

# THE OREGON PLAN *for* *Salmon and* *Watersheds*



**Juvenile Salmonid Monitoring  
In Coastal Oregon and Lower Columbia  
Streams, 2015**

**Report Number: OPSW-ODFW-2016-1**



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**Juvenile Salmonid Monitoring in Coastal Oregon and Lower Columbia Streams,  
2015**

**Oregon Plan for Salmon and Watersheds**

**Annual Monitoring Report No. OPSW-ODFW-2016-1**

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## SUMMARY

This report analyzes data from juvenile salmonid surveys in the three coho Evolutionarily Significant Units (ESU) and the four steelhead Distinct Population Segments (DPS) in coastal Oregon for 2015. Results from 2015 are compared to previous years and used to describe trends in distribution and abundance. To access prior reports visit <https://nrimp.dfw.state.or.us/crl/default.aspx?pn=WORP>.

### Coho:

Density estimates in 2015 for the Oregon Coast Coho (OCC) ESU were higher than in 2014, but similar to the 1998-2014 average for the ESU. Abundance estimates in 2015 were similar to 2004-2014, but higher than those in 1998-2003. Site occupancy rates appeared to be increasing for the ESU since the start of our monitoring in 1998, although the rate from 2015 was lower than in 2014. The average occupancy rate from 2010-2015 has been similar to the average from 2004-2009 and higher than the average from 1998-2003. In the ESU plots of parr abundance against female spawner abundance suggest limits in freshwater habitat to parr production when spawner abundance exceeds approximately 80,000 females. Parr production rates in the ESU typically decrease when female spawner abundance increases.

The density, number of sites at full seeding, occupancy, and pool frequency estimates in 2015 for the Southern Oregon Northern California Coho (SONCC) ESU were the lowest recorded since our monitoring began. Abundance estimates of parr from 2013-2015 were lower than those from 2001-2012 and similar to those from 1998-2000. Occupancy estimates for the last 4 cohorts have been the lowest recorded since monitoring began.

Density estimates in 2015 for the Lower Columbia River Coho (LCR) were higher than in 2014 but similar to the average from 2006-2014 for the ESU. Abundance estimates of parr in 2015 were similar to the estimate in 2014 and to the 2006-2014 average. Site occupancy rates in 2015 were similar to the 2014 rate and the average rate from 2006-2014.

### Steelhead:

The density, abundance, and occupancy rate estimates in 2015 for Oregon Coast Steelhead DPS were lower than in 2014 and lower than the 2002-2014 average for the DPS. The four cohorts previous to 2015 have had the four highest occupancy rates.

Density in 2015 for the Klamath Mountain Province was lower than in 2014 and lower than the 2002-2014 average for the DPS. The 2015 and 2014 abundance estimates were the 1<sup>st</sup> and 2<sup>nd</sup> lowest recorded in the DPS. Site occupancy in 2015 was similar to 2014 and to the 2002-2014 average for the DPS.

As in past years, the 2015 metrics for the two steelhead DPSs in the Lower Columbia River had similar metrics. Densities, pool frequencies, and point estimates for site occupancy and abundance were the lowest recorded in 2015.

The original pool depth criteria was  $\geq 40$ cm in maximum depth. This was changed to  $\geq 20$ cm in 2010. Analyses based on the  $\geq 20$ cm maximum depth criteria typically produce larger abundance estimates with proportionately smaller confidence intervals than analyses based on the  $\geq 40$ cm maximum depth criteria. Abundance estimate trends that included shallow pools tracked with those based on the former pool criteria.

## INTRODUCTION AND METHODS

As part of the Oregon Plan for Salmon and Watersheds, the Oregon Department of Fish and Wildlife (ODFW) initiated this project in 1998 to monitor the abundance and distribution of juvenile coho salmon (*Oncorhynchus kisutch*) in coastal Oregon streams (Figure 1). Originally the project surveyed 1<sup>st</sup>-3<sup>rd</sup> order (wadeable) streams within the rearing distribution of coho in the Oregon Coast Coho (OCC) and Southern Oregon Northern California Coho (SONCC) Evolutionarily Significant Units (ESU). In 2002 surveys were added for juvenile steelhead (*Oncorhynchus mykiss*) in the Klamath Mountain Province (KMP) and Oregon Coast Distinct Population Segments (DPS). In 2002 surveys were also added in 4<sup>th</sup>-6<sup>th</sup> order (non-wadeable) streams. In 2006, the Oregon portions of the Lower Columbia River (LCR) coho ESU and steelhead DPSs were included. Surveys in 4<sup>th</sup> to 6<sup>th</sup> order streams were discontinued in 2009 for the Oregon Coast Coho ESU, in 2012 for the Lower Columbia Coho ESU, and in 2013 for the SONCC.

A Generalized Random Tessellation Stratified design (GRTS, Stevens 2002) was used to select sampling locations (GRTS points) in a spatially balanced, random fashion from within our sampling frame. The original sampling frame, based on a 100k stream layer for the Oregon Coast ESU, was replaced by a frame based on a 24k stream layer in 2007. The 24k frame considered a greater expanse of streams to be within the rearing distribution of coho and steelhead and included distribution in the Oregon portions of the Lower Columbia River coho ESU and steelhead DPSs. Analyses for all years for the Oregon Coast and Lower Columbia ESUs are currently based on the 24k frame. In 2012 a 24k sampling frame was developed for the SONCC/KMP. During development of the SONCC frame a larger expanse of streams was determined to be within salmonid rearing distribution than was formerly assessed. Until the 2012 frame is corroborated by field surveys, analyses in the SONCC/KMP will be based the assumed former distribution. Our sampling frame and survey design are described in detail by Jepsen and Rodgers (2004) and Jepsen and Leader (2007).

GRTS was used to select sample sites that were stratified by Monitoring Area (MA) and stream order (Table 1). Field crews surveyed a one kilometer stream reach encompassing the GRTS points (x, y coordinates) during base flow conditions. Within the reach, all pools that are  $\geq 20$ cm deep and  $\geq 6$  m<sup>2</sup> in surface area were snorkeled with a single pass to identify and enumerate juvenile salmonids. Hard counts were made of all juvenile coho and chinook regardless of length and of steelhead and cutthroat  $\geq 90$  mm in fork length. Presence was noted for dace, shiners, and trout  $< 90$  mm in fork length. Freshwater mussel presence and beaver activity were also noted. Sites with poor water clarity or quality were electrofished using a single pass without block nets to determine pool occupancy for coho and site occupancy for steelhead and cutthroat. For quality control and to assess precision approximately 15% of surveys are resurveyed by supervisory staff.

Data are summarized and presented by ESU, MA, and/or DPS and by stream order. Cumulative Distribution Function (CDF) graphs, variances, and confidence intervals were created using tools developed by the EMAP Design and Analysis Team (EPA 2009). When making year-to-year, year-to-average, and brood group to brood group comparisons we considered a p-value  $\leq 0.05$  to indicate a significant difference. The following measures of fish distribution and abundance were calculated independently for coho and steelhead.



- Site occupancy
  - The percent of sites with at least one fish, calculated by dividing the number of sites with fish by the number of surveyed sites for each MA, ESU, or DPS. Site occupancy is also calculated for cutthroat.
- Pool frequency
  - The average percent of pools in a site that contain at least one fish. Pool frequency is first calculated at each site by dividing the number of pools with fish by the total number of surveyed pools. The resulting percent at each site is then averaged to obtain the estimated percent within the MA, ESU, or DPS.
- Fish density
  - The number of fish divided by the surface area of the pool which contained them. Density is first calculated for each pool in a site. The average density of all the pools in a site is the site density. Site densities are then averaged to produce density estimates within a MA, ESU, or DPS.
- Pool abundance estimates
  - The estimate of the number of fish in pools for each MA, ESU, or DPS. Pool abundance estimates are calculated by multiplying the fish per kilometer at each site by the site weight. Fish per kilometer is the sum of the snorkel count at the site divided by the length of the site. Site weight is the total length (kilometers) of the rearing distribution in the MA, ESU, or DPS divided by the number of successfully surveyed sites in the area, adjusted for non-target sites (Stevens 2002). Pool abundance estimates provided in this report are based on un-calibrated snorkel counts in pools that meet size criteria. As such they do not represent total abundance estimates, but are appropriate for assessing trends.
- Percent full seeding
  - The percent of sites with average fish density  $\geq 0.7$  coho/m<sup>2</sup>. This value is regarded as full seeding Nickelson et al. (1992) and Rodgers et al. (1992). Nickelson et al. estimate full seeding to be 1.0 coho/m<sup>2</sup> from electrofishing removal estimates and Rodgers et al. report that snorkelers observed 70% of the coho in electrofishing removal estimates.

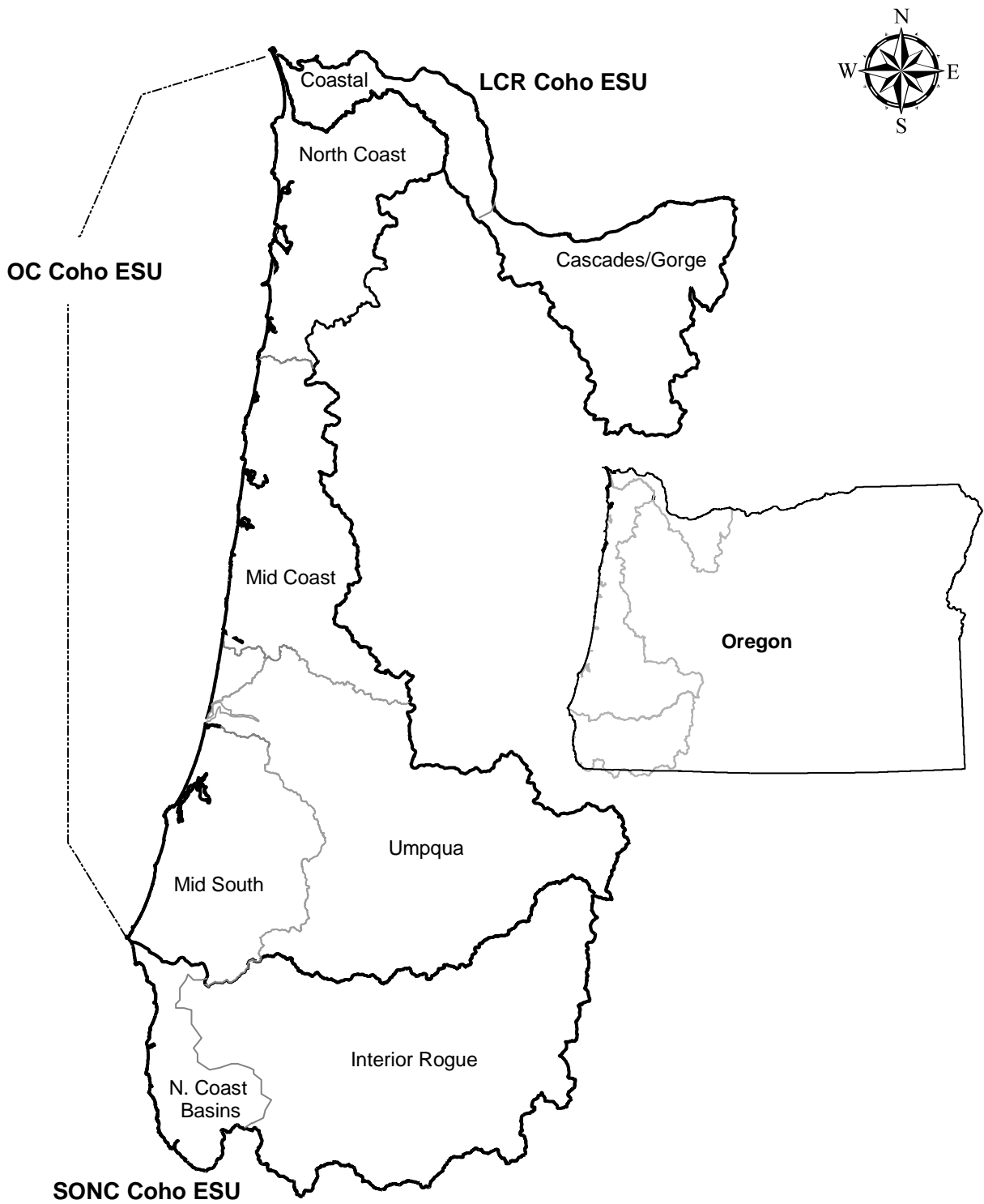


Figure 1. The spatial extent of the study area showing the Oregon portion of coho ESUs and the monitoring areas/strata within each ESU.

