THE OREGON PLAN *for Salmon and Watersheds*

Juvenile Salmonid Monitoring In Coastal Oregon and Lower Columbia Streams, 2013

Report Number: OPSW-ODFW-2014-1

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Oregon Plan for Salmon and Watersheds

Annual Monitoring Report No. OPSW-ODFW-2014-1

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SUMMARY

This report analyzes data from juvenile salmonid surveys across coastal Oregon in 2013. Results from this year are compared with our findings from 1998 – 2012. This unique, long term data set is used to monitor and describe trends in juvenile salmonid distribution and abundance for the three coho Evolutionarily Significant Units (ESU) and the four steelhead Distinct Population Segments (DPS) in coastal Oregon. Full reports from prior years are available at: https://nrimp.dfw.state.or.us/crl/default.aspx?pn=WORP.

Oregon Coast Coho (OCC) ESU juvenile density estimates in 2013 were higher than any other year. The site occupancy rate in 2013 was similar to 2012. The latest three cohorts had the 1st, 3rd, and 2nd highest occupancy rates estimated over the duration of the project. Pool population estimates in 2013 were similar to 2012 and to the average of the last three cohorts. Overall, we observed a small, positive trend in occupancy and pool population estimates across the ESU from 1998-2013.

In the Oregon Coast Coho ESU plots of parr abundance with female spawner abundance suggest limits to parr production in freshwater habitats.

Southern Oregon Northern California Coho (SONCC) ESU juvenile density estimates were similar to 2012 and to the average since 1998. Site occupancy was higher in 2013 than in 2012 but these estimates were the two lowest observed. Pool population estimates were similar to 2012, but lower than in most years, with the exclusion of the 1998-2000 estimates. Regressions of both site occupancy and pool population estimates to survey year do not show detectable trend since the start of monitoring in the ESU.

Lower Columbia River Coho (LCR) density, site occupancy, and pool population estimates were similar to 2012 and to the average since 2006. Regressions of both site occupancy and pool population estimates to survey year do not show detectable trends since the start of monitoring in the ESU.

The Oregon Coast Steelhead DPS density estimate in 2013 was higher than in 2012 and the average since 2002. Pool population estimates in 2013 were similar to 2012 and to the average. Site occupancy estimates from 2013 were similar to 2012 and the latest three years have had the three highest occupancy estimates.

In the Klamath Mountain Province (KMP) DPS, steelhead density in 2013 was the lowest recorded and similar to the next lowest estimate in 2012. Pool population estimates were similar to the average and to 2012. Site occupancy was the third lowest estimate, and similar to the low in 2012.

Steelhead density estimates in the LCR and the Southwest Washington (SWW) DPSs in 2013 were similar to each other, to average, and to the 2012 estimates. Site occupancies in the LCR and SWW were similar to 2012 and to the average estimates for the DPSs. Point estimates for site occupancy in SWW for the last two years have been the first and second highest recorded. Pool population estimates for both DPSs were similar to 2012 and to the average.

Analyses which included shallow pools (below our former 40cm maximum depth criteria) produced higher site occupancies and larger pool population estimates with proportionately smaller confidence intervals. Population estimates 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 1st-3rd order (wadeable) streams within the rearing distribution of coho in the Oregon Coast Coho (OCC) and in the Oregon portion of the 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 4th -6th order (non-wadeable) streams. In 2006, the Oregon portions of the Lower Columbia River (LCR) coho ESU and steelhead DPSs were included. Surveys in 4th to 6th 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 was based on a 100k stream layer for the Oregon Coast ESU. This 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 on the coast and Lower Columbia are currently based on the 24k frame. In 2012 a 24k sampling frame was developed for the SONCC/KMP. This frame also considered a larger expanse of streams to be within the rearing distribution than was formerly assessed. Until the 2012 frame is corroborated by field surveys, analyses in the SONCC/KMP will be based the former distribution. Our sampling frame and survey design is 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 (wadeable and non-wadeable) (Table 1). Field crews surveyed a one kilometer stream reach encompassing the GRTS points during base low flow conditions. Within the reach, all pools that are ≥20cm deep and ≥6 m^2 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 and of trout (steelhead and cutthroat) that are ≥90 mm. Presence was noted for dace, shiners, and trout <90 mm. Freshwater mussel presence and beaver activity were also described. 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 repeatability/precision approximately 15% of surveys in wadeable reaches are resurveyed.

Our depth criterion was changed from ≥40cm to ≥20cm 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 ≥20 cm would allow surveyors to sample a larger and more consistent portion of the juvenile coho and steelhead summer populations. 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 ≥40cm depth criterion and a second analysis of data form pools meeting the new depth criterion.

Data are summarized and presented by ESU, MA, and/or DPS and by stream order (wadeable and non-wadeable). Cumulative Distribution Frequency (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 ≤ 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. The average of the site densities for all sites within a MA, ESU, or DPS produces the density estimate for the area.
- Pool population estimates
  - The estimate of the number of fish in pools for each MA, ESU, or DPS. Pool population 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 population 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 population estimates, but are appropriate for assessing trends.
- Percent Full Seeding
  - The percent of sites with average fish density $\geq$0.7 coho/m^2. This value was calculated by Nickelson et al. (1992), which considered streams with coho densities from electrofishing removal estimates ≥1.0 coho/m^2 to be fully seeded, and Rodgers et al. (1992) which estimated snorkelers observed 70% of the coho in electrofishing removal estimates.

