in 1^{st}-3^{rd} order streams for the years 1998-2019. Gray bars and error bars show the abundance estimate with the 95%CI. P-values for selected comparisons among brood groups are given above the horizontal arrows where $p \leq 0.05$. Note the differences in Y-axis scales among panels.

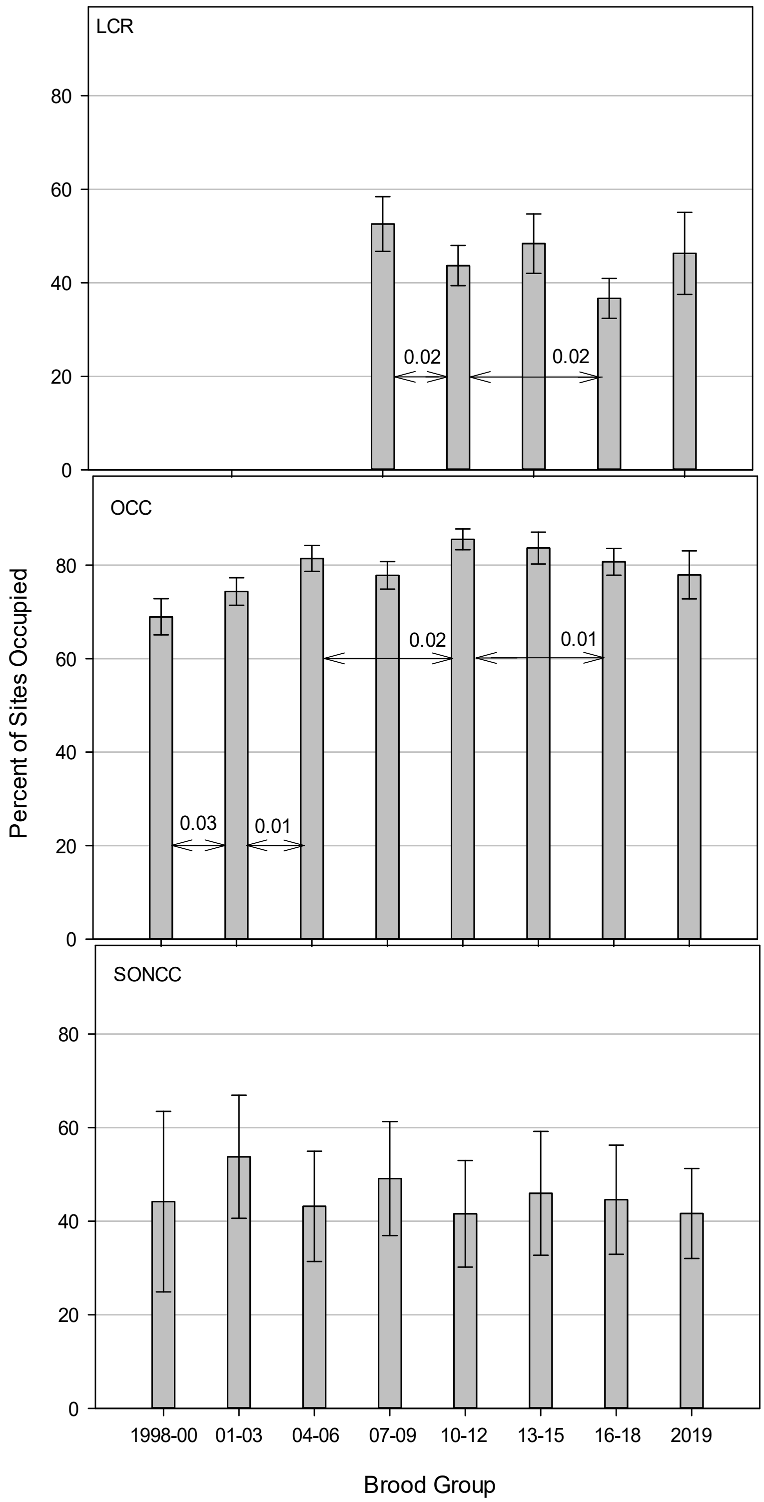


Figure 5. Three year (brood group) trends of Coho Salmon parr site occupancy in the three western Oregon Coho ESUs based on snorkel surveys in 1st-3rd order streams for the years 1998-2019. Gray bars and error bars show the percent of sites occupied with the 95%CI. P-values for selected comparisons among brood groups are given above the horizontal arrows where $p \leq 0.05$.

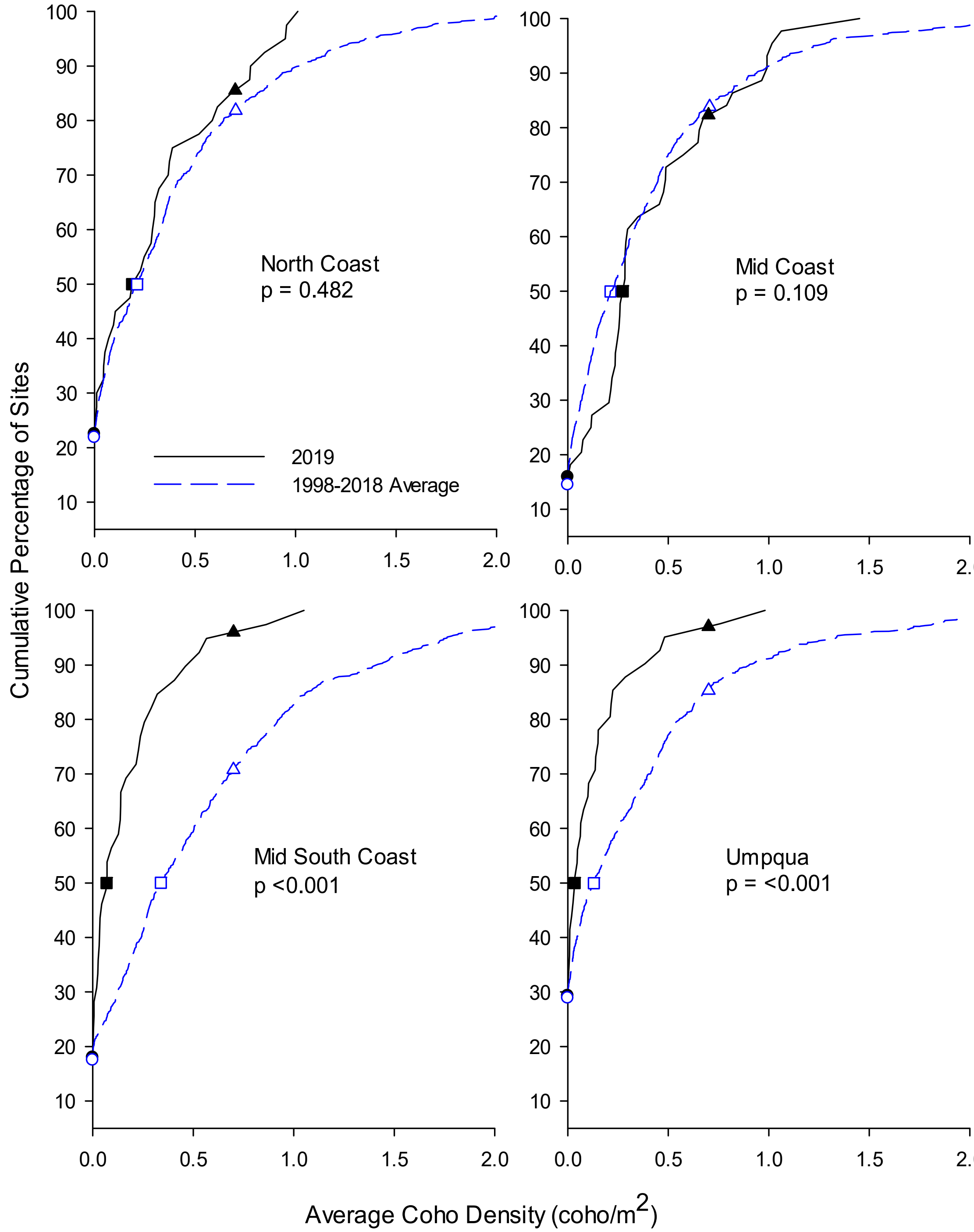


Figure 6. Average Coho Salmon parr density CDFs based on snorkel surveys in 1st-3rd order streams in the four strata of the Oregon Coast Coho ESU for survey years 1998-2019. The points shown on the curves are the percentage of unoccupied sites (circles), the median density (squares), and the percentage of sites below full seeding (triangles). The average condition of each stratum based on the CDF of these three metrics (blue, dashed line) is compared to the condition in 2019 (black, solid line). P values are from the comparison test of the two curves.