In 2015, the 18<sup>th</sup> season of juvenile coho monitoring in the OCC and SONCC ESUs was completed, yielding 18 years of distribution and abundance data. To facilitate analyses across this time, occupancy and abundance estimate data were pooled for each three-year interval into six successive brood groups, based on the conventional three-year coho life cycle (reviewed by Weitkamp et al., 1995). Analyses based on brood groups will supplement analyses based on a year-to-year or year-to-average condition. Comparisons among brood groups (as opposed to individual cohorts or years), can assist long term analysis by moderating variation in brood lines, i.e. comparing a weak brood line to a strong brood line, and allow the detection of trends among composites of the three cohorts across time, giving a more complete picture of coho summer rearing abundance than an individual year. Brood groups provide a much greater sample size that can result in smaller confidence intervals which provide added sensitivity for trend detection.

Juvenile steelhead data was pooled into brood groups following the 2015 field season. Steelhead brood groups were based on a typical four-year life cycle (reviewed by Busby et al., 1996). In the Lower Columbia River coho data was pooled following the 2015 field season and steelhead will be following the 2017 season.

Our depth criterion was changed from  $\geq 40$ cm to  $\geq 20$ cm in 2010 when data from the Smith River Verification study (Constable and Suring, in prep.) was analyzed. The study suggested lowering the maximum depth threshold to  $\geq 20$  cm would allow surveyors to sample a larger and more consistent portion of juvenile coho and steelhead summer abundance. In order to compare current data to that from previous years, reports following the 2010 field season include an analysis of data from pools meeting the  $\geq 40$ cm depth criterion and a second analysis of data from pools meeting the new depth criterion.

## **RESULTS**

### **Survey Effort and Resurveys**

In 2015 we selected 502 sites within our sampling frame. Thirty seven of these sites were non-target (either above barriers to anadromy, in tidal areas, or beyond the distribution of potential coho and steelhead rearing habitat). Of the remaining 465 sites, 92 were not surveyed because of landowner access restrictions, 34 were un-sampleable, 5 were inaccessible, and 22 were not visited due to time restrictions. Sites that were not surveyed are assumed to be target, non-response.

A total of 3,647 pools in 312 sites were surveyed; 292 of these sites were snorkeled and 20 were electrofished. We met our goals for survey effort only in the Mid Coast Monitoring Area (Table 1). We were within 90% of the survey effort goal in all other monitoring strata except the SONCC. Access to private land was denied more frequently in the Interior Rogue than in other monitoring areas and the stratum had a much higher proportion of sites that were dry (non-target). Landowner denial rates were also high in the Coast stratum of the LCR. The high proportion of non-response sites in the Cascades/Gorge stratum of the LCR was due to poor visibility from glacial till in streams originating on Mt. Hood.

Table 1. Survey effort goals and status for 2015 sites.

ESU	Stratum	Survey Goal	Snorkeled	Electrofished	Target -Non response	Non-Target
OCC	North Coast	40	30	8	14	6
	Mid Coast	40	40	0	18	0
	Mid-South Coast	40	36	1	16	4
	Umpqua	40	37	2	14	3
LCR	Coast	40	33	3	26	0
	Cascades/Gorge	40	34	4	26	6
SONCC	Interior Rogue	60	47	2	30	15
	N. Coast Basins	40	35	0	7	3

The goal of a 95% confidence interval  $\leq 30\%$  of the density estimate was only met in the Mid Coast and Mid-South Coast monitoring areas (Table 2). All other monitoring areas, with the exception of the SONCC, had 95% CIs that were  $< 35\%$  of the estimate. Low precision in the SONCC is common in most years due to the difficulties in obtaining access to streams that can be surveyed (have water) and the high variation of coho abundance within the strata's streams.

Table 2. Distribution and density estimates for juvenile coho from snorkel surveys in western Oregon streams, summer 2015.

Monitoring Area	Distribution			Density		
	Site Occupancy	Mean Pool Frequency	95% CI	Percent Sites > 0.7 coho/m <sup>2</sup>	Mean Average Pool Density (coho/m <sup>2</sup> )	95% CI
North Coast	71%	63%	± 19%	30%	0.492	± 32%
Mid Coast	85%	77%	± 10%	8%	0.348	± 30%
Mid-South Coast	76%	70%	± 15%	17%	0.426	± 25%
Umpqua	74%	65%	± 11%	19%	0.401	± 33%
South Coast Coho	28%	15%	± 32%	2%	0.019	± 66%
Lower Columbia	46%	39%	± 20%	0%	0.116	± 34%

Twenty-nine (10%) of the snorkeled sites were resurveyed by supervisory staff. Three of the resurveyed sites that were completed during the first week of our field season identified difficulties with fish identification. These problems were corrected by additional training and the resurvey data was used in place of the original survey data. These three resurveys were not used to examine the precision of our methodology. The remaining 26 resurveyed sites were used to inform the precision and repeatability of our methodology. The significant relationship between counts of coho in surveys and resurveys (Figure 2, top left panel,  $R^2 = 0.995$ ) was similar to previous years (bottom left panel,  $R^2 = 0.947$ ) and indicated our snorkel counts of coho were precise and repeatable. Resurvey counts of steelhead were more variable (top right panel,  $R^2 =$

0.698) than coho in 2015, and this was similar to previous years (bottom right panel,  $R^2 = 0.776$ ).

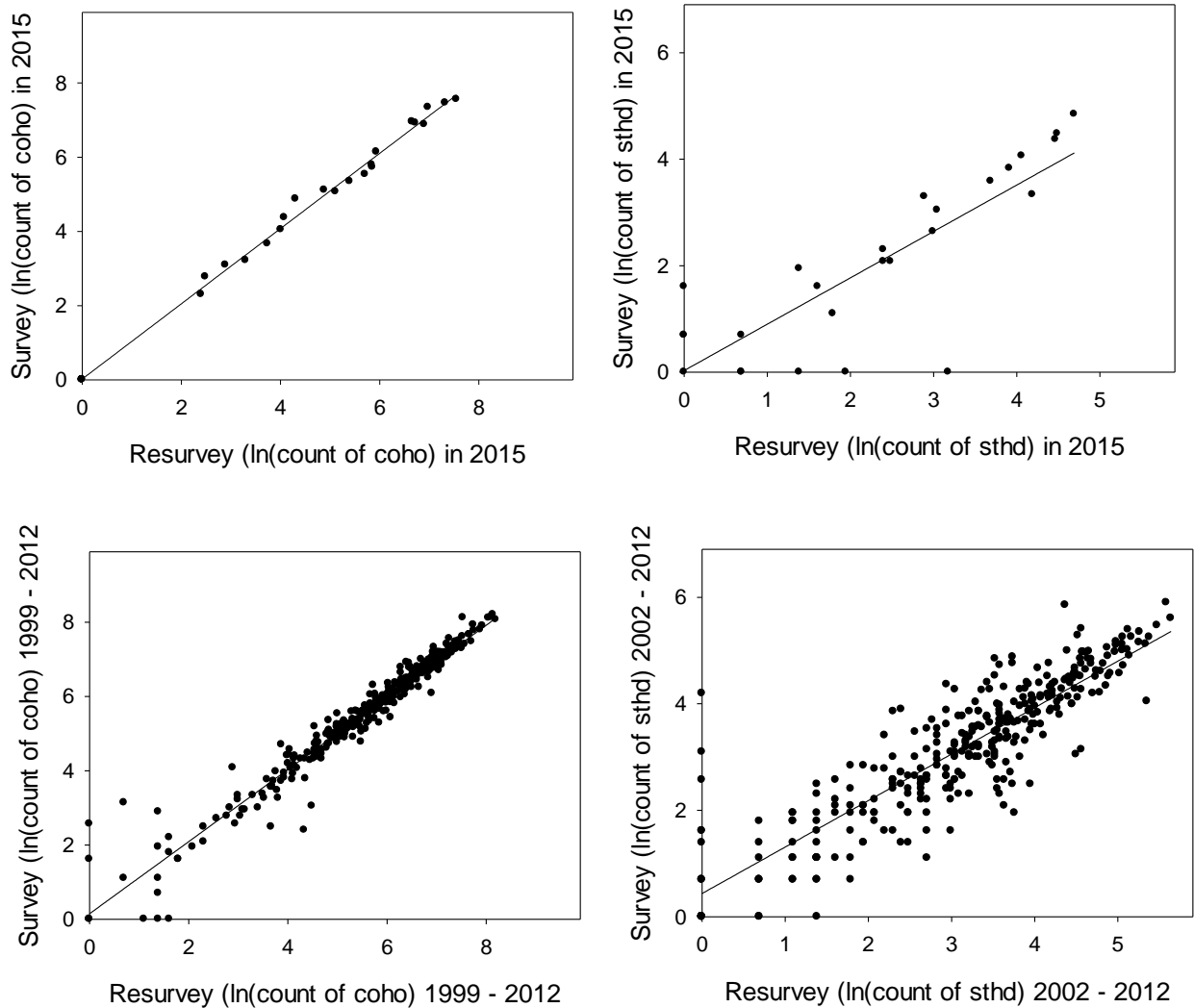


Figure 2. The relationship between counts of juvenile coho and steelhead in surveys and resurveys of the same sites for 2015 (top panels,  $n = 26$ ) and for all years (bottom panels,  $n = 414$  for coho and  $n = 360$  for steelhead, respectively). Data are log transformed to satisfy regression assumptions.

## Trends in Salmonid Distribution and Abundance

### Oregon Coast Coho

In the North Coast, Mid-South Coast, and Umpqua the CDF curve in 2015 was similar to the average condition (Figure 3). In the Mid Coast the curve was below the average condition.