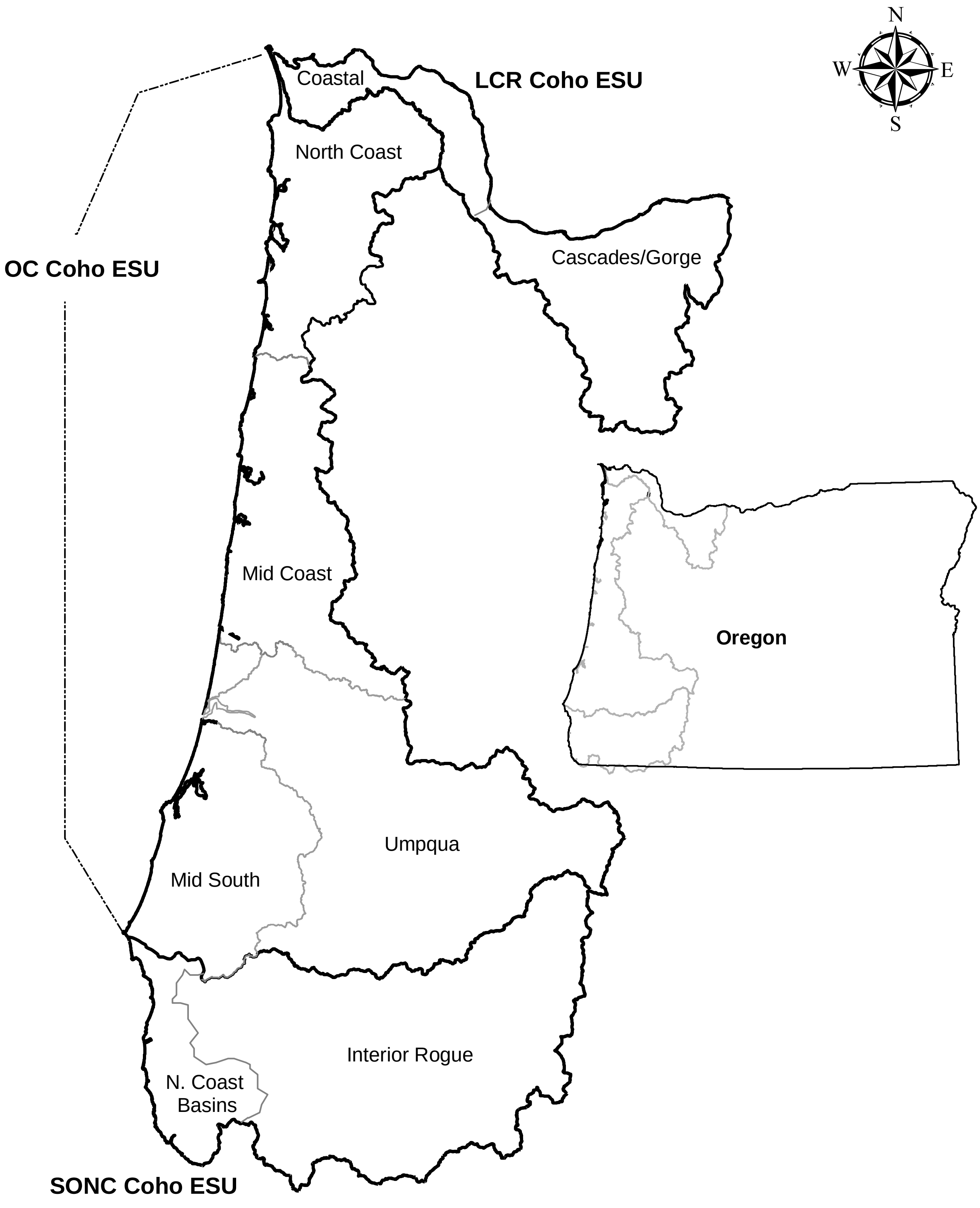

Figure 1. The spatial extent of the study area showing the Oregon portion of coho ESUs and the monitoring areas/strata within each ESU.

In 2013, the 16th season of juvenile coho monitoring in the OCC and SONCC ESUs was completed, yielding 16 years of distribution and abundance data. To facilitate analyses and monitoring across this extended time period, site occupancy and population estimate data were pooled by each three-year interval into five successive brood groups, based on the conventional three-year coho life cycle (reviewed by Weitkamp et al., 1995). The last complete brood group was from 2010-2012. Analyses based on these 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 monitoring by tempering 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 the overall coho summer rearing population than an individual year. Comparisons of brood groups can also mitigate the effects of extreme years on an average condition (a combination of all years) when compared to a single year yet still be sensitive enough to illustrate trends in a population across time. Brood groups provide a much greater sample size that can result in smaller confidence intervals which provide added sensitivity for trend detection. Combining three successive brood years into a single brood group can present a composite perspective of the status of juvenile coho populations.

In 2013 juvenile steelhead data was pooled into three successive brood groups based on the typical four-year steelhead life cycle (reviewed by Busby et al., 1996). Coho data from the lower Columbia will be pooled following the 2015 field season.