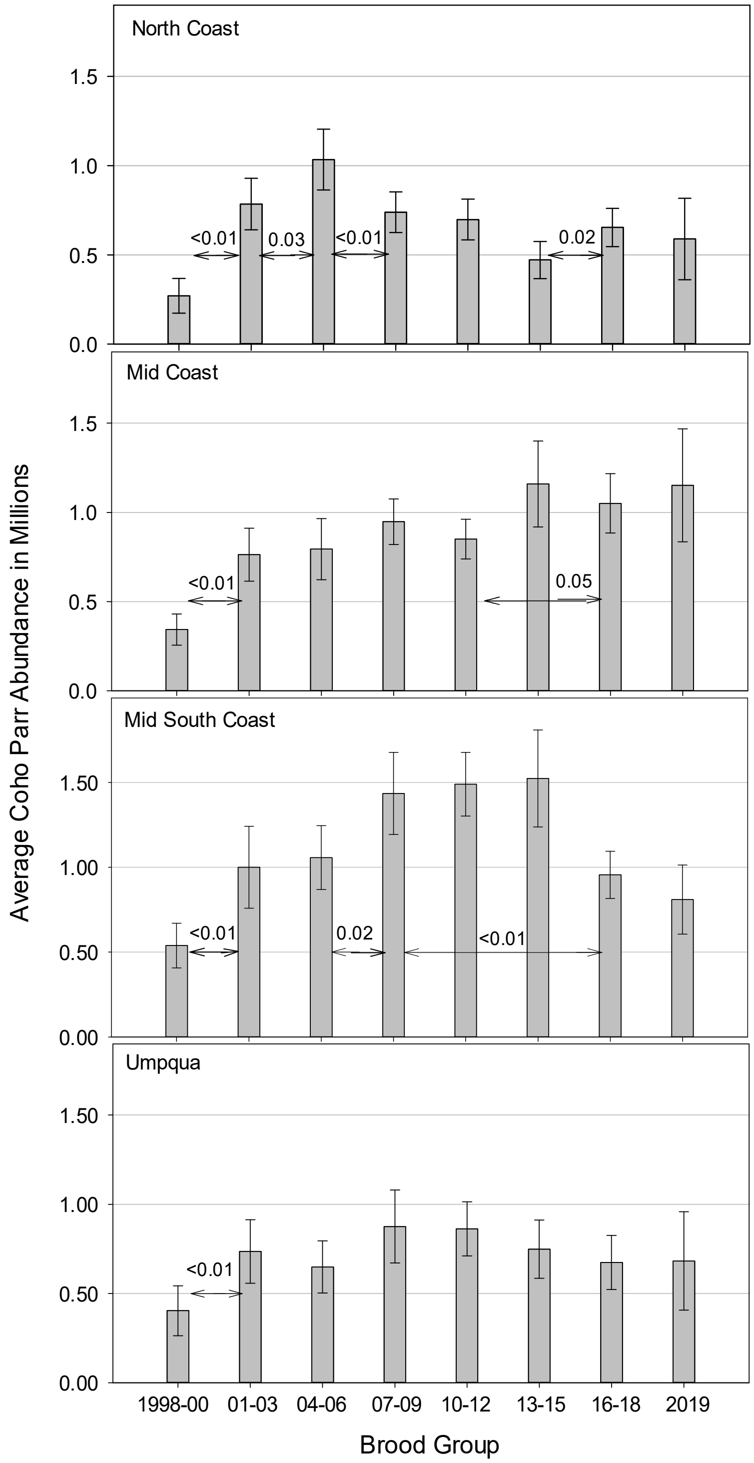


Figure 7. Three year (brood group) trends of Coho Salmon parr abundance estimates in the four strata of the Oregon Coast Coho ESU, based on snorkel surveys in 1st-3rd order streams for the years 1998-2019. Gray bars and error bars show the abundance estimate with the 95%CI. P-values for selected comparisons among brood groups are given above the horizontal arrows where p ≤ 0.05.

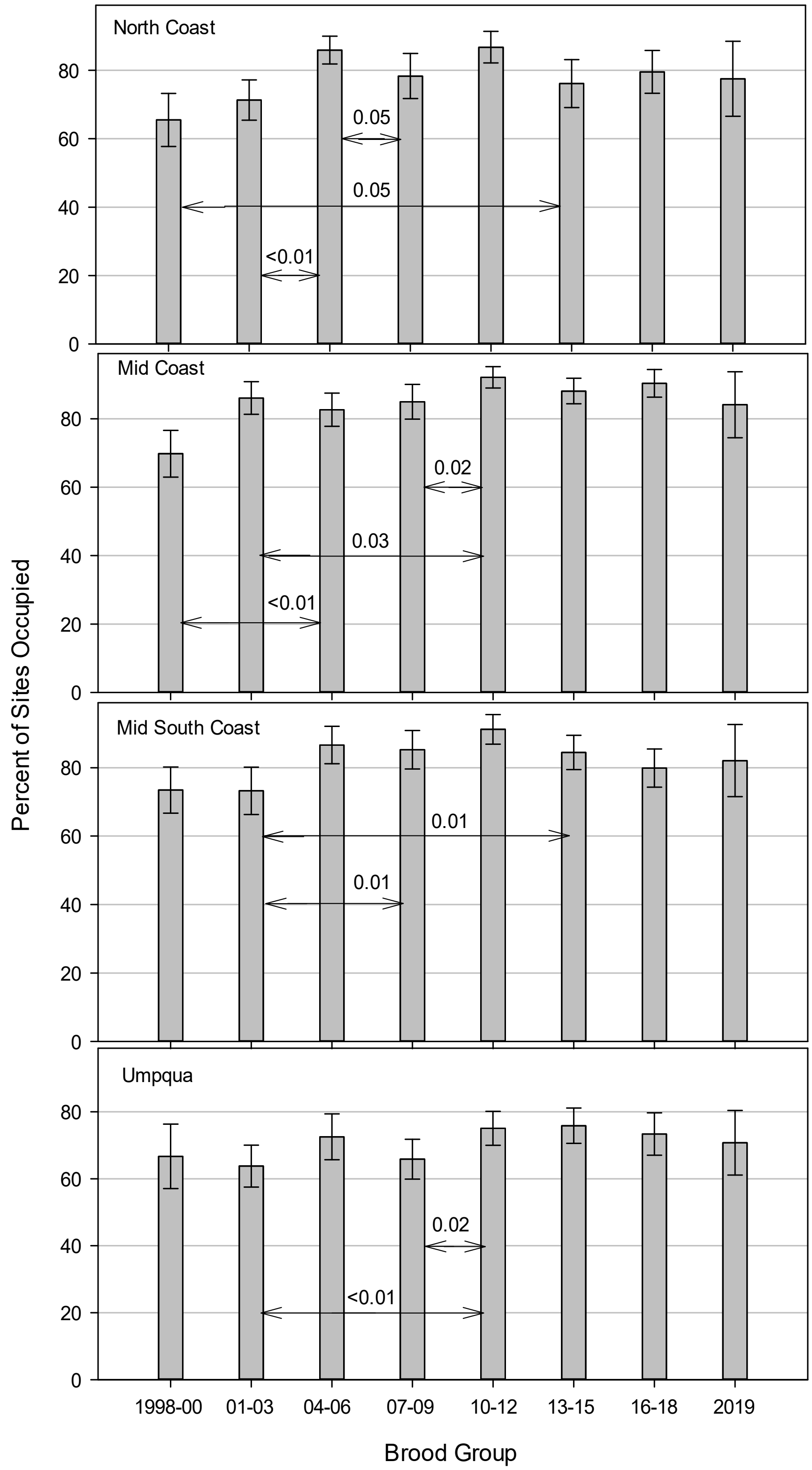


Figure 8. Three year (brood group) trends of Coho Salmon parr site occupancy in the four strata of the Oregon Coast Coho ESU, based on snorkel surveys in 1st-3rd order streams for the years 1998-2019. Gray bars and error bars show the percent of sites occupied with the 95%CI. P-values for selected comparisons among brood groups are given above the horizontal arrows where $p \leq 0.05$.

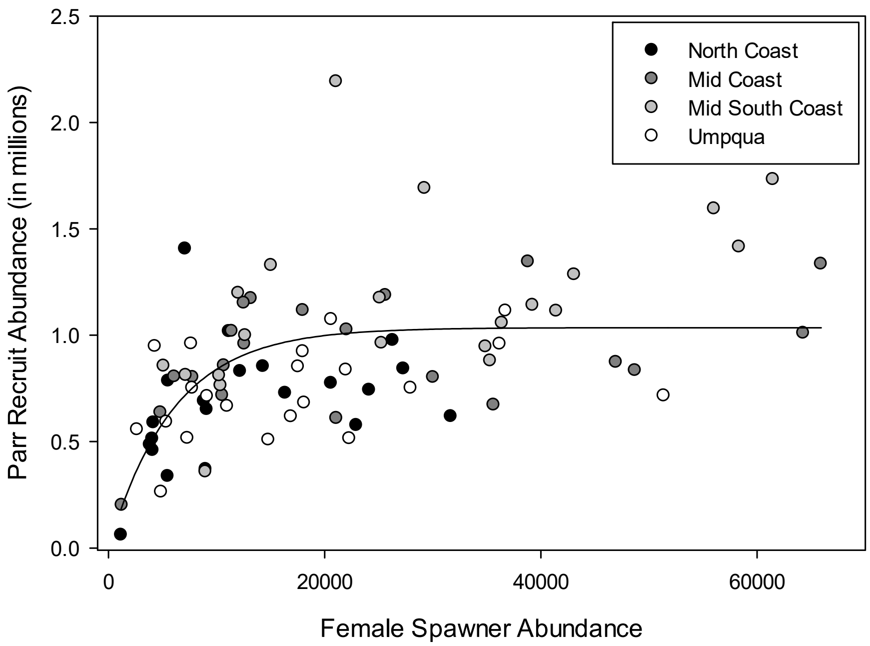


Figure 9. A Beverton-Holt model showing the relationship between the abundance of Coho Salmon parr recruits and female spawners in the strata of the Oregon Coast Coho ESU for brood years 1998-2018. Parr abundance is from un-calibrated snorkel surveys in 1st-3rd order streams. Female spawner abundance is from spawning ground surveys.