Densities in 2015 were higher than 2014 for the North Coast, Mid Coast and Mid-South Coast (Figure 4). For the Umpqua, density in 2015 was similar to 2014. The percent of fully seeded sites in 2015 was similar to 2014 for the Mid Coast, Mid-South Coast and the Umpqua. The percent of fully seeded sites in 2015 was higher than in 2014 for the North Coast. Density for the ESU in 2015 was 0.41 coho/m<sup>2</sup>, which was higher than in 2014 and similar to the average density from 1998-2014 (Figure 5). Percent full seeding in 2015 was higher than in 2014 and similar the average estimate from 1998-2014 (Figure 5).

Pool abundance estimates for the ESU are combined by three-year periods to form six successive brood groups (Figure 6). The estimate for a brood group is the total of its three annual estimates. The 2013-2015 brood group had a pool abundance estimate that was similar to the three preceding groups, and higher than estimates for the earliest two groups (1998-2000 and 2001-2003). The pool abundance estimate in 2015 was higher than in 2014.

In all MAs the earliest brood group (1998-2000) had a lower pool abundance estimate than any other brood group (Figure 7). In the North Coast the pool abundance estimate in 2015 was similar to 2014. The 2013-2015 brood group in the North Coast had a lower pool abundance estimate than that of the four preceding groups (but higher than the 1998-2000 group). In the Mid Coast the 2015 pool abundance estimate was similar to the 2014 estimate. The 2013-2015 brood group in the Mid Coast had a higher pool abundance estimate than all of the preceding groups, with the exception of the 2007-2009 group. In the Mid-South Coast the 2015 pool abundance estimate was similar to the 2014 estimate. The three most recent brood groups in the Mid-South Coast had similar pool abundance estimates and these estimates were higher than those for the first three brood groups. The 2015 pool abundance estimate for the Umpqua was similar to the 2014 estimate. The five most recent brood groups in the Umpqua had similar pool abundance estimates, all of which were higher than the estimates for the first group.

Site occupancies are also pooled into brood groups for the OCC ESU (Figure 8). Site occupancies in the 2013-2015 brood group and 2010-2012 brood group were similar. The 2015 site occupancy estimate was lower than the estimate in 2014. Site occupancies in the ESU have increased in each successive brood group except between the 2004-2006 and 2007-2009 groups and between the 2010-2012 and 2013-2015 groups, where there were not significant differences.

In all MAs except the Umpqua, site occupancies in the 2013-2015 group were higher than in the earliest group (Figure 9). In the North Coast site occupancy in the 2013-2015 brood group was lower than the estimate for the 2010-2012 brood group and similar to the three groups from 2001 to 2009. The estimate in 2015 for the North Coast was lower than the estimate in 2014. In the Mid Coast occupancy for the 2013-2015 brood group was similar to the four preceding groups, all of which were higher than the

first group. The estimate in 2015 for the Mid Coast was lower than the 2014 estimate. In the Mid-South Coast the occupancy for the 2013-2015 brood group was lower than the estimate for the 2010-2012 brood group, but higher than the first two brood groups and similar to the two groups from 2004 to 2009. The 2015 site occupancy estimate in the Mid-South Coast was lower than in 2014. For the Umpqua the estimate for the 2013-2015 brood group was similar to the estimate for the 2010-2012 brood group. These two groups were higher than the 2001-2003 and 2007-2009 groups but similar to the 1998-2000 and 2004-2006 groups. The 2015 site occupancy estimate in the Umpqua was similar to the estimate in 2014.

Plots of parr abundance against the abundance of female spawners which produced them suggest parr production was limited in the ESU at current spawner levels (Figure 10). In years where female spawners number approximately 80,000 or less (1997-2001, 2005-2007, and 2012-2013) there is a positive relationship between increased female abundance and higher estimates of parr ( $R^2 = 0.644$ ), but in years when female spawner abundance exceeds approximately 80,000 (2002-2004, 2008-2011, 2014) there does not appear to be a corresponding increase in parr ( $R^2 = 0.015$ ).

The number of parr produced per female was high when female spawner abundance was low and decreased when the number of spawners increased (Figure 11). The number of parr per female ranged from 58 in brood year 2011 (which had the second highest number of females) to 324 in brood year 1999 (which had the 3<sup>rd</sup> lowest female abundance). It is important to note that parr abundance given in the figure was from un-calibrated visual estimates conducted only in pools meeting protocol criteria. Actual parr numbers are likely to be higher, although production would still seem to be limited above 80,000 female spawners and the relationship of decreased parr production to increases in spawner abundance would remain the same. The lack of a corresponding increase in parr as female spawner abundances increase above 80,000 did not seem to be an effect of parr “spilling over” into less optimal habitats, such as riffles, where they would not be observed by snorkelers using our protocols. The number of fully seeded sites in years of high spawner abundance averaged 24%, which is similar to years of low spawner abundance.

## **Southern Oregon Northern California Coho**

In 2015 the average density in pools was 0.019 fish/m<sup>2</sup> and 0% of the sites were fully seeded (Table 2) for the second year in a row. Coho occurred in 28% of the sites in the ESU and pool frequency was 15%. Density and the percent of sites fully seeded are shown in Figure 4. The metrics (density, full seeding, occupancy, and pool frequency) from 2015 were the lowest recorded in the ESU. Pool abundance estimates from the 2013-2015 brood group are lower than the four preceding brood groups and similar to the first group in 1998-2000 (Figure 6). Although the point pool abundance estimate for 2015 was nearly three times smaller than the point estimate in 2014, there was not a significant difference due to the high standard errors in these years. Site occupancy for the 2013-2015 brood group was similar to the preceding group (Figure 8). The 2013-2015 and 2010-2012 brood groups had lower occupancies than any of the preceding groups. The occupancy estimate for 2015 was similar to 2014. Occupancy estimates from 2012 to 2015 were the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 1<sup>st</sup> lowest recorded, respectively.

Regressions of both site occupancy and pool abundance estimates to survey year do not show detectable trend since monitoring began in 1998.

## Lower Columbia Coho

The 2015 mean average density in pools was 0.116 fish/m<sup>2</sup> and coho occurred in 46% of 1<sup>st</sup>-3<sup>rd</sup> order stream reaches with a mean pool frequency of 39% (Table 2). 1.6% of the sites were fully seeded in the ESU. Density estimates and estimates of full seeding are shown in Figure 4. The 2015 density estimate was higher than in 2014, and similar to the average of the density estimates from 2006-2014. Although no sites were fully seeded in 2014, the average rate of full seeding for the ESU since 2006 is 2% with a high standard error, consequently 2015 was similar to this average. Pool abundance estimates in 2015 were similar to 2014 (Figure 6). Pool abundance estimates for the 2013-2015 brood group were similar to the preceding groups, although this is at least partially due to the large standard error in the first brood group. Site occupancy in 2015 was similar to 2014. Site occupancy for the 2013-2015 brood groups is similar to the 2010-2012 and 2007-2009 groups (Figure 8).

Regressions of both site occupancy and pool abundance estimates to survey year do not show detectable trends since monitoring began in 2006.



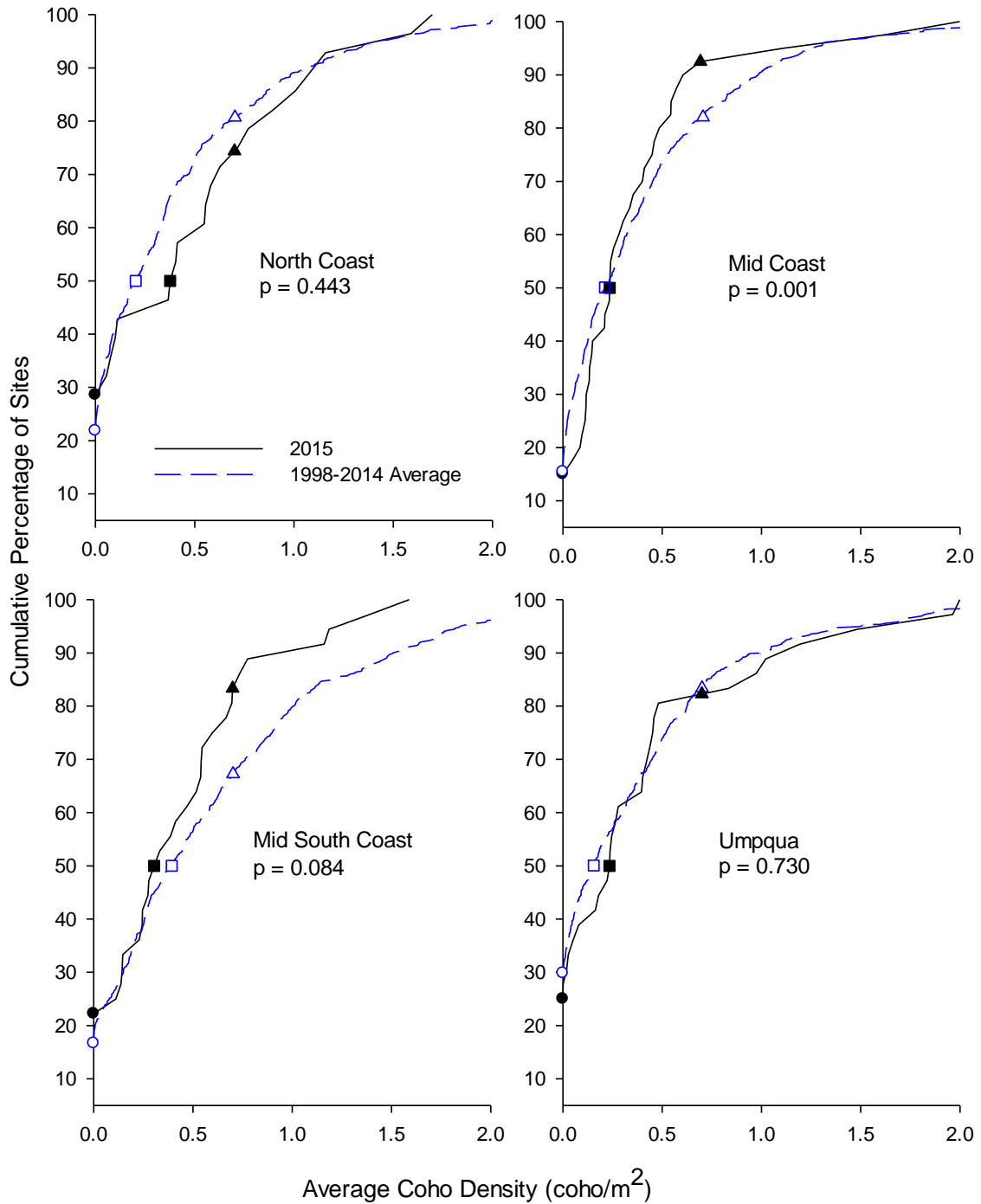


Figure 3. Average coho density CDFs from snorkeled tributary sites for the four monitoring areas of the Oregon Coast Coho ESU comparing 2015 with the average from 1998-2014. P values are for the comparison test of the two curves. The points shown on the curves (from left to right) are the percentage of unoccupied sites (circles), the median density (squares), and the percentage of sites below full seeding (triangles).