RESULTS

Survey Effort and Resurveys

In 2013 we selected 579 sites from our sampling frame as candidate stream reaches for field surveys. Seventy four (64%) of these sites were non-target (either above barriers to anadromy, in tidal areas, or otherwise beyond the distribution of potential rearing habitat). Of the remaining 505 sites, 334 (66%) were successfully snorkeled or electrofished, 74 (15%) were not surveyed because of landowner access restrictions, 42 (8%) were un-sampleable, 12 (2%) were inaccessible, and 38 (8%) were not visited due to time restrictions (Table 1). Sites that were not surveyed are assumed to be target, non-response. Goals for survey effort were met or exceeded in all MAs and stratum in 2013, with the exception of the Interior Rogue, where 48 sites were completed with a goal of 50. A total of 5,482 pools at 315 sites were snorkeled. An additional 353 pools at 19 sites were electrofished.

Table 1. Site status by coho ESU, monitoring area, and stream order for 2013.

ESU	Monitoring Area/ Stratum	Stream Order	Snorkeled	Electrofished	Target Non-response	Non-target
OCC	North Coast	1-3 Order	34	7	14	9
	Mid Coast	1-3 Order	46	0	16	3
	Mid-South Coast	1-3 Order	37	3	24	8
	Umpqua	1-3 Order	38	2	19	18
LCR	Coast	1-3 Order	37	3	25	9
	Cascades/Gorge	1-3 Order	38	3	33	9
SONC	Interior Rogue	1-3 Order	47	1	28	14
	North Coast Basins	1-3 Order	38	0	11	4

Table 2. Distribution and density estimates for juvenile coho in 2013. Distribution is from snorkeled or electrofished sites. Density is from snorkeled sites.

	Distribution			Density		
Monitoring Area	Site Occupancy	Mean Pool Frequency	95% CI	Percent Sites > 0.7 coho/m²	Mean Average Pool Density (coho/m²)	95% CI
1-3 Order Streams						
North Coast	78%	54%	± 19%	15%	0.317	± 33%
Mid Coast	89%	79%	± 10%	43%	0.701	± 20%
Mid-South Coast	85%	77%	± 12%	51%	0.943	± 24%
Umpqua	75%	64%	± 16%	23%	0.498	± 30%
South Coast Coho	39%	26%	± 28%	7%	0.232	± 86%
Lower Columbia	52%	35%	± 19%	0%	0.078	± 36%

In previous years approximately 15% of surveyed sites were resurveyed by supervisory staff. Within the first week of the field season resurveys were used as part of our training process to resolve difficulties with fish ID and inconsistencies with survey protocols. After the first week of the field season resurveys were used to assess the precision or repeatability of our surveys. In 2013, due to budget restrictions, resurvey effort was reduced and only used for crew training.

Past resurveys of coho (Figure 2) from 1999-2012, n= 414, have indicated that counts of coho are precise and repeatable (R^2 = 0.95). Resurvey counts of steelhead from 2002-2012, n=350, were more variable, but correlated with counts from original surveys (R^2 = 0.78).

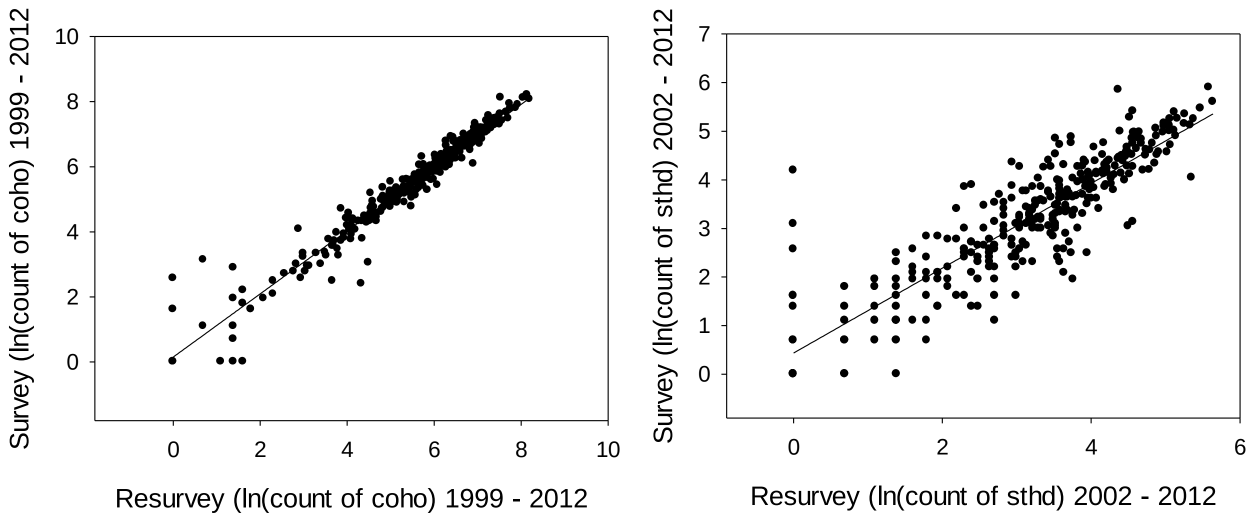

Figure 2. The relationship between original snorkel counts of juvenile coho and steelhead and resurvey counts in the same sites. Data are log transformed to satisfy regression assumptions.

Trends in Salmonid Distribution and Abundance

Oregon Coast Coho

A Cumulative Distribution Frequency (CDF) graph comparing density, percent occupancy, and percent of sites fully seeded in 2013 to the average of these metrics for all previous years are shown in Figure 3. In the Mid Coast and Mid-South Coast, these metrics in 2013 were greater than the average condition from 1998 - 2012. In the Umpqua and North Coast these metrics were similar to the average condition.