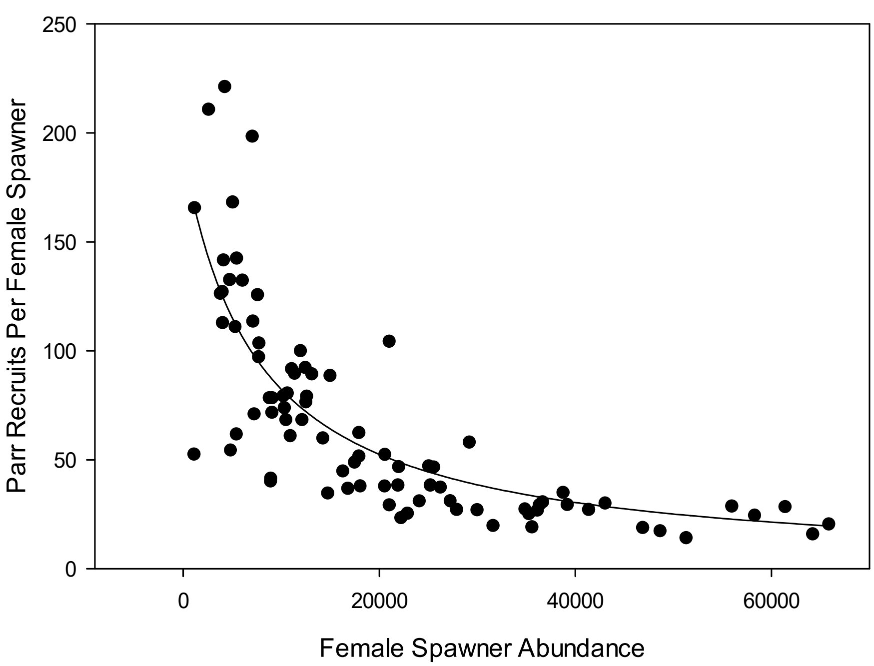


Figure 10. The relationship between the abundance of Coho Salmon female spawners and the number of parr recruits per female spawner in the Oregon Coast Coho ESU for brood years 1998-2018. Parr abundance is from un-calibrated snorkel surveys in 1st-3rd order streams. Spawner abundance is from spawning ground surveys.

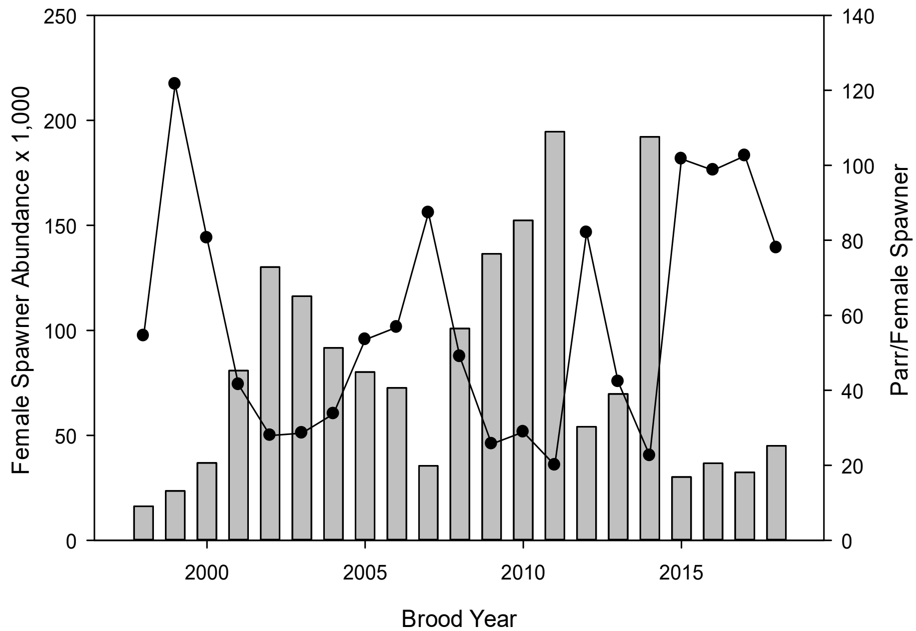


Figure 11. The abundance of Coho Salmon female spawners (gray bars) and the number of parr recruits per female spawner (black dots and line) over time in the Oregon Coast Coho ESU. Parr abundance is from un-calibrated snorkel surveys in 1st-3rd order streams. Spawner abundance is from spawning ground surveys.

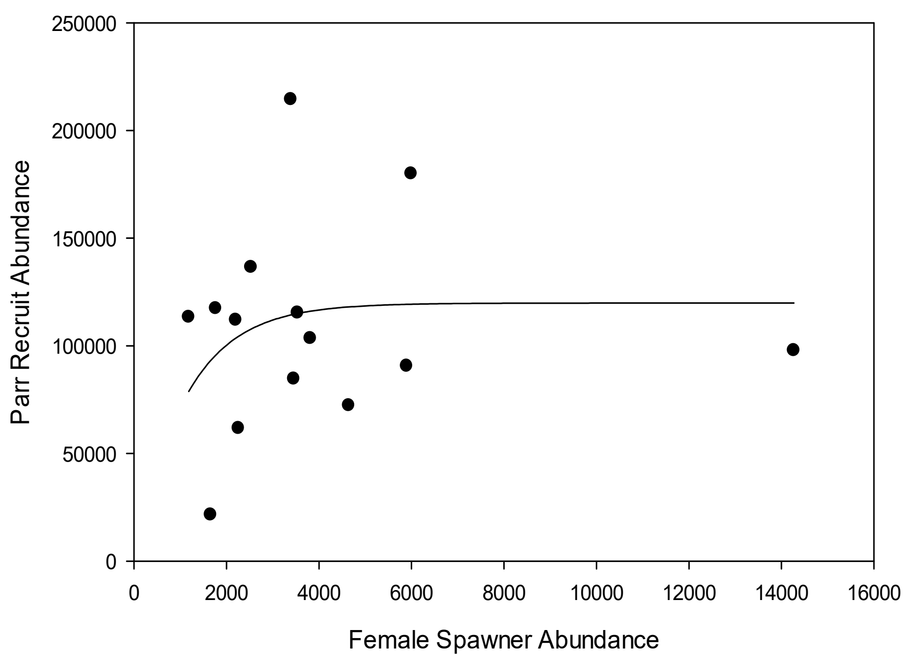


Figure 12. A Beverton-Holt model showing the relationship between the abundance of Coho Salmon parr recruits and female spawners in the Lower Columbia River ESU for brood years 2005-2018. Parr abundance is from un-calibrated snorkel surveys in 1st-3rd order streams. Female spawner abundance is from spawning ground surveys.

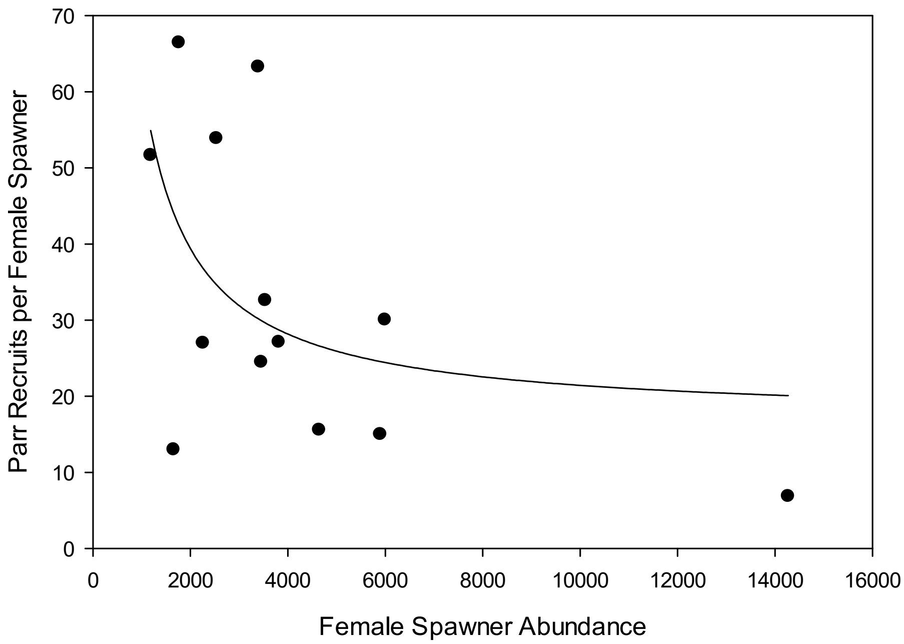


Figure 13. The relationship between the abundance of Coho Salmon female spawners and the number of parr recruits per female spawner in the Lower Columbia River ESU for brood years 2005-2018. Parr abundance is from un-calibrated snorkel surveys in 1st-3rd order streams. Spawner abundance is from spawning ground surveys.