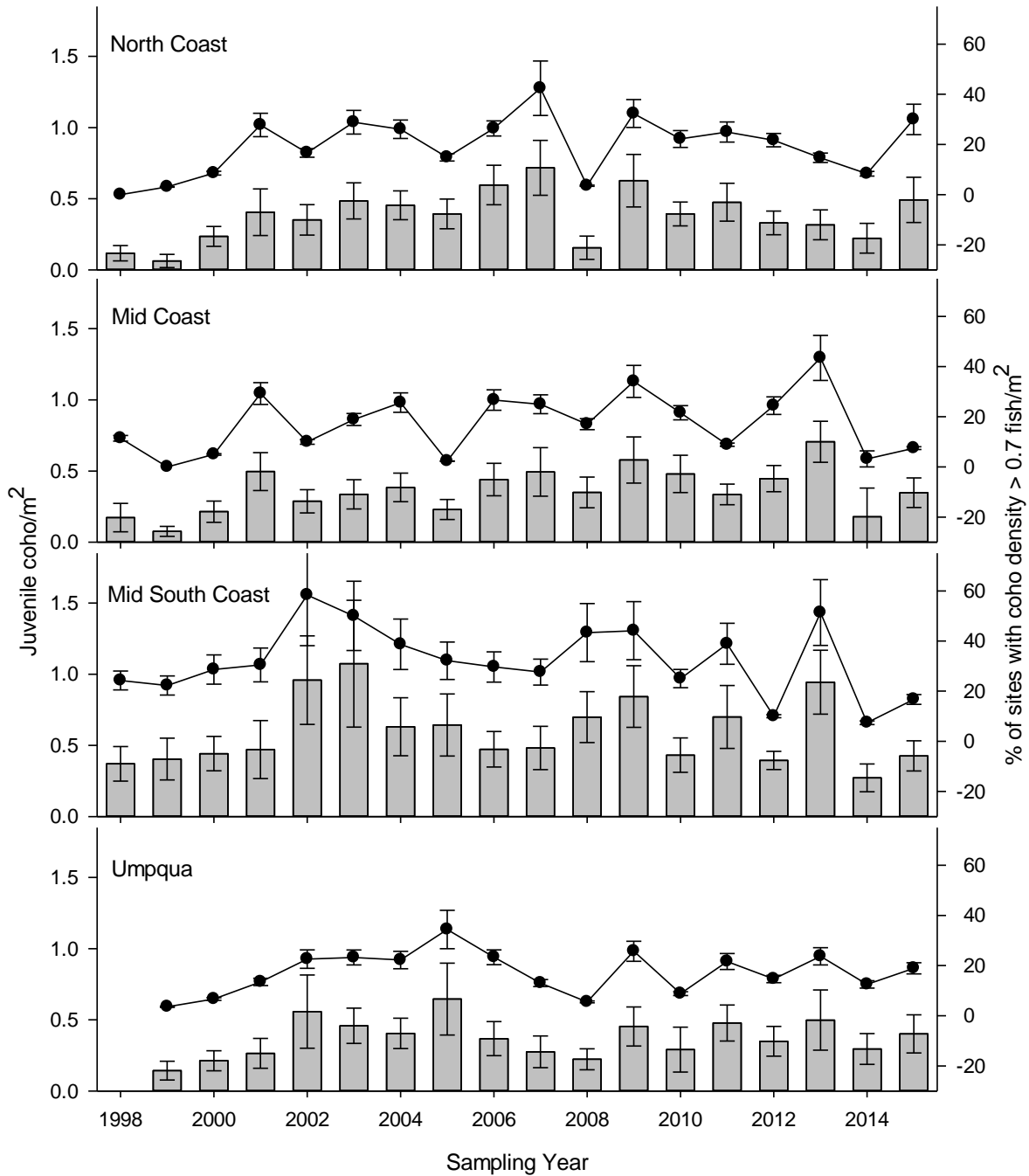


Figure 4. Annual trends in density and full seeding for juvenile coho salmon in monitoring areas of the Oregon Coast Coho ESU, based on snorkel surveys in 1<sup>st</sup>-3<sup>rd</sup> order stream reaches. Panels are organized by monitoring strata. Gray bars are for mean average density (coho/meter<sup>2</sup>) and black dots are the percent of fully seeded sites.

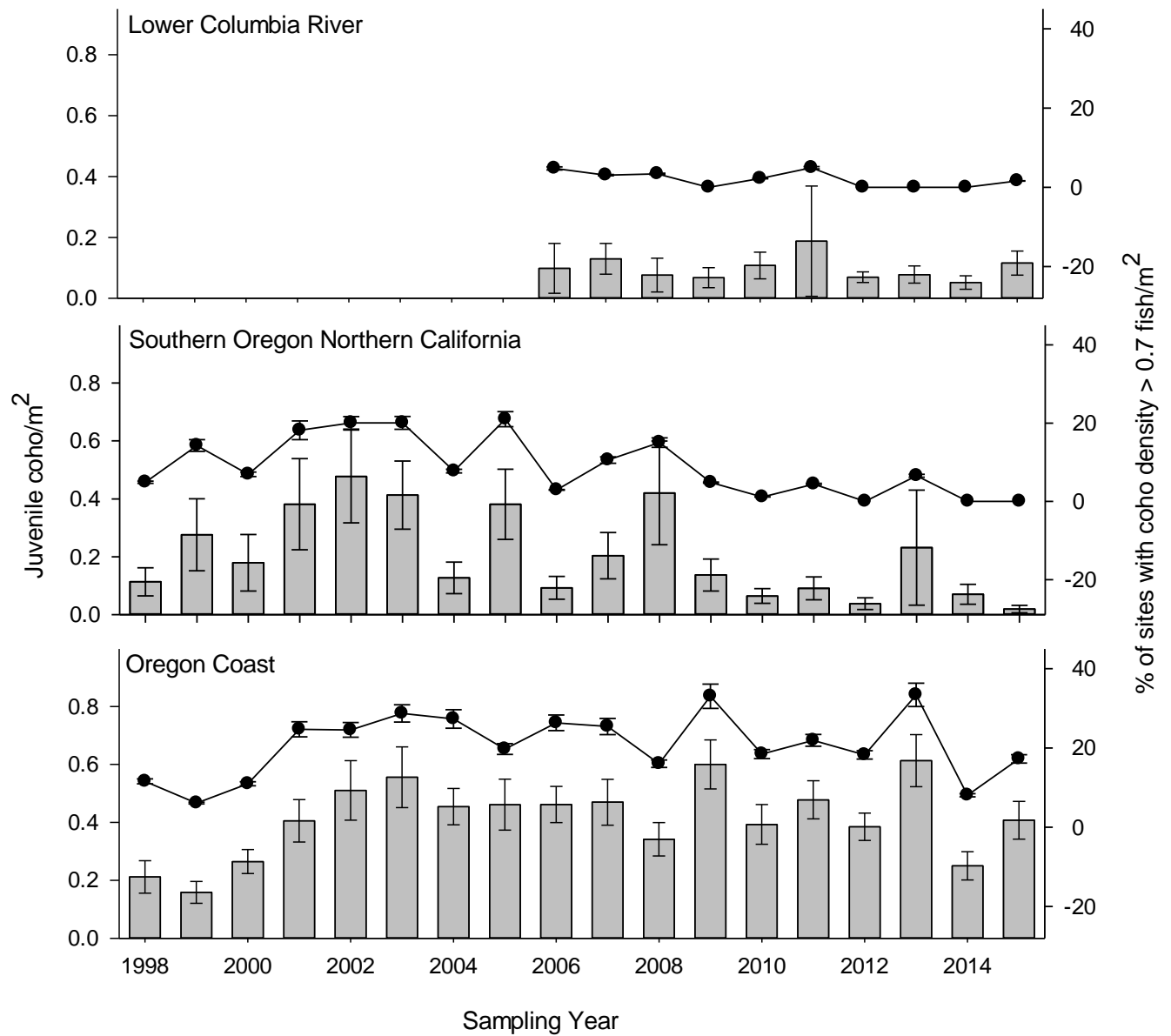


Figure 5. Annual trends in density and full seeding for juvenile coho salmon in Western Oregon Coho ESUs, based on snorkel surveys in 1<sup>st</sup>-3<sup>rd</sup> order stream reaches. Gray bars are for mean average density (coho/m<sup>2</sup>) and black dots are the percent of fully seeded sites.

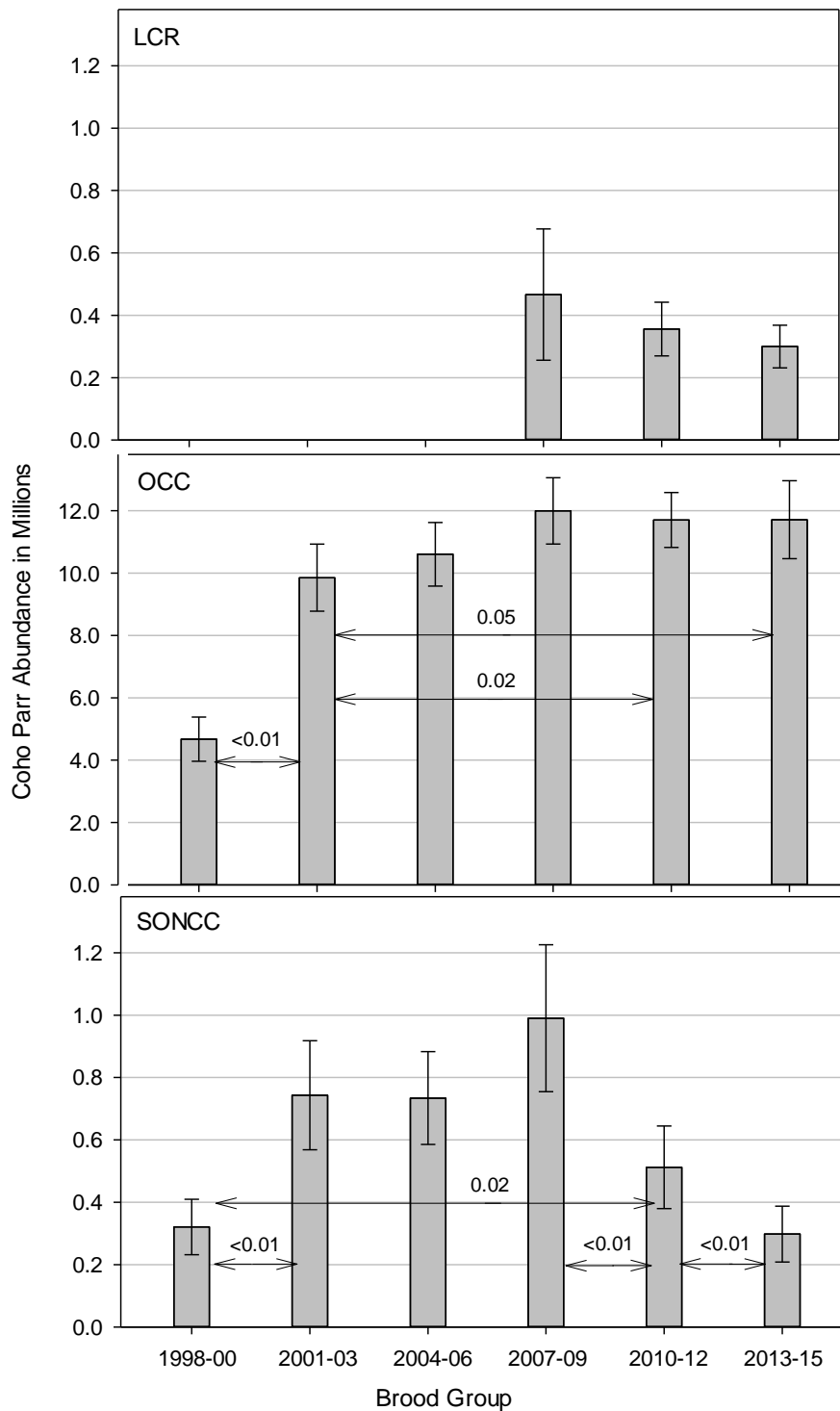


Figure 6. Trends in pool abundance estimates of coho by brood group in the three Western Oregon ESUs. Note the difference in Y-axis scale between panels. Gray bars show the abundance estimate (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow where there are significant differences. Data is from uncalibrated, extrapolated snorkel survey counts in 1<sup>st</sup>-3<sup>rd</sup> order streams.