Density estimates and the percent full seeding across time are shown for each of the four Oregon Coast Coho MAs in Figure 4. Densities in 2013 were similar to 2012 for the North Coast and Umpqua and higher than in 2012 for the Mid Coast and Mid-South Coast. The percent of fully seeded sites in 2013 was similar to 2012 for the North Coast and the Umpqua and higher than in 2012 for the Mid Coast and the Mid-South Coast.

For the ESU as a whole, densities and percent full seeding are shown for each year in Figure 5. In 2013 average pool density for the ESU was 0.61 coho/m^2. This was the highest estimate observed since monitoring began in 1998. Average density for the ESU in 2013 was higher than in 2012 and higher than the average from 1998-2012. The percent of sites fully seeded for the ESU (33%) was also the highest recorded since the start of monitoring. Percent full seeding in 2013 was higher than in 2012 and higher than the average of previous years. The high density did not appear to be driven by lower pool surface area measurements nor the number of spawners for the brood, which was below average.

Pool population estimates for the ESU (which were combined by three-year periods to form five successive brood groups) are shown in Figure 6. The pool population estimate for each brood group is the average of the three years that comprise the group. The current brood group (2010-2012) had a pool population estimate that is similar to the two preceding groups, but this estimate is significantly higher than estimates for the earliest two brood groups (1998-2000 and 2001-2003). The estimate for 2013 was similar to the average estimate for the current group and to 2012.

Pool population estimates for the coastal MAs are shown in Figure 7. In all MAs, the estimate for the current brood group is similar to that of the preceding group (2007-2009) and higher than that of the earliest group (1998-2000). In all cases the earliest group has a lower estimate than any other group. The 2013 pool population estimate is similar to 2012 in each MA and to the average for the 2010-2012 brood group in the Umpqua, Mid Coast, and Mid-South Coast (but with a low p-value of 0.06). The 2013 pool population estimate for the North Coast is lower than the average for the 2010-2012 brood group in the MA.

Site occupancy estimates for the ESU are shown in Figure 8. The average site occupancy in the ESU is higher in the current brood group than in any other group. The estimate for 2013 was similar to 2012 and to the average of the current brood group. Occupancies in the ESU have increased in each successive brood group except between the third (2004-2006) and forth (2007-2009) group, where there was no significant difference.

Site occupancies for the Oregon coast MAs are shown in Figure 9. In all MAs except the Umpqua, occupancies in the current brood group are higher than in the earliest group. In all MAs except the Mid-South Coast, occupancies in the current brood group are higher than those in the preceding group. Occupancy estimates in 2013 for each MA are similar to those in 2012 and to the average of the current brood group.

When regressed with survey year both site occupancy ($R^2 = 0.504$, p value<0.003) and pool population estimates ($R^2 = 0.605$, p value< 0.001) exhibit a moderate increasing trend. The significance of the trend for both metrics is linked to lower spawner abundance during the first four years of the project. When these years are removed, the increasing trend is not significant.

The relationship between parr abundance in pools and the abundance of female spawners which produced them indicates that parr production is limited by available spawning habitat and/or early rearing habitat when spawner abundance is high (Figure 10). In years where female spawners number approximately 80,000 or less (1997-2001, 2005-2007, and 2012) there is a positive relationship between increased female spawner 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) there does not appear to be a corresponding increase in parr ($R^2 = 0.015$) as female spawner abundance increases.

Egg-to-parr survival rates are greatest when female spawner abundance is low and the rate decreases as the number of spawners increases (Figure 11). Percent egg-to-parr survival ranged from 0.8% in brood year 2011 (which had the highest number of females) to 4.5% in brood year 1999 (which had the 3rd lowest female abundance). It is important to note that the parr numbers given (and the survival rates that are based on these numbers) are from un-calibrated visual estimates 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 rise above the 80,000 mark does not seem to be an effect of parr “spilling over” into less optimal habitats, such as riffles, where they would not be observed/counted by snorkelers using our protocols. The number of fully seeded sites in years of high spawner abundance averages 24%, which is similar to years of low spawner abundance.

Southern Oregon Northern California Coho

For 2013 average density in pools was 0.232 fish/m^2 and 7% of the sites were fully seeded (Table 2). Coho occurred in 39% of the sites in the ESU and pool frequency was 26%. Density and the percent of sites fully seeded are shown in Figure 5. Although the 2013 point estimate for density is over 6 times the point estimate from 2012, the large standard error in 2013 did not allow for a significant difference between the estimates (p-value = 0.06). The 2013 density estimate was similar to the average density for the ESU from 1998-2012. The percent of sites fully seeded in 2013 was higher than in 2012 and similar to the 1998-2012 average. Pool population estimates for the ESU are shown in Figure 6. Average pool population estimates from the current brood group (2010-2012) are lower than those of the 2007-2009 and 2004-2006 groups, similar to those in 2001-2003 (but with a low p value of 0.06), and higher than those in the earliest group. The pool population estimate for 2013 is similar to the estimate for 2012 and to the average for the current brood group. Site occupancies for the ESU are shown in Figure 8. The estimate for the current group is lower than any of the preceding groups. The estimate for 2013 was higher than in 2012 but similar to the average of the current brood group. Occupancy estimates for the past three years have been the 2nd, 1st, and 6th lowest recorded, respectively.