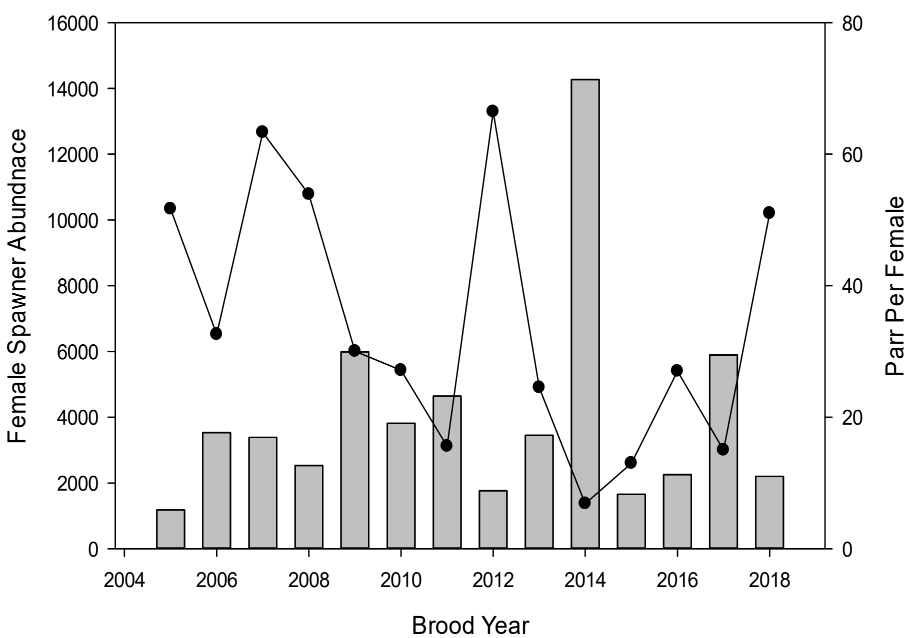


Figure 14. The abundance of Coho Salmon female spawners (gray bars) and the number of parr recruits per female spawner (black dots and line) over time in the Lower Columbia River ESU. Parr abundance is from un-calibrated snorkel surveys in 1st-3rd order streams. Spawner abundance is from spawning ground surveys.

Steelhead

Klamath Mountain Province

The 2019 density estimate was the lowest on record (Table 3). The 2019 abundance estimate was also the lowest on record with 59,402 parr, and the five lowest abundance estimates recorded were during the last 5 years. Average abundance for the current, partial brood group from 2018-2019 was lower than that of the 2014-2017 brood group (Figure 15). Most of the declining abundance in the past five years for the DPS was due to low abundances in the Rogue Stratum, where point estimates in 2015 and 2016 were under two-thirds of the average point estimate, and where point estimates in 2017-2019 were under one-third of the average point estimate for the stratum. Abundance estimates in the South Coast Stratum during the same time period were the lowest and second lowest recorded in 2015 and 2019, respectively, but these were over half of the average point estimate, and point estimates from 2016-2018 were near or above the average point estimate. In 2019 the site occupancy estimate was 57%. This was the lowest estimate recorded for the DPS and site occupancy estimates for the partial 2018-2019 brood group were lower than those of the 2014-2017 brood group (Figure 16). Similar to abundance, low site occupancy in 2019 for the DPS was driven by a record low site occupancy of 45% in the Rogue Stratum, while 100% of sites were occupied in the South Coast Stratum. In the Rogue Stratum the five lowest site occupancies were recorded in the last 5 years.

Oregon Coast

Density was similar from 2018 to 2019. As in the majority of the years, density estimates in 2019 were higher in the North Coast and Mid Coast Strata than they were in the Mid-South and Umpqua Strata. The 2019 steelhead abundance estimate was 185,529 parr, which was similar to the estimate in 2018. Abundance for the partial brood group from 2018-2019 was lower than in the two previous brood groups, but similar to the first two brood groups. Abundance estimates have had the most variation in the Umpqua and were typically higher in the Mid Coast, relative to the other strata. The 2019 site occupancy estimate was 72%, which was similar to the site occupancy in 2018 and to the 2014-2017 brood group. Site occupancy for the partial brood group from 2018-2019 was lower compared to the 2010-2013 brood group, but similar to the three other brood groups. Among the strata, site occupancy has typically been highest in the Mid-South or Mid Coast, lowest in the Umpqua, and most variable in the North Coast.

Lower Columbia River

Steelhead density was similar from 2018 to 2019. The 2019 abundance estimate was 4,441 parr, which was similar to the estimate from 2018. Abundance for the partial brood group from 2018-2019 was similar to the brood group from 2014-2017, but abundance for these brood groups are low compared to the first two brood groups. The five lowest abundance estimates for the DPS have been recorded in the last 5 years. The 2019 site occupancy estimate was 60%, which was similar to the estimate for 2018. Although 3 of the lowest site occupancies have been recorded in the last 5 years, site occupancy is similar for all brood groups in the DPS.

South West Washington

Density was similar from 2018 to 2019 in SWW. The four lowest densities were recorded in the last 5 years. The 2019 abundance estimate was 3,524 parr. Abundance for the partial brood group from 2018-2019 was low compared to abundance for the 2010-2013 brood group. The four lowest steelhead abundance estimates were recorded in the last 5 years but 95% confidence intervals that averaged 55% of their respective abundance estimates have made comparisons among brood groups in the DPS difficult. The 2019 site occupancy estimate was 54%. Site occupancy for the partial brood group from 2018-2019 and for the brood group from 2014-2017 was lower than it was for the 2010-2013 brood group. The three lowest site occupancies were recorded in the last 5 years.

Table 3. Distribution and density estimates for juvenile steelhead (≥90cm in fork length) in eight strata of Western Oregon Steelhead DPS, based on snorkel surveys in 1st-3rd order streams for 2019.

Stratum	Distribution			Density	
	Site Occupancy	Mean Pool Frequency	95% CI	Mean Average Pool Density ($sthd/m^2$)	95% CI
North Coast	68%	33%	± 16%	0.022	± 21%
Mid Coast	68%	33%	± 22%	0.016	± 32%
Mid-South	76%	38%	± 22%	0.008	± 40%
Umpqua	73%	30%	± 24%	0.009	± 44%
KMP Rogue	45%	21%	± 28%	0.007	± 34%
KMP South Coast	100%	70%	± 12%	0.039	± 33%
Lower Columbia	60%	27%	±26%	0.011	± 46%
Southwest WA	54%	17%	± 37%	0.003	± 39%

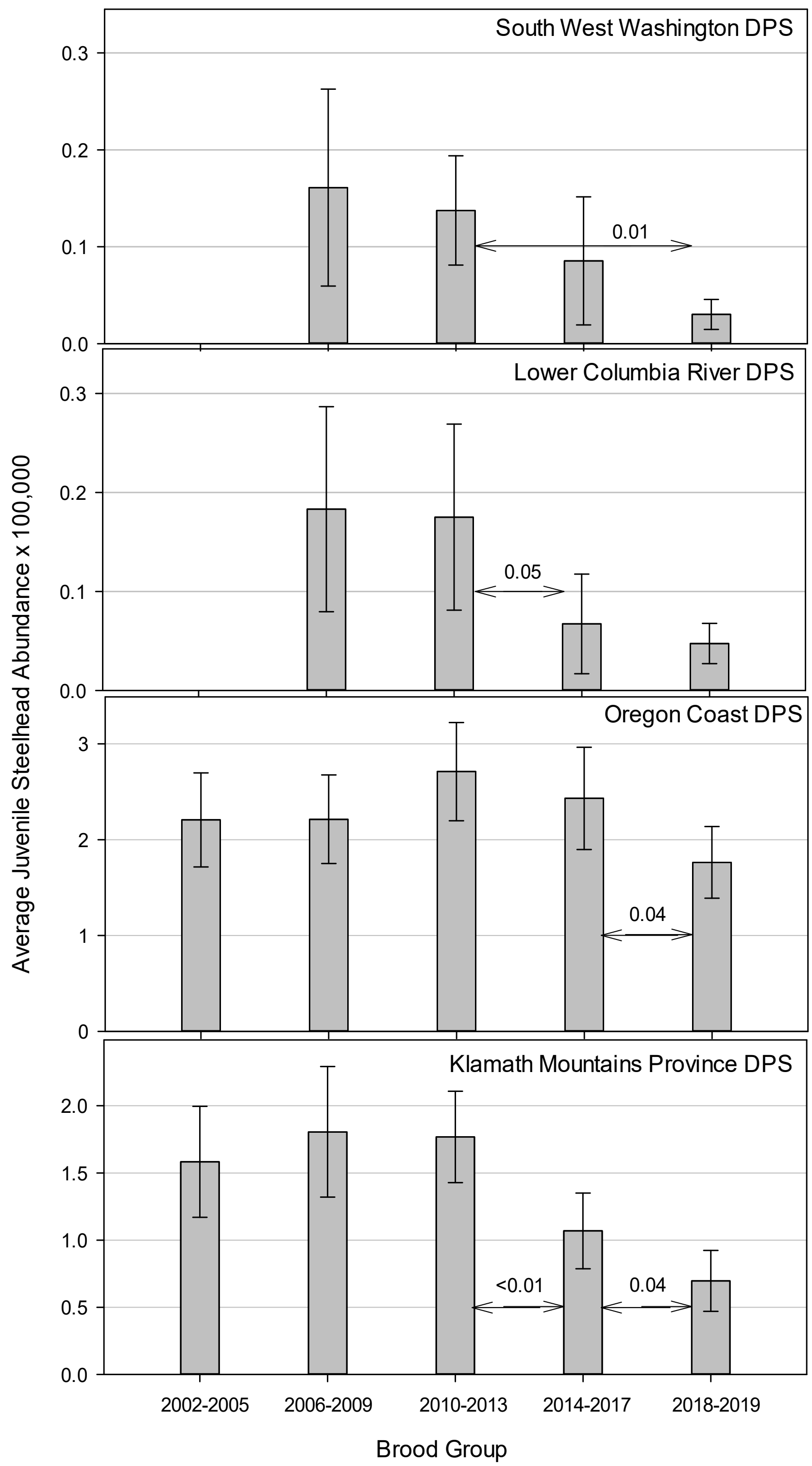


Figure 15. Four year (brood group) trends of juvenile steelhead (≥90cm in fork length) abundance estimates in the four western Oregon DPSs, based on snorkel surveys in 1st-3rd order streams for years 2002-2019. The 2018-2019 data are presented as a partial brood group. Gray bars and error bars show the abundance estimate with the 95% CI for the brood group. P-values for selected comparisons among brood groups are given above the horizontal arrows where p ≤ 0.05