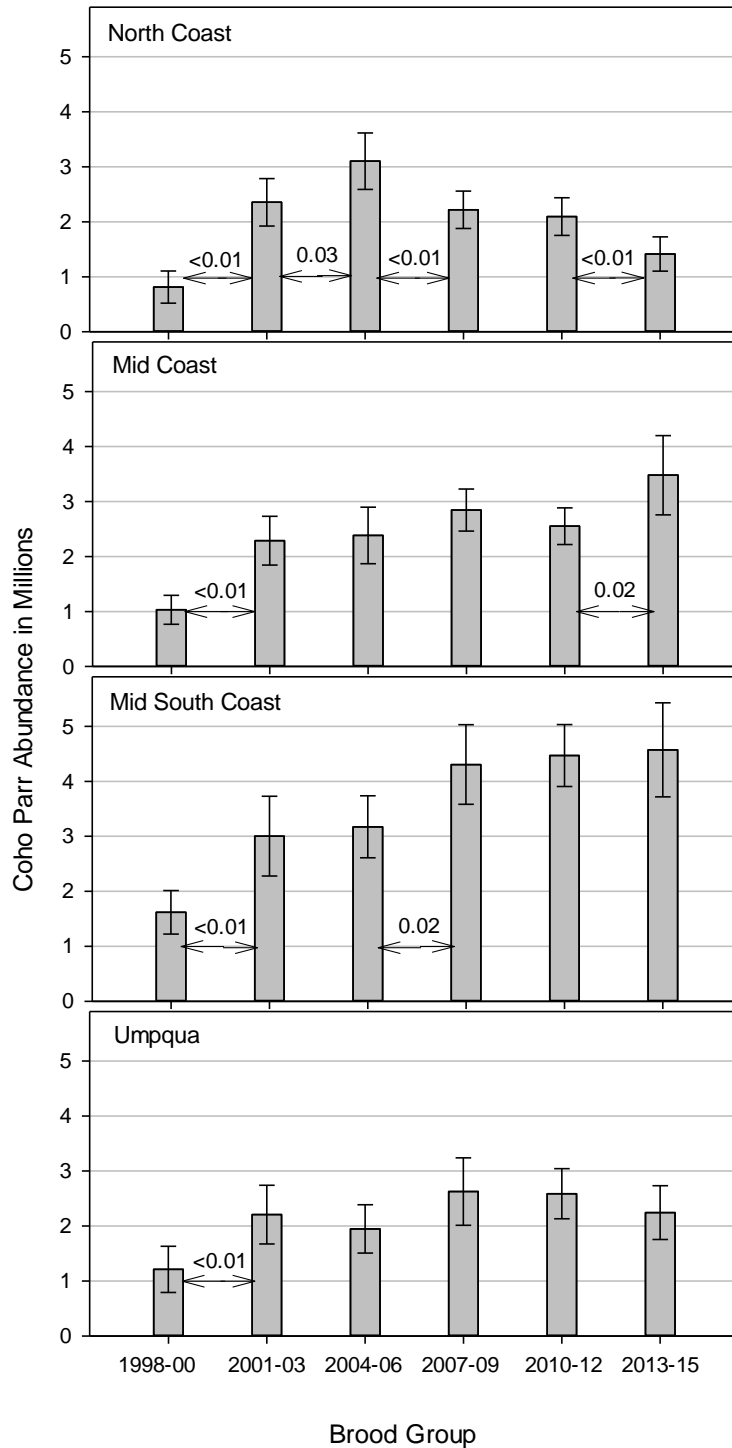


Figure 7. Trends in pool abundance estimates of coho by brood group in the four monitoring areas of the OCC ESU. Gray bars show the abundance estimate (with 95%CI), p values for comparisons among brood groups are given above each vertical arrow where there are significant differences. Data is from uncalibrated, extrapolated snorkel survey counts in 1<sup>st</sup>-3<sup>rd</sup> order streams.

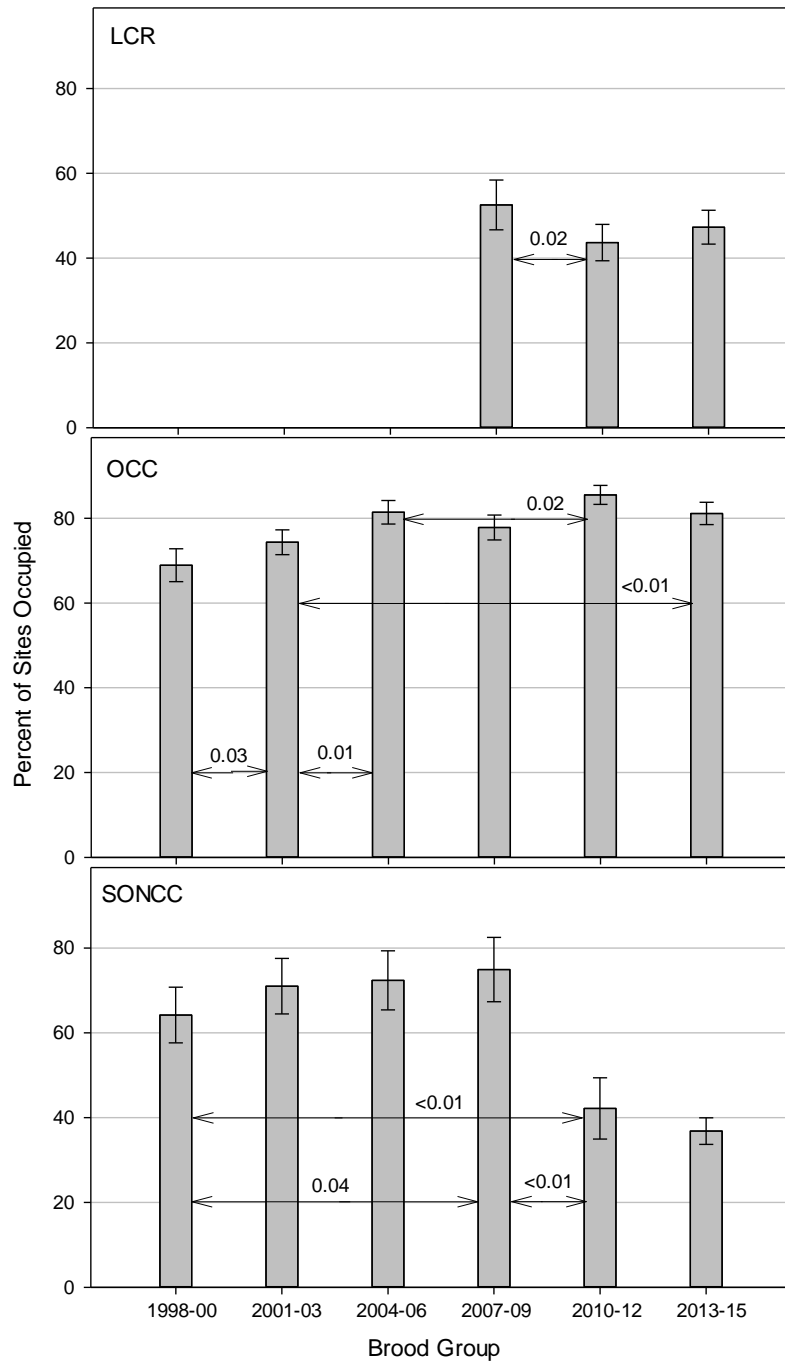


Figure 8. Trends in site occupancy of coho by brood group in the three Western Oregon ESUs. Gray bars show the percent occupied (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow where there are a significant differences.

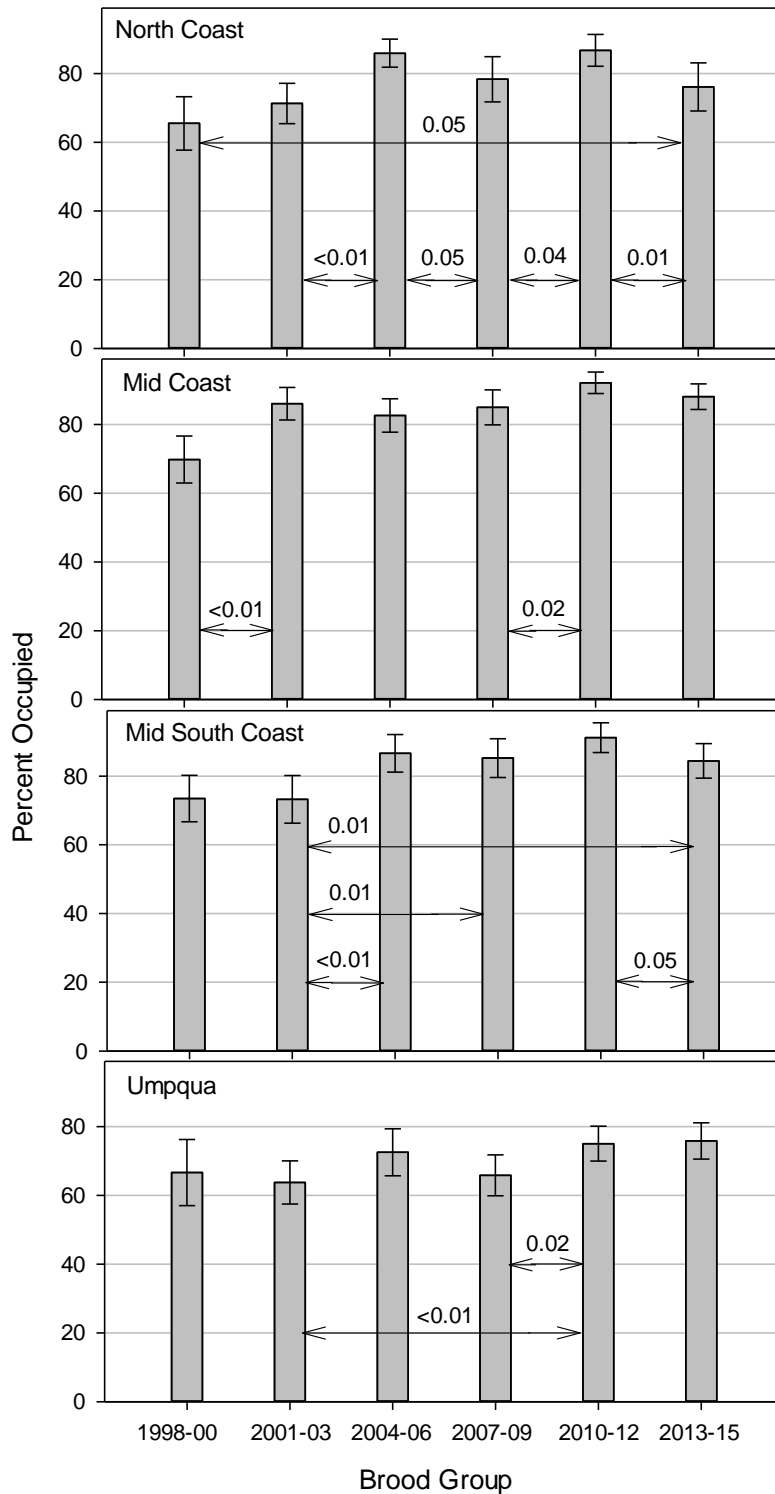


Figure 9. Trends in site occupancy of coho by brood group in the four Oregon Coast Coho Monitoring Areas. Gray bars show the percent occupied (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow where there are significant differences.