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

Lower Columbia Coho

The 2013 mean average density in pools was 0.078 fish/m^2 and coho occurred in 52% of 1st-3rd order stream reaches with a mean pool frequency of 35% (Table 2). No sites were fully seeded in the ESU for the second year in a row. Density estimates and estimates of full seeding are shown in Figure 5. The 2013 density estimate was similar to 2012, and was not significantly different from the average for 2006-2012. Although no sites were fully seeded in 2013, the average for the ESU since 2006 is 2% with a high standard error, consequently 2013 was similar to the average. Pool population estimates and site occupancies are shown in Figure 10. These metrics will be pooled into brood groups at the end of the 2015 field season. The percent of occupied sites in 2013 was similar to 2012 and to the average for the ESU. Pool population estimates in 2013 were similar to 2012 (but with a low p-value of 0.08) and the average for the ESU.

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

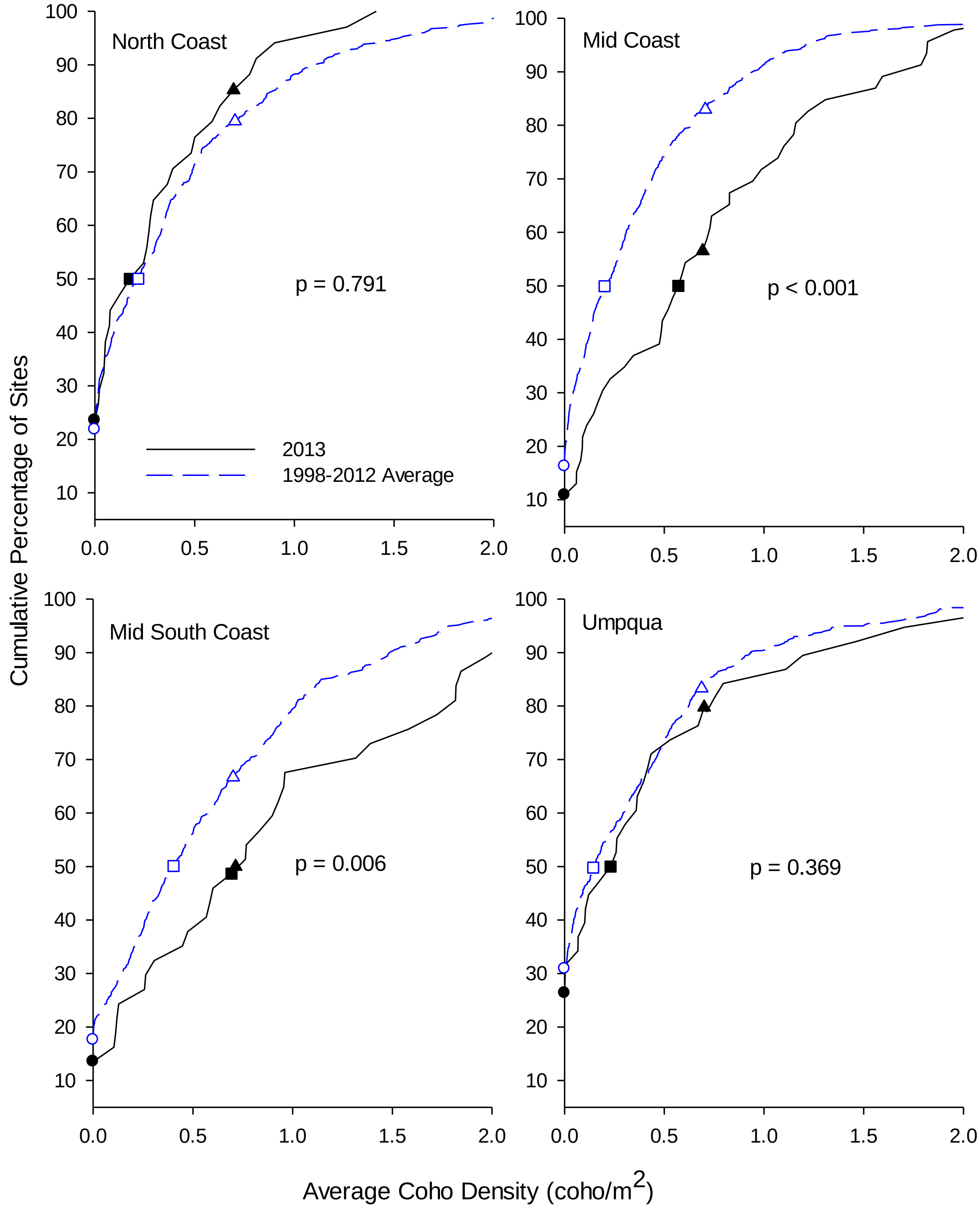

Figure 3. Average coho density CDFs from snorkeled tributary sites for the four monitoring areas of the Oregon Coast Coho ESU comparing 2013 with the average from 1998-2012. P values are for the comparison test of the two curves. The points shown on the curves are the percentage of unoccupied sites (circles), the median density (squares), and the percentage of sites below full seeding (triangles).