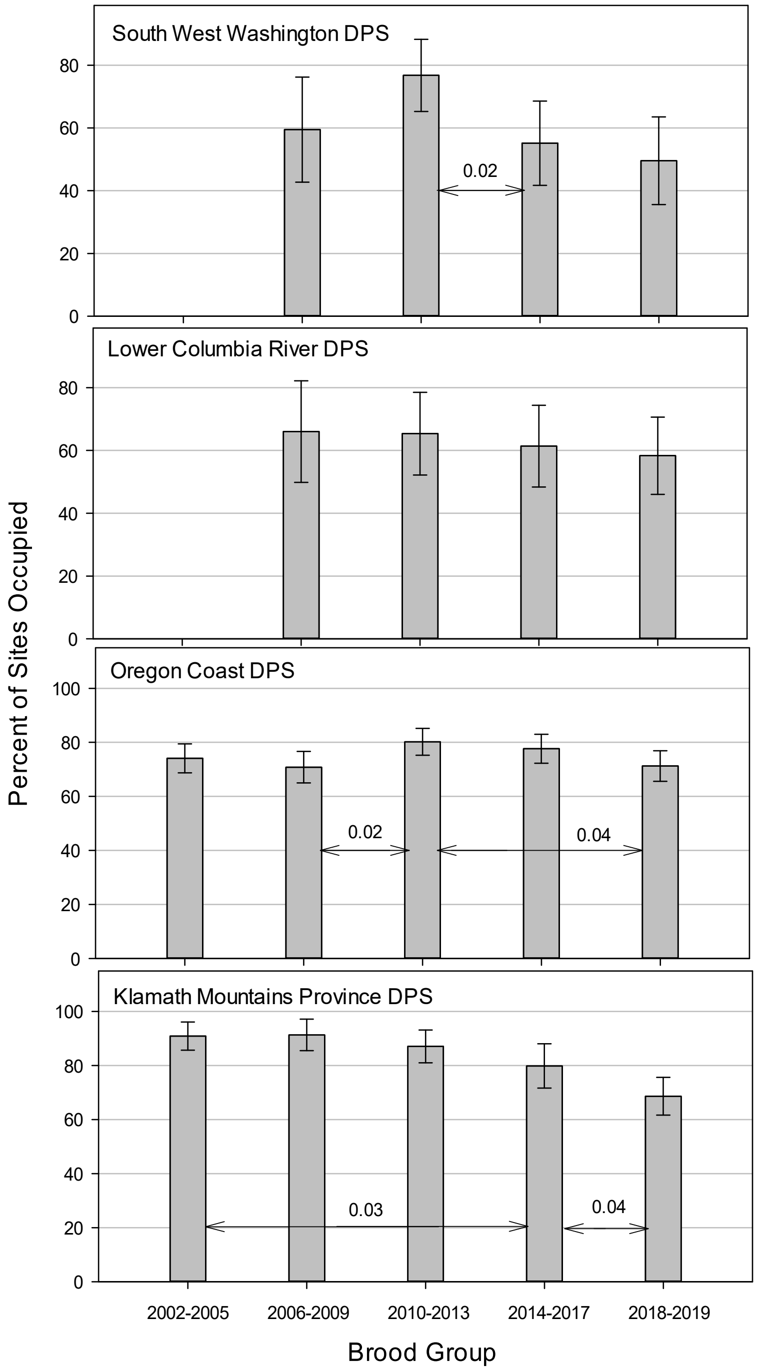


Figure 16. Four year (brood group) trends of juvenile steelhead (≥90cm in fork length) site occupancy in four western Oregon DPS, based on snorkel surveys in 1st-3rd order streams for years 2002-2019. The 2018-2019 data are presented as a partial brood group. Gray bars and error bars show the percent of sites occupied with the 95%CI for each brood group. P-values for selected comparisons among brood groups are given above the horizontal arrows where p ≤ 0.05.

Effects of Pool Depth on Snorkel Counts

At the onset of the project only pools that were ≥40cm in maximum depth were surveyed. This criterion was refined as a result of The Smith River Verification Study (Constable and Suring, unpublished report). This study used electrofishing removal estimates (Amour et al. 1983) to determine the portion of the total (from all habitats) summer rearing abundances of Coho Salmon and steelhead that was contained in pools that met the ≥40cm in maximum depth criterion. Results of this study indicated pools ≥40cm maximum depth contained an average of 46% of the Coho Salmon and 68% of the steelhead summer rearing abundances. The percentage varied annually over the six-year study; ranging 31-61% for Coho Salmon and 49-82% for steelhead. Pools in the Smith River study area that were ≥20cm in maximum depth, the lowest depth recommended for snorkel surveys (O'Neal 2007), contained an average of 74% of the Coho Salmon and 79% of the steelhead summer rearing distribution. The annual variation in pools this size was 61-82% for Coho Salmon and 54-91% for steelhead. Abundance estimates in pools ≥40cm in maximum depth related moderately to abundance estimates in all habitats for Coho Salmon ($R^2 = 0.791$, $p= 0.007$) and strongly to abundance estimates in all habitats for steelhead ($R^2 = 0.918$, $p= 0.001$). Abundance estimates in pools ≥20cm in maximum depth related strongly to abundance estimates in all habitats for both species (Coho Salmon $R^2 = 0.974$, $p< 0.001$; steelhead $R^2 = 0.936$, $p< 0.001$). Due to these results, the maximum depth criterion was lowered to ≥20cm in 2010.

The lower criterion allowed an additional 1107 pools to be surveyed in 2019 (a 24% increase). Four survey sites did not have pools that were ≥40cm in maximum depth, but did have pools that were ≥20cm in maximum depth. Steelhead were found in one of these sites and this slightly improved our survey effort over the results presented in Table 1 for the Umpqua, Interior Rogue, and Cascade/Gorge strata. Additionally, there were 14 sites that contained pools that were ≥40cm in maximum depth, but where Coho Salmon or steelhead were only observed in pools that were <40cm in maximum depth. The inclusion of these sites changed site occupancy estimates. For Coho Salmon, site occupancy estimates increased by 2% in the SONCC and LCR, by 3% in the Mid-South, and by 7% in the North Coast compared to those given in Table 2. In the remaining strata, site occupancy changed by <1%. Site occupancy estimates for steelhead increased by 1% in the KMP, by 2% in the Mid-South and North Coast, and by 7% in the Mid Coast over those given in Table 3. In the remaining DPS site occupancy rates changed by less than 1%.

Coho Salmon density estimates decreased in most strata in 2010-2013 and in 2016-2018 when the lower criterion was applied. In most cases this was less than a 10% decrease. In 2014 Coho Salmon densities increased by 1-5% in most strata when the lower criterion was applied. In 2019 densities increased by 3% and 4% in the LCR and Umpqua, respectively, and in the remaining strata changed by <3%. Steelhead density estimates decreased by <10% with the lower criterion in each DPS during the years 2010-2015 and 2017-2018. In 2016, a similar decrease was observed in the KMP and in the OC, but the LCR increased by 16% while the SWW decreased by 12%. In 2019 densities decreased with the lower criterion by <10% in all strata except in the North Coast and LCR, where they decreased approximately 13 percent.

Paired t-tests from abundance estimates in 2019 from pools ≥40cm and pools ≥20cm indicate that applying the lower criterion produced significant differences in the abundance estimates of Coho Salmon (Table 4) and steelhead (Table 5) parr in the Oregon Coast ESU/DPS. This was similar to results from 2010-2014 and 2017-2018. As in past years, abundance estimates based on the lower criterion produced proportionally smaller 95% confidence intervals for Coho Salmon and steelhead estimates in most strata (Tables 4 and 5). Resurveys since the adoption of the lower criterion (n=277) have indicated the precision of Coho Salmon counts using the ≥20cm maximum depth criterion (R^2=0.973) was similar to the precision of Coho Salmon counts using the ≥40cm maximum depth criterion (R^2=0.972) (Figure 17). Resurvey results for steelhead since the adoption of the lower criterion also indicated similar precision in counts when the ≥20cm maximum depth criterion was used (R^2=0.766) and when the ≥40cm maximum depth criterion was used (R^2=0.795). The yearly variability for Coho Salmon abundance in each stratum and ESU estimated by surveys in pools ≥40cm in depth has tracked with the variability estimated by surveys in pools ≥20cm in depth (Figure18).

Table 4. Comparison of estimates of Coho Salmon abundance in pools using a maximum depth of ≥20 cm and in pools using a maximum depth of ≥40 cm.