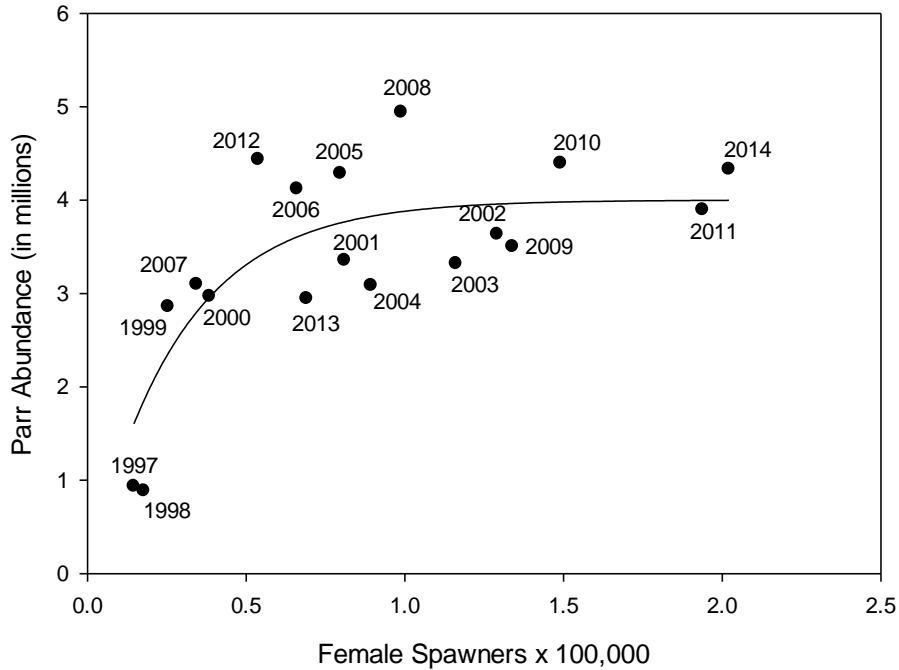


Figure 10. The relationship between parr abundance in pools and the abundance of female spawners which produced them. Parr numbers are from un-calibrated visual estimates in pools that met snorkeling criteria. Brood year is given for each data point.

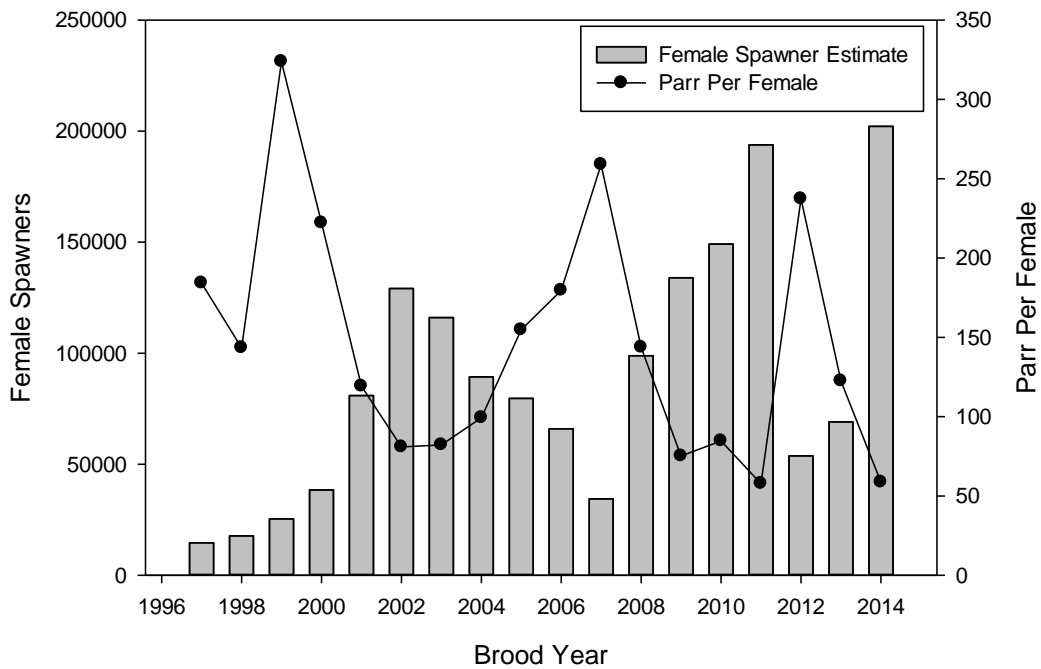


Figure 11. The abundance of female spawners (grey bars) and the number of parr per female spawner (black dots and line) by brood year in the Oregon Coast Coho ESU.



## **Oregon Coast Steelhead**

Density and pool frequency in 2015 were lower than in 2014 and lower than the 2002-2014 average for the DPS (Figure 12).

Pool abundance estimates in 2015 were lower than in 2014 and lower than the 2002-2014 average for the DPS. However, the average of the 2014 and 2015 estimates was similar to the average for the 2010-2013 brood group (Figure 13). Site occupancy in 2015 was lower than the (record high) site occupancy in 2014 and also lower than the 2002-2014 average for the DPS. The average site occupancy from 2014 and 2015 was similar to the 2010-2013 steelhead brood group (Figure 14). The four years previous to 2015 (2011-2014) have had the 4 highest steelhead site occupancy rates.

## **Klamath Mountain Province Steelhead**

In 2015 steelhead density was lower than in 2014 and lower than the 2002-2013 average for the DPS (Figure 12). Pool frequency in 2015 was similar to 2014 and lower than the 2002-2013 average for the DPS.

The pool abundance estimate in 2015 was the lowest recorded since the start of monitoring in 2002 and lower than the average estimate from 2002-2014. The average of the pool abundance estimates from 2014-2015 was lower than the average for the 2010-2013 steelhead brood group (Figure 13). Site occupancy in 2015 was similar to the estimate in 2014 and similar to the 2002-2014 average for the DPS. Average occupancy for 2014-2015 is similar to the 2010-2013 brood group and the brood groups that precede 2010-2013 (Figure 14).

Pool frequency and site occupancy were higher in the Non-Rogue portions of the DPS (Table 3).

## **Lower Columbia River/Southwest Washington Steelhead**

As in past years, the two steelhead DPSs in the Lower Columbia River had similar density estimates (Table 3). In 2015 density estimates for the DPSs were the lowest recorded and lower than the 2006-2014 averages in the respective areas (Figure 12).

Pool Frequencies in the two DPSs for 2015 were the lowest recorded and lower than the 2006-2014 average in both areas (Figure 12). Pool abundance estimates (Figure 15) for LCR and SWW in 2015 were similar to each other. In both DPSs the point estimate for pool abundance size was the lowest recorded (Figure 15). In both DPSs the pool abundance estimate was lower than the 2006-2014 average for each area, respectively. In both DPSs the point estimate for site occupancy in 2015 was the lowest recorded (Figure 15). In the LCR the 2015 site occupancy was similar to the 2006-2014 average and in SWW the 2015 site occupancy was lower than the 2006-2014 average.

Table 3. Distribution and density estimates for juvenile steelhead  $\geq 90$ cm in fork length from snorkel surveys in western Oregon wadeable streams, summer 2015.

Monitoring Area	Distribution			Density	
	Site Occupancy	Mean Pool Frequency	95% CI	Mean Average Pool Density (sthd/m <sup>2</sup> )	95% CI
North Coast	53%	24%	± 30%	0.015	± 59%
Mid Coast	83%	33%	± 20%	0.025	± 47%
Mid-South	76%	34%	± 22%	0.015	± 48%
Umpqua	51%	20%	± 34%	0.006	± 42%
KMP Rogue	81%	47%	± 18%	0.024	± 32%
KMP South Coast	100%	69%	± 13%	0.027	± 23%
Lower Columbia	50%	20%	± 36%	0.007	± 37%
Southwest WA	42%	15%	± 49%	0.007	± 80%

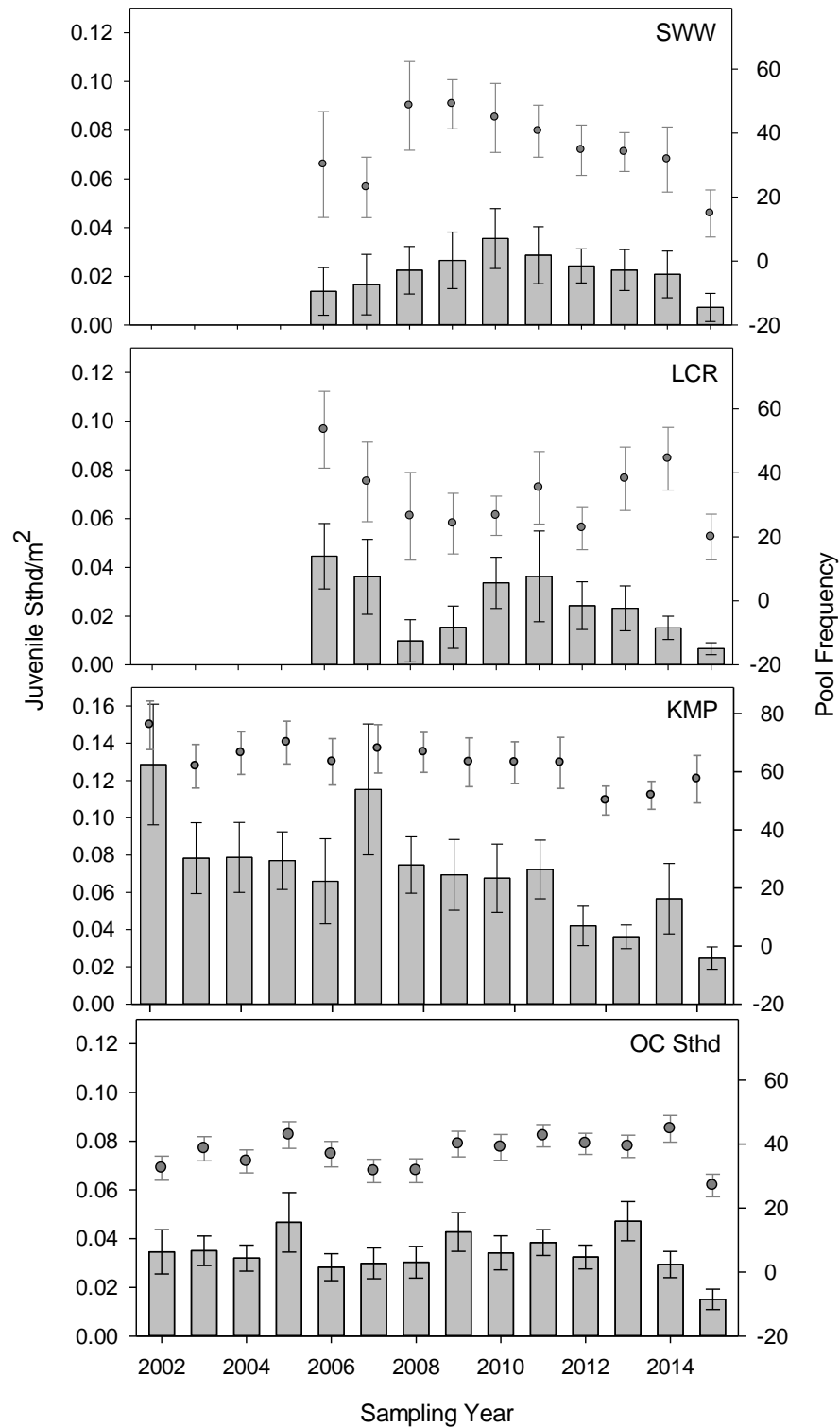


Figure 12. Annual trend in mean density (bars) and pool frequency (dots) metrics for steelhead in the four Distinct Population Segments, based on snorkel surveys in 1<sup>st</sup>-3<sup>rd</sup> order streams. Error Bars are the 95% CI. Note density scale difference for the KMP.