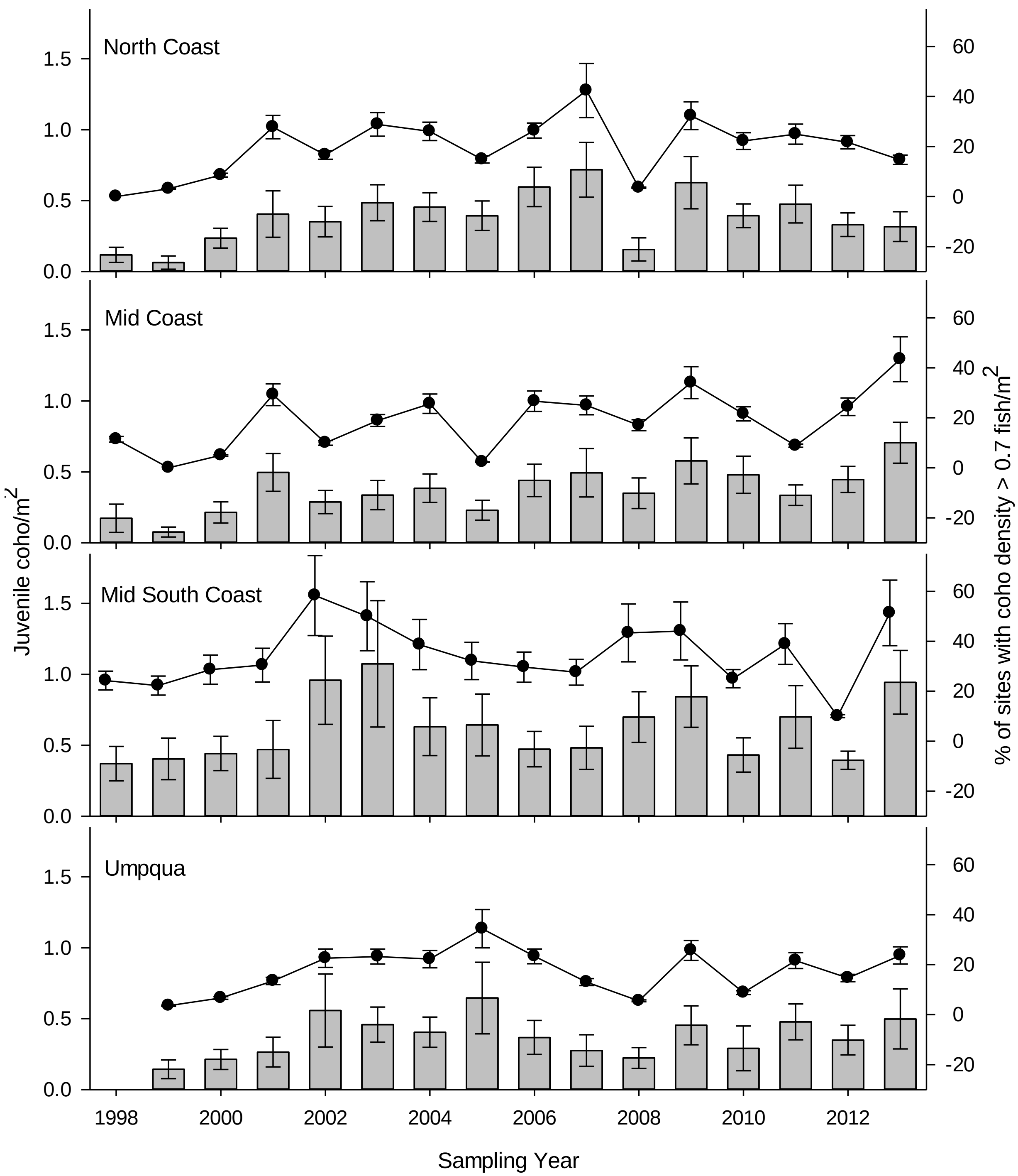

Figure 4. Annual trends in density and full seeding for juvenile coho salmon in monitoring areas of the Oregon Coast Coho ESU, based on snorkel surveys in 1st-3rd order stream reaches. Panels are organized by monitoring strata. Gray bars are for mean average density (coho/meter^2) and black dots are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