Stratum	2019 Coho Estimates				
	Pools ≥40cm Max Depth		Pools ≥20cm Max Depth		95% CI Difference
	Estimate	95% CI	Estimate	95% CI	
North Coast	588,926	39%	663,059	36%	2.4%
Mid Coast	1,151,923	27%	1,370,458	23%	4.2%
Mid-South Coast	809,809	25%	837,115	25%	-0.2%
Umpqua	682,272	41%	749,281	38%	2.3%
SONCC	54,890	51%	58,943	52%	-0.3%
Lower Columbia	112,044	61%	120,819	58%	3.6%

Table 5. Comparison of estimates of steelhead abundance in pools using a maximum depth of ≥20 and in pools using a maximum depth of ≥40 cm.

Stratum	2019 Steelhead Estimates				
	Pools ≥ 40cm Max Depth		Pools ≥ 20cm Max Depth		95% CI Difference
	Estimate	95% CI	Estimate	95% CI	
North Coast	31,098	46%	35,558	43%	2.2%
Mid Coast	65,430	45%	70,575	42%	2.7%
Mid-South Coast	41,030	36%	41,472	36%	0.2%
Umpqua	47,971	42%	51,588	40%	1.6%
KMP Rogue	22,006	52%	22,204	50%	1.3%
KMP South Coast	37,396	28%	38,214	28%	0.3%
Lower Columbia DPS	4,441	45%	4,498	44%	1.0%
Southwest WA DPS	3,524	52%	3,553	52%	0.0%

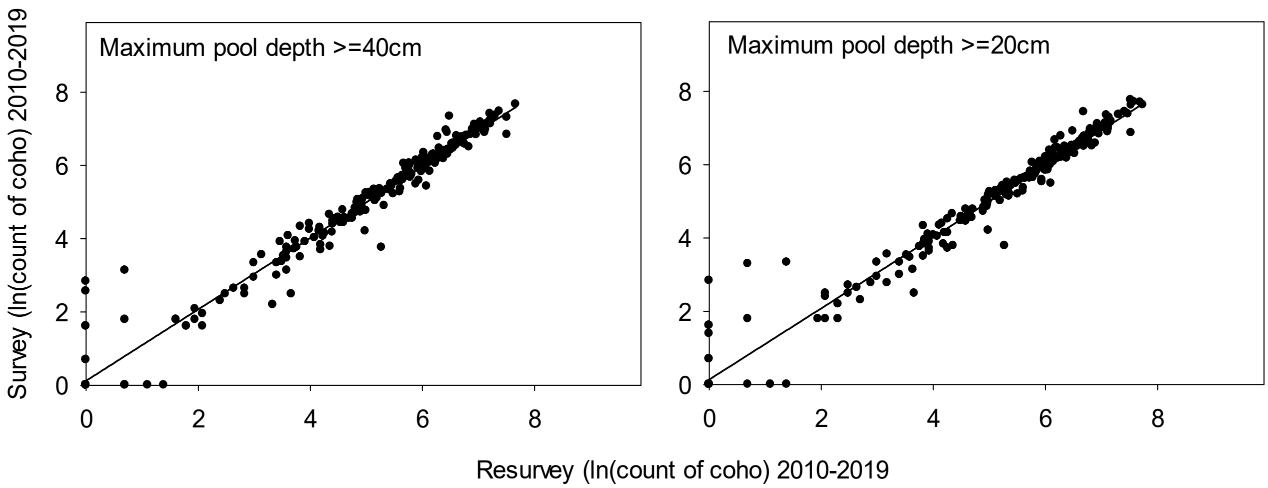


Figure 17. The relationship of Coho Salmon parr counts from surveys and resurveys (n=277) using a maximum pool depth criterion of ≥40cm (left panel) and using a maximum depth criterion of ≥20cm (right panel). Data are log transformed to satisfy regression assumptions.

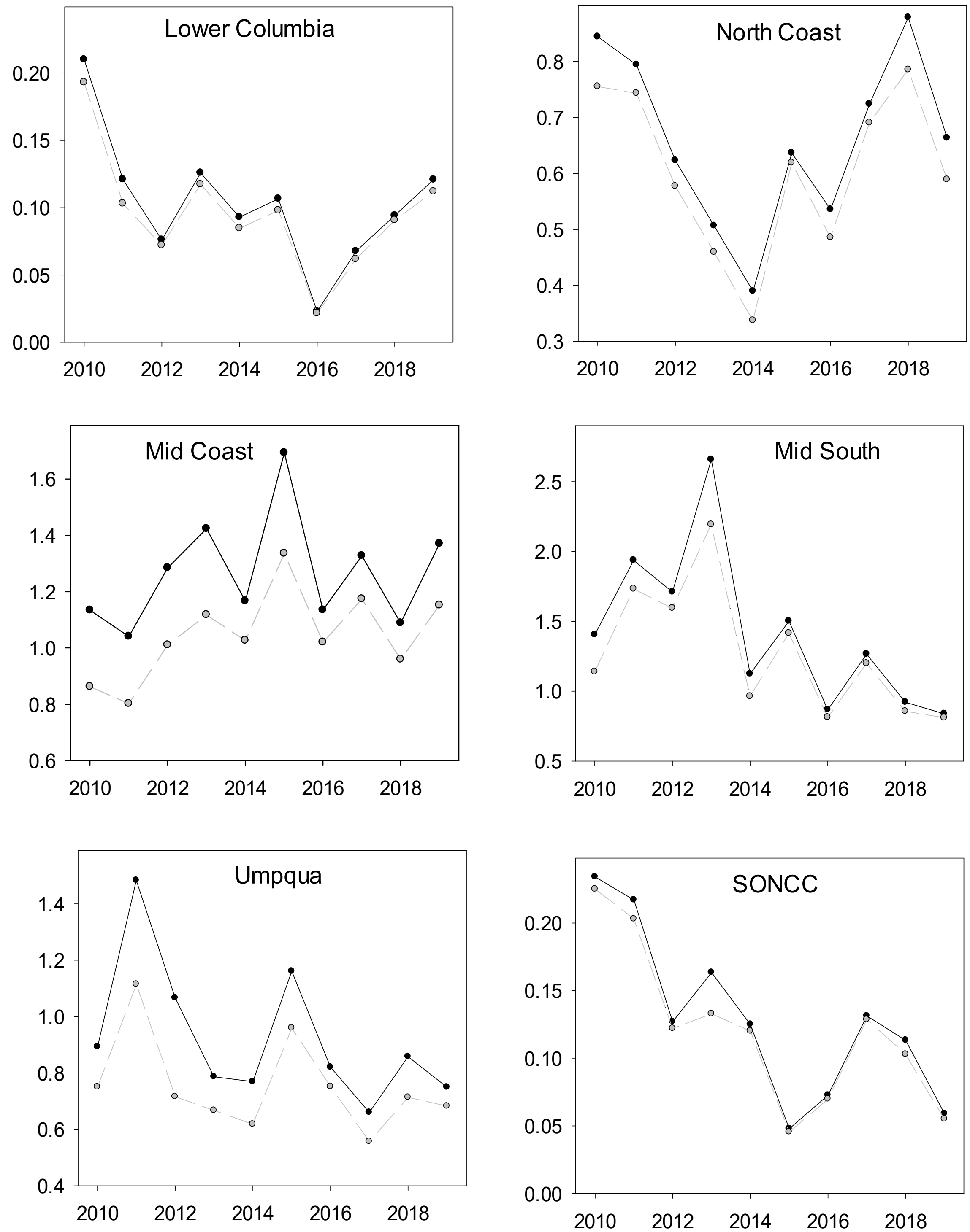


Figure 18. Annual differences in estimates of Coho Salmon parr abundance in western Oregon strata based on snorkel surveys in 1st-3rd order streams using *(i)* a ≥20cm pool depth criterion (solid black line) and *(ii)* a ≥40cm pool depth criterion (dashed gray line). Sample year is on the x-axis and parr abundance is on the y-axis in millions. Note differences in the y-axis scale for each graph.

ACKNOWLEDGEMENTS

Thank you to the field crews and supporting cast for their professional and dedicated work. 2019 was a banner year. The list of people we would like to acknowledge is long, but we feel obligated to mention each by name: Kelsey Anderson, Kara Jaenecke, Frank “Chief Hopper” Drake, Rookie of the year Jesse Vargas, Linda Xiong, Commander Scott Kirby, Wild Bill Ratliff, Wesley Shum, Brent Priz, Eric Bailey, the imperturbable Ryan Emig, Maria Farinacci, Peter Cole, Professor Davies, Chickpea, the salubrious Brandon Smith, Mike Koranda , Brah Josh, NEERMAN!, Dony Carderson, Elijah Schumacher, Jennifer King, Sir Michael Hayworth, Benny Pugh, the intrepid Patrick Kohl, “Pep Talk” Pete Samarin, Anna Lee, Aly Ervin, Javan Bailey, Breyanna Waldsmith, Sharon Crowley, Peggy Kavanagh, Matt Strickland, Matt Weeber (thanks for the adult data), Matt Falcy, and Eric Brown. A big special thanks to Julie Firman for her help with our South Coast sampling frame and to the many, many landowners who granted us permission to survey creeks on their property.