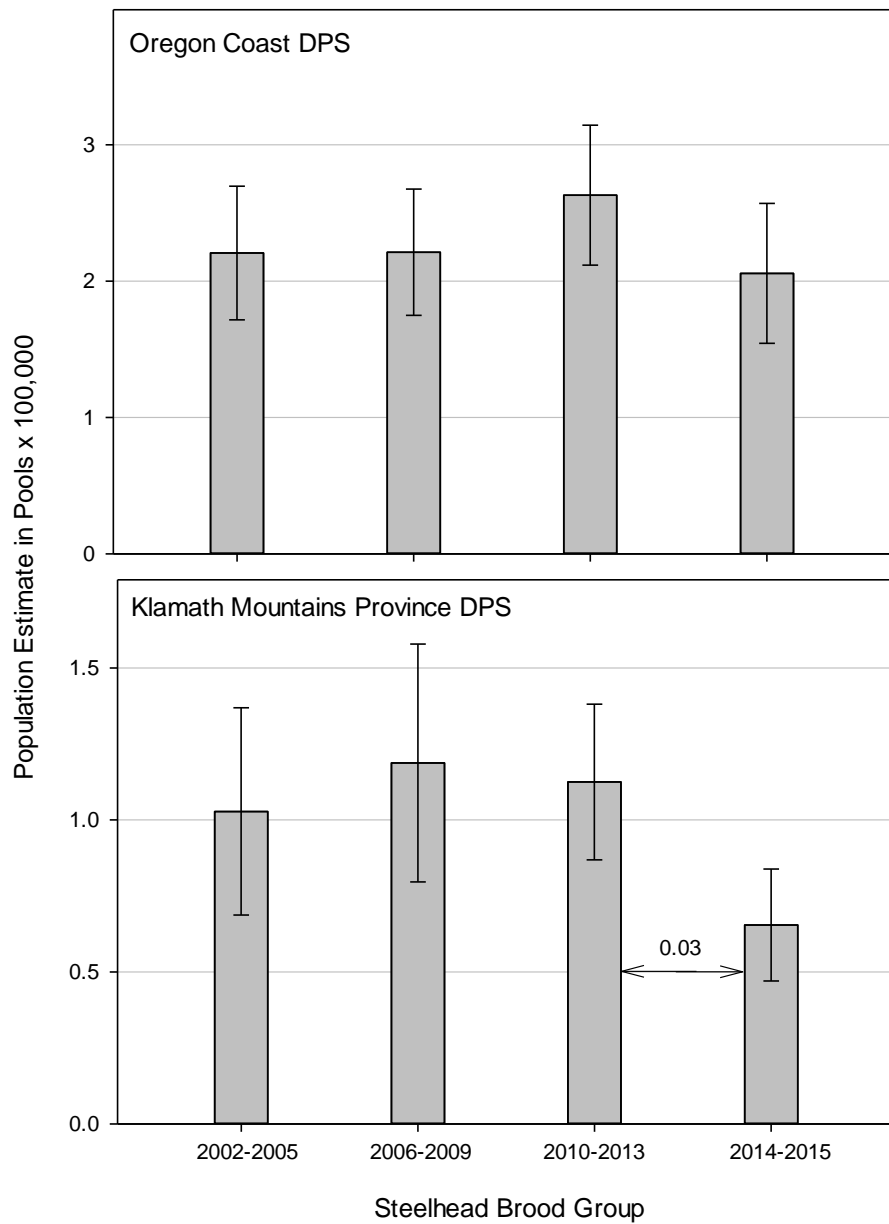


Figure 13. Trends in pool abundance estimates of steelhead juveniles by brood group in the Oregon Coast DPS (top panel) and the Klamath Mountains Province DPS (bottom panel). Gray bars show the abundance estimate with the 95% CI for the brood group.

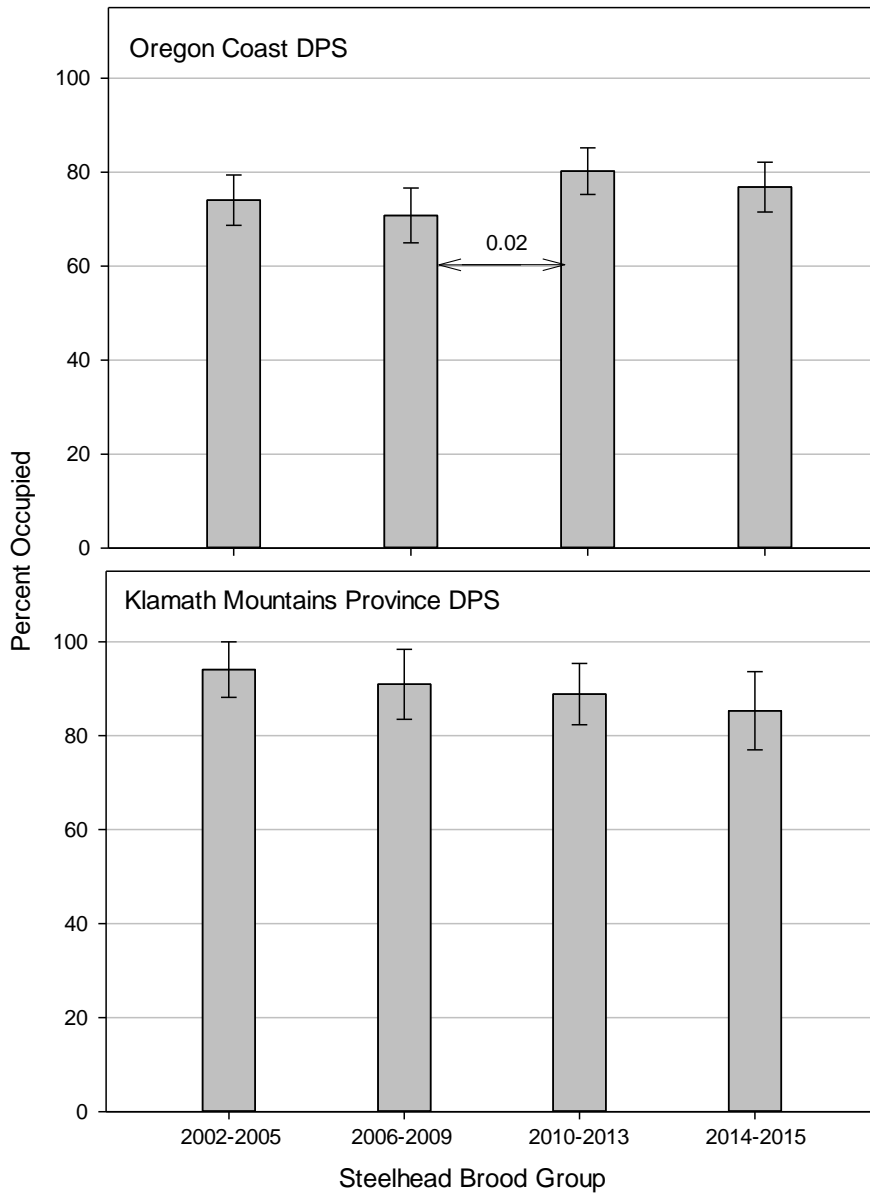


Figure 14. Trends in site occupancy for steelhead by brood group in the Oregon Coast DPS (top panel) and Klamath Mountains Province DPS (bottom panel). Gray bars show the percent occupied (with 95% CI) for each brood group, p values for comparison are given above the vertical arrows when there is a significant difference.

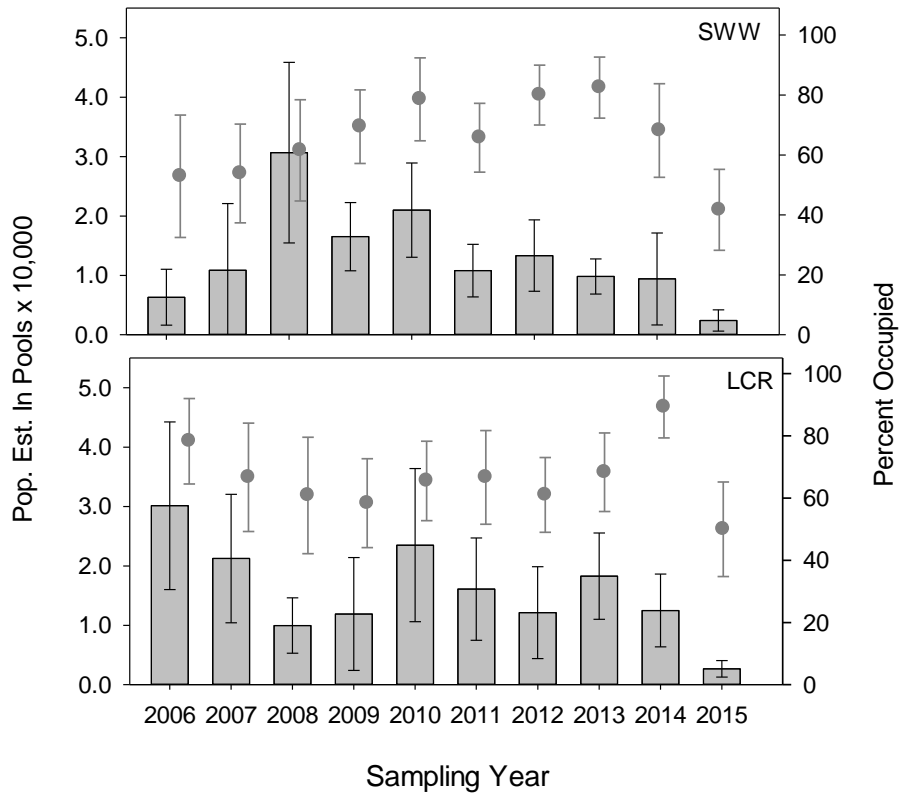


Figure 15. Annual trend in abundance estimates from pools (gray bars) and site occupancy (dots) for steelhead based on surveys in 1<sup>st</sup>-3<sup>rd</sup> order streams in the two lower Columbia River DPS. Error bars show the 95% CI.