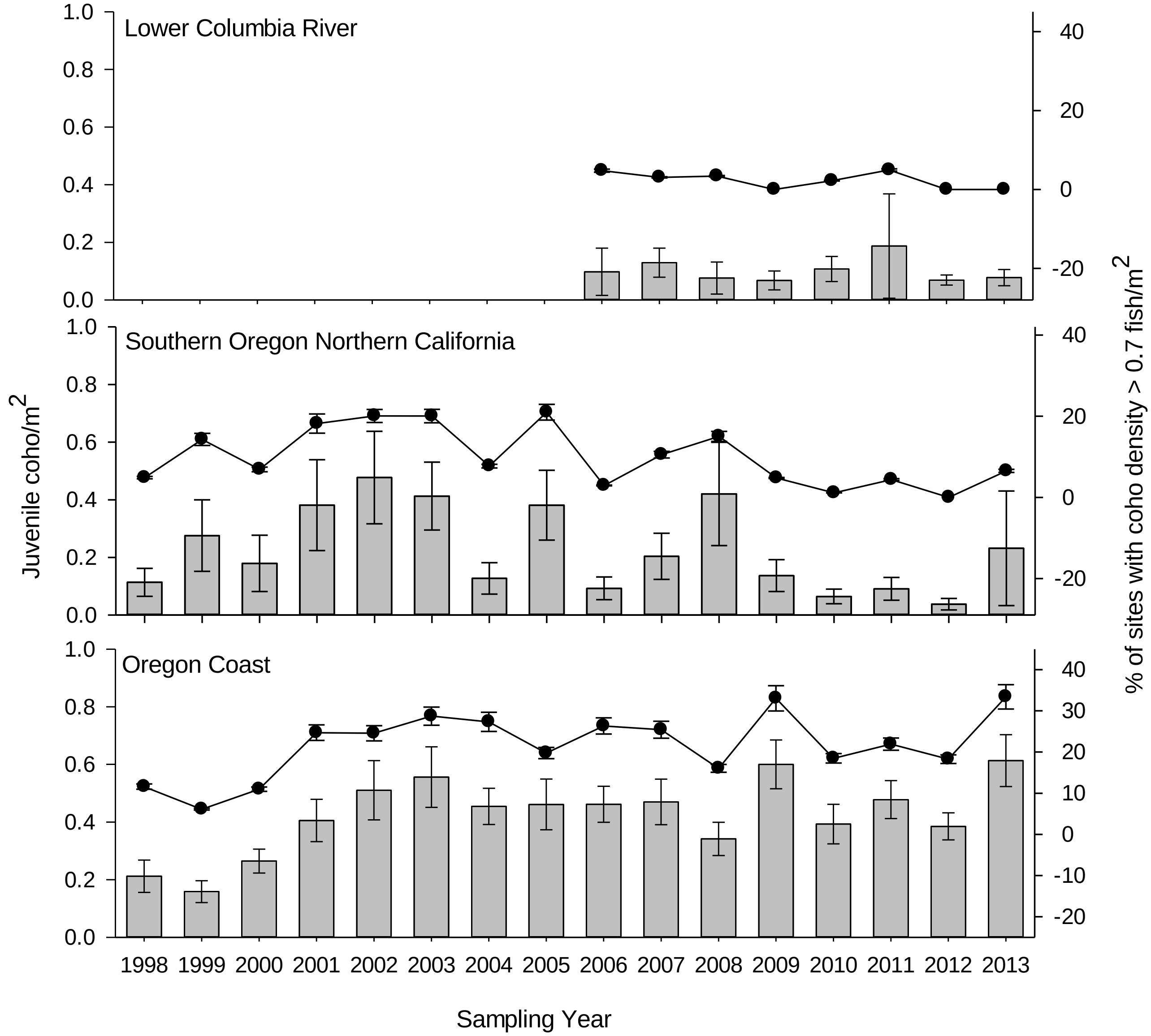

Figure 5. Annual trends in density and full seeding for juvenile coho salmon in Western Oregon Coho ESUs, based on snorkel surveys in 1st-3rd order stream reaches. Gray bars are for mean average density (coho/meter^2) and black dots are the percent of fully seeded sites.