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APPENDIX 1 COHO METRICS

Table 6. Estimated metrics and associated 95% confidence intervals for Coho Salmon parr in the Oregon portion of the Southern Oregon Northern California Coho ESU. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Southern Oregon Northern Californian Coho ESU Coho Parr Estimates								
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI	Pct Full Seeding	±95% CI
1998	176,522	51%	0.051	49%	30	35%	2	3%
1999	116,557	51%	0.218	73%	52	37%	10	9%
2000	112,029	37%	0.061	78%	51	56%	2	3%
2001	223,607	45%	0.265	46%	53	29%	12	10%
2002	325,508	37%	0.442	37%	58	23%	38	8%
2003	215,030	28%	0.413	34%	50	20%	22	8%
2004	157,239	36%	0.148	40%	42	28%	9	6%
2005	286,009	30%	0.296	37%	51	27%	23	9%
2006	168,501	34%	0.110	42%	37	28%	4	4%
2007	276,186	51%	0.227	40%	52	26%	11	8%
2008	285,760	26%	0.360	43%	57	21%	17	8%
2009	190,112	46%	0.141	42%	38	29%	4	3%
2010	140,949	43%	0.056	41%	43	23%	2	2%
2011	185,972	38%	0.114	50%	49	25%	5	5%
2012	128,124	65%	0.045	52%	33	37%	0	0%
2013	166,543	50%	0.323	95%	51	22%	7	6%
2014	118,403	46%	0.062	52%	48	35%	0	0%
2015	64,231	55%	0.026	68%	39	30%	0	0%
2016	89,967	38%	0.083	53%	45	27%	1	2%
2017	120,803	37%	0.074	46%	42	26%	1	2%
2018	101,893	46%	0.053	53%	47	26%	2	3%
2019	54,890	51%	0.040	47%	42	23%	0	0%

Table 7. Estimated metrics and associated 95% confidence intervals for Coho Salmon parr in the Oregon Coast Coho ESU. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Oregon Coast Coho ESU Coho Parr Estimates								
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI	Pct Full Seeding	±95% CI
1998	935,199	30%	0.212	26%	67	11%	12	6%
1999	884,929	26%	0.158	24%	60	13%	6	4%
2000	2,861,072	20%	0.265	16%	79	7%	11	5%
2001	2,969,004	24%	0.407	18%	65	9%	24	8%
2002	3,355,610	21%	0.511	20%	81	6%	25	8%
2003	3,632,891	18%	0.556	19%	78	6%	28	8%
2004	3,319,231	16%	0.454	14%	77	6%	28	9%
2005	3,086,536	15%	0.461	19%	85	5%	20	7%
2006	4,285,481	18%	0.462	14%	82	6%	26	7%
2007	4,120,906	17%	0.470	17%	76	7%	26	8%
2008	3,097,981	18%	0.341	17%	75	8%	15	6%
2009	4,941,814	16%	0.600	14%	83	6%	33	9%
2010	3,503,440	13%	0.392	17%	86	5%	18	6%
2011	4,393,927	13%	0.478	14%	88	5%	22	7%
2012	3,898,052	15%	0.383	12%	83	5%	18	6%
2013	4,436,290	17%	0.613	15%	82	6%	33	9%
2014	2,944,019	24%	0.250	20%	84	7%	8	5%
2015	4,329,397	17%	0.407	16%	77	6%	17	6%
2016	3,069,097	17%	0.273	18%	82	6%	11	5%
2017	3,619,893	17%	0.252	16%	80	7%	6	3%
2018	3,313,424	16%	0.297	14%	80	7%	11	5%
2019	3,232,929	16%	0.241	15%	78	7%	11	4%

Table 8. Estimated metrics and associated 95% confidence intervals for Coho Salmon parr in the North Coast Stratum of the Oregon Coast Coho ESU. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

North Coast Stratum Coho Parr Estimates								
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI	Percent Full Seeding	±95% CI
1998	238,372	71%	0.117	45%	64	25%	0	0%
1999	61,228	57%	0.064	73%	53	29%	3	5%
2000	513,448	39%	0.236	30%	79	14%	9	9%
2001	650,882	40%	0.411	39%	53	23%	27	16%
2002	728,083	39%	0.352	31%	80	12%	17	10%
2003	976,142	33%	0.485	26%	80	13%	29	16%
2004	842,367	30%	0.454	22%	87	9%	26	14%
2005	853,247	28%	0.394	27%	82	9%	15	10%
2006	1,406,547	28%	0.597	23%	88	7%	26	11%
2007	1,017,969	24%	0.717	27%	83	13%	42	26%
2008	370,797	48%	0.156	53%	70	22%	4	6%
2009	829,855	30%	0.627	29%	82	13%	32	17%
2010	775,036	25%	0.394	21%	93	7%	22	15%
2011	742,914	30%	0.476	28%	85	12%	25	16%
2012	577,017	33%	0.331	25%	82	12%	22	12%
2013	459,220	29%	0.317	33%	78	14%	15	13%
2014	337,136	28%	0.223	47%	79	18%	8	11%
2015	618,560	47%	0.492	32%	71	18%	30	20%
2016	485,460	33%	0.219	32%	80	13%	6	7%
2017	690,210	30%	0.225	24%	80	14%	3	4%
2018	784,995	28%	0.413	24%	78	13%	20	13%
2019	588,926	39%	0.290	28%	78	14%	15	11%

Table 9. Estimated metrics and associated 95% confidence intervals for Coho Salmon parr in the Mid Coast Stratum of the Oregon Coast Coho ESU. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Mid Coast Stratum Coho Parr Estimates								
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI	Pct Full Seeding	±95% CI
1998	201,219	46%	0.173	57%	63	18%	12	10%
1999	201,765	49%	0.076	46%	58	26%	0	0%
2000	636,561	34%	0.215	35%	88	11%	5	6%
2001	803,171	31%	0.497	27%	80	12%	28	15%
2002	717,782	35%	0.288	28%	88	10%	10	9%
2003	873,357	35%	0.336	30%	89	9%	17	12%
2004	672,677	32%	0.385	26%	74	16%	26	16%
2005	610,126	27%	0.230	30%	86	8%	2	4%
2006	1,187,999	39%	0.440	26%	87	9%	26	15%
2007	857,588	29%	0.494	35%	78	14%	26	15%
2008	805,066	27%	0.350	31%	83	12%	15	12%
2009	1,345,667	21%	0.578	28%	93	7%	33	18%
2010	834,439	24%	0.480	27%	92	9%	19	13%
2011	802,427	27%	0.336	22%	93	7%	9	8%
2012	1,009,801	23%	0.447	21%	91	8%	24	14%
2013	1,117,548	29%	0.706	20%	89	9%	43	21%
2014	1,025,977	51%	0.202	32%	90	10%	3	6%
2015	1,335,493	22%	0.348	30%	85	10%	8	8%
2016	1,019,727	31%	0.423	29%	92	8%	18	11%
2017	1,173,889	35%	0.318	33%	89	9%	7	6%
2018	959,394	28%	0.278	27%	90	9%	8	7%
2019	1,151,923	27%	0.389	22%	84	11%	18	12%

Table 10. Estimated metrics and associated 95% confidence intervals for Coho Salmon parr in the Mid-South Coast Stratum of the Oregon Coast Coho ESU. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Mid-South Coast Stratum Coho Parr Estimates								
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI	Pct Full Seeding	±95% CI
1998	495,608	40%	0.370	33%	76	17%	24	15%
1999	358,029	46%	0.404	36%	70	18%	22	17%
2000	763,557	40%	0.442	27%	74	15%	29	20%
2001	998,651	56%	0.470	43%	63	24%	30	22%
2002	1,057,355	45%	0.958	33%	81	12%	58	35%
2003	946,047	34%	1.074	41%	75	16%	50	28%
2004	880,565	31%	0.631	32%	85	10%	39	26%
2005	1,114,794	29%	0.643	34%	94	8%	32	23%
2006	1,176,018	37%	0.472	26%	82	14%	30	20%
2007	1,285,252	38%	0.482	32%	84	12%	28	19%
2008	1,329,052	31%	0.698	26%	88	11%	43	27%
2009	1,691,157	30%	0.843	26%	84	11%	44	26%
2010	1,141,767	20%	0.431	28%	90	9%	25	15%
2011	1,733,106	21%	0.699	32%	88	9%	39	21%
2012	1,595,194	28%	0.394	16%	88	9%	10	6%
2013	2,192,920	29%	0.943	24%	85	10%	51	26%
2014	963,062	35%	0.272	36%	93	10%	7	10%
2015	1,415,931	33%	0.426	25%	76	14%	17	12%
2016	812,154	28%	0.293	31%	84	11%	16	13%
2017	1,198,942	25%	0.329	23%	84	12%	14	9%
2018	855,895	36%	0.314	35%	71	17%	14	12%
2019	809,809	25%	0.171	31%	82	13%	5	5%