## ESU/DPS Comparisons

### Coho

The Oregon Coast Coho ESU had the broadest coho distribution and the highest density estimates (Table 2, Figures 5 and 8). The Lower Columbia River ESU had higher density and site occupancy estimates than the SONCC. Abundance estimates in pools are not directly comparable because the number of stream kilometers differs among the ESUs.

### Steelhead

Density was highest in the KMP (Figure 12). Densities in the Coast DPS were higher than in the LCR and SWW, which were similar to each other. Site occupancy and pool frequency in the four DPSs were similar to the density pattern, with the KMP having the highest portion of sites and pools occupied and the LCR the lowest (Table 3). Abundance estimates in pools are not directly comparable because the number of stream kilometers differs among the DPSs.

## Effects of Pool Depth on Snorkel Counts

The Smith River Steelhead and Coho Monitoring Verification Study (Constable and Suring, under review.) indicated a large portion of coho and steelhead rearing abundances are often found in pools that did not meet the original snorkeling criterion of  $\geq 40$  cm in maximum depth. Data from removal estimates (electrofishing with block nets) indicated pools  $\geq 40$  cm max depth contained an average of 46% of the coho abundance and 68% of the steelhead abundance in the Smith River study area. The yearly difference ranged from 31% to 61% for coho and 49% to 82% for steelhead. Abundance estimates in pools  $\geq 40$  cm (based on removal estimates and expanded to the basin) related moderately to total abundance estimates (for coho  $R^2 = 0.791$ ,  $p = 0.007$ ; for steelhead the relation was stronger ( $R^2 = 0.918$ ,  $p = 0.001$ ). Lowering the maximum depth criterion to  $\geq 20$  cm allowed an average of 74 % of the coho abundance and 79% of the steelhead abundance to be sampled by electrofishing with a yearly range of 61 - 82% for coho and 54 - 91% for steelhead. Abundance estimates from pools  $\geq 20$  cm had a strong and significant relationship with total abundance estimates (for coho  $R^2 = 0.974$ ,  $p < 0.001$  and for steelhead  $R^2 = 0.936$ ,  $p < 0.001$ ). The Smith River study did not include snorkel estimates in pools below 40 cm in depth and we were unable to estimate observation probability of coho and steelhead in the small pool category for visual counts.

As a result of the study, we lowered maximum depth criterion for snorkel pools to  $\geq 20$  cm in 2010. This change will be monitored for survey effort, accuracy and repeatability, and influences on occupancy, density and abundance estimates. Results from 2015 are reported below. As more data are collected, future reports will provide a more detailed analyses and comparisons between the two depth criteria.

## Survey Effort

Lowering the maximum depth criterion allowed an additional 1,273 pools to be snorkeled in 2015. Ten sites did not have pools that were  $\geq 40$ cm in maximum depth, but did have pools that were  $\geq 20$ cm in maximum depth. With the lower depth criterion the status of these ten sites would change from non-target to target (Table 1).

## Distribution

Coho and steelhead were observed in four of the ten sites for which all pools were  $< 40$ cm in maximum depth. In the remaining six sites, neither coho nor steelhead were observed. Additionally, there were four sites that contained pools that were  $\geq 40$ cm in maximum depth, but coho (1 site) and steelhead (3 sites) in these sites were only observed in pools that were  $< 40$ cm in depth. These observations slightly increased ( $< 2\%$ ) site occupancy estimates in the Mid-South Coast, Umpqua, Cascades/Gorge, and Interior Rogue strata over those given in Table 2 and Table 3. Average pool frequency decreased when depth criteria was adjusted to include more shallow pools. The decrease was  $\leq 5\%$  in all Monitoring Areas and strata for coho and steelhead.

## Density

From 2010-2013 coho density estimates decreased in most Monitoring Areas when the lower depth criterion was applied. In most cases this was less than a 10% decrease. In 2014 coho densities increased by 1-5% in most MAs when the lower criterion was applied. In 2015 densities did not change by more than 2% except in the SONCC, where they increased over 60% (this was primarily due to high densities in one site with a single pool  $< 40$ cm in maximum depth). In 2015, as in the past 4 years, steelhead density estimates decreased with the lower depth criterion. In all MAs the decrease was  $< 10\%$ .

## Pool Abundance Estimates

Paired t-tests from pools  $\geq 40$ cm and pools  $\geq 20$ cm indicate that including the shallower pools did not produce significant differences in abundance estimates in 2015, but with low p-values of 0.054 and 0.057 for coho and steelhead, respectively (Tables 4 and 5). In all previous years paired t-tests indicated there were significant differences in abundance estimates from pools  $\geq 40$ cm and pools  $\geq 20$ cm. Results of resurveys conducted from 2010-2012 and in 2015 (resurveys were not fully completed in 2013 and 2014 due to budget restrictions) indicate that including pools between the  $\geq 40$ cm depth criteria and the  $\geq 20$ cm depth criteria has little impact of the variability of coho and steelhead counts between surveyors.

The yearly variability for the coho abundance in each MA and ESU estimated by surveys in pools  $\geq 40$ cm in depth has tracked with the variability estimated by surveys in pools  $\geq 20$ cm in depth (Figure 16). Any differences in abundance between years observed using the  $\geq 20$ cm criterion would also have been observed using the  $\geq 40$ cm criterion. As in past years, abundance estimates including pools that met the 20cm depth criterion produced proportionally smaller 95% confidence intervals for coho and steelhead estimates in most Monitoring Areas (Tables 4 and 5).



As more data are collected we will provide additional analyses that address the differences in pool size criteria. Of specific interest to our monitoring efforts are variations in site occupancies and in the percentage of the abundance that is distributed in pools that are less than 40cm in depth and how these impact our sensitivity to trend detection.

Table 4. Comparison of total estimates of coho in snorkel pools using a maximum depth of  $\geq 20$  cm and those using a maximum depth of  $\geq 40$  cm.

Monitoring Area	2015 Coho Estimates				
	Pools $\geq 20$ cm Max Depth		Pools $\geq 40$ cm Max Depth		95% CI Difference
	Estimate	95% CI	Estimate	95% CI	
North Coast	636,225	46%	618,560	47%	1%
Mid Coast	1,692,471	20%	1,335,493	22%	2%
Mid-South Coast	1,502,373	32%	1,415,931	33%	1%
Umpqua	1,160,774	41%	959,413	43%	2%
SONCC	47,846	52%	45,308	53%	1%
Lower Columbia	106,530	29%	97,896	28%	0%

Table 5. Comparison of total estimates of steelhead in snorkel pools using a maximum depth of  $\geq 20$  and those using a maximum depth of  $\geq 40$  cm.

Monitoring Area	2015 Steelhead Estimates				
	Pools $\geq 20$ cm Max Depth		Pools $\geq 40$ cm Max Depth		95% CI Difference
	Estimate	95% CI	Estimate	95% CI	
North Coast	22,464	59%	21,374	61%	2%
Mid Coast	68,452	34%	61,922	37%	3%
Mid South Coast	34,539	45%	33,641	46%	3%
Umpqua	21,388	46%	19,823	46%	0%
KMP Rogue	31,794	40%	31,081	41%	1%
KMP South Coast	15,121	31%	15,030	31%	0%
Lower Columbia DPS	2,763	49%	2,676	52%	3%
Southwest WA DPS	2,441	74%	2,422	74%	0%

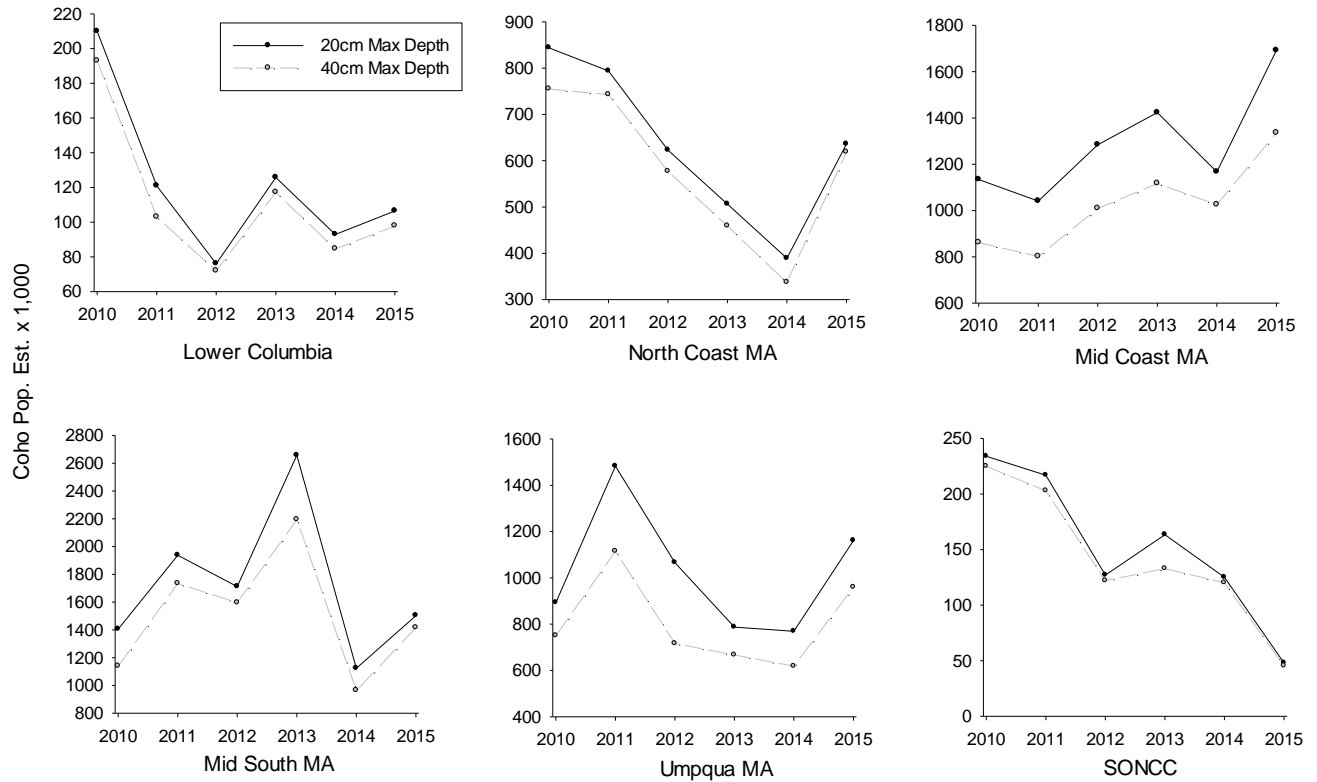


Figure 16. Trends in the coho rearing abundance from 2010 to 2015 based on the  $\geq 20\text{cm}$  pool depth criteria (solid black line) and the  $\geq 40\text{cm}$  pool depth criteria (dashed grey line).

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