Table 11. Estimated metrics and associated 95% confidence intervals for Coho Salmon parr in the Umpqua Stratum of the Oregon Coast Coho ESU. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Umpqua Stratum Coho Parr Estimates								
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI	Pct Full Seeding	±95% CI
1999	263,907	44%	0.144	46%	61	25%	4	6%
2000	947,507	40%	0.213	33%	73	16%	7	8%
2001	516,299	47%	0.265	40%	58	17%	13	11%
2002	852,391	44%	0.558	46%	74	14%	23	16%
2003	837,345	35%	0.458	27%	67	14%	23	13%
2004	923,622	36%	0.404	26%	67	15%	22	16%
2005	508,369	35%	0.645	39%	80	14%	34	22%
2006	514,918	39%	0.368	33%	73	17%	23	13%
2007	960,097	34%	0.275	41%	65	15%	13	11%
2008	593,066	41%	0.223	33%	63	19%	5	7%
2009	1,075,136	42%	0.453	30%	73	15%	26	16%
2010	752,199	39%	0.291	54%	72	13%	9	9%
2011	1,115,480	28%	0.477	26%	80	11%	22	15%
2012	716,040	29%	0.349	30%	73	13%	15	10%
2013	666,602	27%	0.498	42%	75	13%	24	15%
2014	617,845	44%	0.295	37%	78	15%	13	12%
2015	959,413	43%	0.401	33%	74	12%	19	12%
2016	751,757	39%	0.174	45%	74	16%	6	7%
2017	556,851	45%	0.164	31%	70	18%	3	5%
2018	713,140	38%	0.226	34%	76	16%	8	8%
2019	682,272	40%	0.128	38%	71	14%	5	6%

Table 12. Estimated metrics and associated 95% confidence intervals for Coho Salmon parr in the Oregon portion of the Lower Columbia River Coho ESU. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Lower Columbia River Coho ESU Coho Parr Estimates								
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI	Pct Full Seeding	±95% CI
2006	113,374	54%	0.103	69%	43	28%	4	7%
2007	115,289	39%	0.130	39%	72	13%	3	5%
2008	214,467	96%	0.076	73%	44	26%	3	6%
2009	136,558	41%	0.068	48%	41	22%	0	0%
2010	179,989	42%	0.108	41%	49	18%	2	4%
2011	103,458	45%	0.188	97%	44	22%	5	6%
2012	72,323	33%	0.066	26%	45	17%	0	0%
2013	117,372	39%	0.078	36%	52	15%	0	0%
2014	84,705	57%	0.052	42%	44	23%	0	0%
2015	97,896	28%	0.116	34%	46	19%	2	3%
2016	21,627	55%	0.011	57%	24	31%	0	0%
2017	61,780	43%	0.050	42%	39	20%	1	2%
2018	90,675	41%	0.069	38%	45	20%	2	3%
2019	112,044	61%	0.096	59%	46	19%	3	3%

APPENDIX 2 STEELHEAD METRICS

Table 13. Estimated metrics and associated 95% confidence intervals for steelhead parr in the Oregon portion of the Klamath Mountains Province Steelhead DPS. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Klamath Mountains Province Steelhead DPS Steelhead Parr Estimates						
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI
2002	202,091	34%	0.091	28%	83	8%
2003	121,823	19%	0.059	20%	90	6%
2004	131,678	18%	0.069	20%	97	4%
2005	177,326	18%	0.062	16%	94	5%
2006	133,153	28%	0.052	23%	90	7%
2007	196,727	20%	0.098	29%	93	7%
2008	200,838	27%	0.057	21%	93	5%
2009	191,378	31%	0.057	22%	89	7%
2010	205,008	20%	0.065	24%	94	5%
2011	188,466	18%	0.060	19%	92	6%
2012	146,020	20%	0.038	27%	80	9%
2013	167,523	18%	0.034	18%	83	7%
2014	131,396	26%	0.059	34%	87	11%
2015	71,675	30%	0.026	25%	85	8%
2016	109,079	28%	0.028	26%	70	12%
2017	115,284	21%	0.029	22%	79	10%
2018	79,917	35%	0.018	32%	81	8%
2019	59,402	26%	0.014	24%	57	13%

Table 14. Estimated metrics and associated 95% confidence intervals for steelhead parr in the Rouge Stratum of the Klamath Mountains Province steelhead DPS. Data are from un-calibrated snorkel surveys in 1^{st}-3^{rd} order streams. The 95% confidence interval is express as a percentage of the estimate.

Klamath Mountains Province Rouge Stratum Steelhead Parr Estimates						
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI
2002	76,150	23%	0.080	38%	78	10%
2003	42,583	32%	0.056	26%	87	8%
2004	76,930	27%	0.069	25%	96	5%
2005	105,148	26%	0.064	19%	94	5%
2006	86,038	42%	0.052	28%	90	8%
2007	107,054	26%	0.107	33%	91	9%
2008	125,545	41%	0.056	25%	92	7%
2009	116,343	44%	0.061	24%	87	8%
2010	149,522	25%	0.067	28%	93	6%
2011	122,431	20%	0.065	21%	90	8%
2012	74,258	27%	0.028	41%	77	12%
2013	71,877	23%	0.028	23%	78	10%
2014	77,646	42%	0.063	40%	83	14%
2015	51,751	40%	0.025	31%	80	11%
2016	48,920	47%	0.020	37%	66	16%
2017	25,358	33%	0.022	32%	76	12%
2018	22,670	39%	0.012	39%	77	10%
2019	22,006	51%	0.007	34%	45	21%

Table 15. Estimated metrics and associated 95% confidence intervals for steelhead parr in the South Coast Stratum of the Klamath Mountains Province steelhead DPS. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is express as a percentage of the estimate.

Klamath Mountains Province South Coast Stratum Steelhead Parr Estimates						
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI
2002	125,941	53%	0.130	32%	100	0%
2003	79,240	22%	0.069	20%	100	0%
2004	54,748	19%	0.070	23%	100	5%
2005	72,178	24%	0.057	20%	93	9%
2006	47,115	24%	0.053	18%	93	8%
2007	89,672	32%	0.058	33%	100	0%
2008	75,293	27%	0.061	24%	100	0%
2009	75,035	39%	0.043	35%	97	5%
2010	55,486	21%	0.057	24%	100	0%
2011	66,034	35%	0.042	27%	97	5%
2012	71,762	31%	0.073	30%	90	11%
2013	95,646	28%	0.055	25%	100	0%
2014	53,750	35%	0.044	22%	100	0%
2015	19,924	31%	0.027	23%	100	0%
2016	60,159	39%	0.060	35%	85	13%
2017	89,926	24%	0.058	27%	89	13%
2018	57,247	46%	0.045	50%	94	8%
2019	37,396	28%	0.039	33%	100	0%

Table 16. Estimated metrics and associated 95% confidence intervals for steelhead parr in the Oregon Coast Steelhead DPS. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Oregon Coast Steelhead DPS Steelhead Parr Estimates						
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI
2002	183,127	20%	0.035	26%	68	9%
2003	241,263	22%	0.035	17%	79	7%
2004	169,713	21%	0.032	17%	73	7%
2005	288,482	22%	0.047	26%	77	6%
2006	204,924	17%	0.028	19%	72	8%
2007	219,687	25%	0.030	21%	71	8%
2008	229,564	20%	0.030	21%	68	9%
2009	230,839	21%	0.043	19%	72	8%
2010	290,410	19%	0.034	20%	78	7%
2011	275,137	19%	0.038	14%	83	5%
2012	226,411	14%	0.032	15%	81	25%
2013	292,388	21%	0.047	17%	79	24%
2014	274,672	24%	0.029	18%	88	34%
2015	136,759	23%	0.015	28%	65	18%
2016	247,939	19%	0.020	17%	73	22%
2017	313,308	20%	0.021	16%	84	29%
2018	166,980	20%	0.018	19%	71	19%
2019	185,529	22%	0.014	17%	72	8%

Table 17. Estimated metrics and associated 95% confidence intervals for steelhead parr in the Oregon portion of the Lower Columbia River Steelhead DPS. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Lower Columbia River Steelhead DPS Steelhead Parr Estimates						
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI
2006	30,142	47%	0.045	30%	78	18%
2007	21,259	51%	0.036	43%	67	26%
2008	9,965	47%	0.010	88%	61	31%
2009	11,920	80%	0.015	56%	58	24%
2010	23,497	55%	0.034	31%	66	19%
2011	16,102	53%	0.036	51%	67	23%
2012	12,148	64%	0.024	40%	61	31%
2013	18,283	40%	0.023	40%	68	40%
2014	12,495	49%	0.015	32%	89	93%
2015	2,676	52%	0.007	37%	50	30%
2016	2,905	42%	0.006	39%	46	29%
2017	8,870	88%	0.013	67%	60	33%
2018	5,067	41%	0.011	46%	57	28%
2019	4,441	45%	0.011	50%	60	21%

Table 18. Estimated metrics and associated 95% confidence intervals for steelhead parr in the Oregon portion of the Southwest Washington Steelhead DPS. Data are from un-calibrated snorkel surveys in 1st-3rd order streams. The 95% confidence interval is expressed as a percent of the estimate.

Southwest Washington Steelhead DPS Steelhead Parr Estimates						
Year	Abundance	±95% CI	Density	±95% CI	Site Occupancy	±95% CI
2006	6,333	74%	0.014	71%	53	39%
2007	10,874	103%	0.017	75%	54	31%
2008	30,671	50%	0.023	43%	62	27%
2009	16,540	35%	0.027	44%	69	18%
2010	20,996	38%	0.036	35%	79	18%
2011	10,815	41%	0.029	41%	66	17%
2012	13,339	45%	0.024	30%	80	50%
2013	9,824	30%	0.023	37%	83	59%
2014	9,411	82%	0.021	46%	68	49%
2015	2,422	74%	0.007	80%	42	23%
2016	20,362	52%	0.022	28%	69	41%
2017	2,026	42%	0.004	54%	42	20%
2018	2,525	48%	0.003	54%	45	24%
2019	3,524	52%	0.003	39%	54	27%

Fish & Wildlife

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