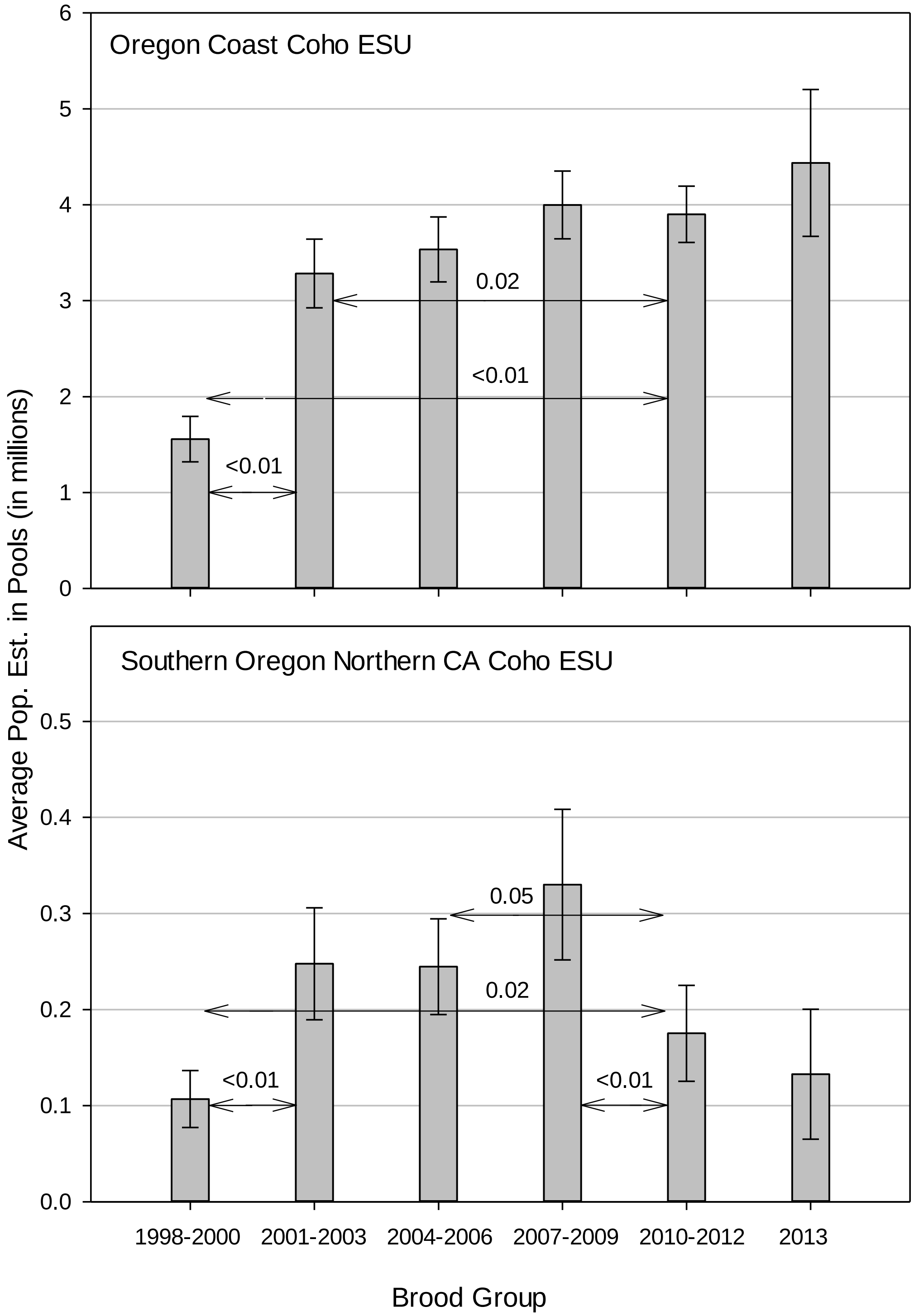

Figure 6. Trends in average pool population estimates of coho by brood group in the Oregon Coast Coho ESU (top panel) and Southern Oregon Northern California Coho ESU (bottom panel). Note the difference in Y-axis scale between the two panels. Gray bars show the population estimate (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow where differences are significant.

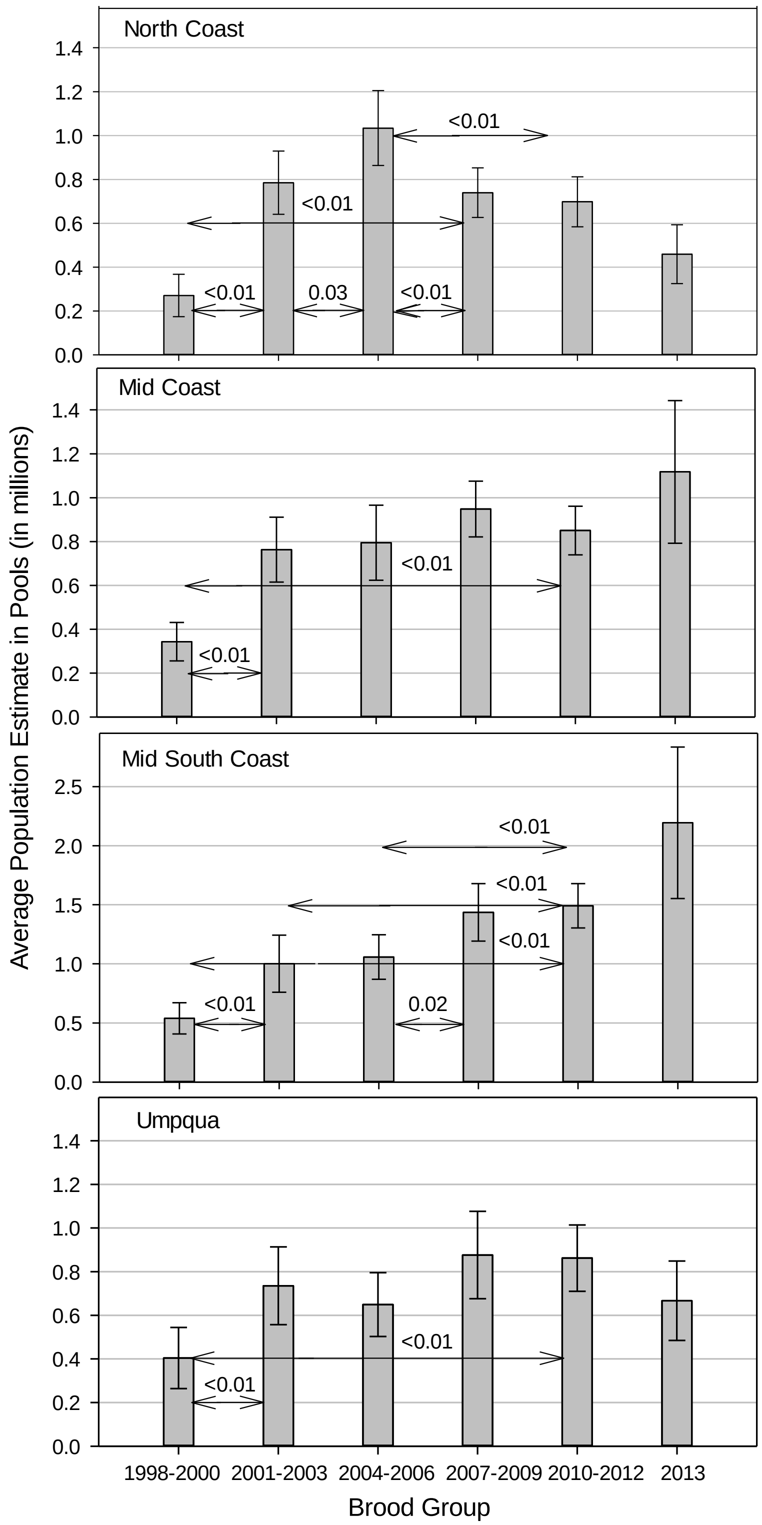

Figure 7. Trends in average pool population estimates of coho by brood group in the four monitoring areas of the OCC ESU. Gray bars show the population estimate (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow where there are significant differences.

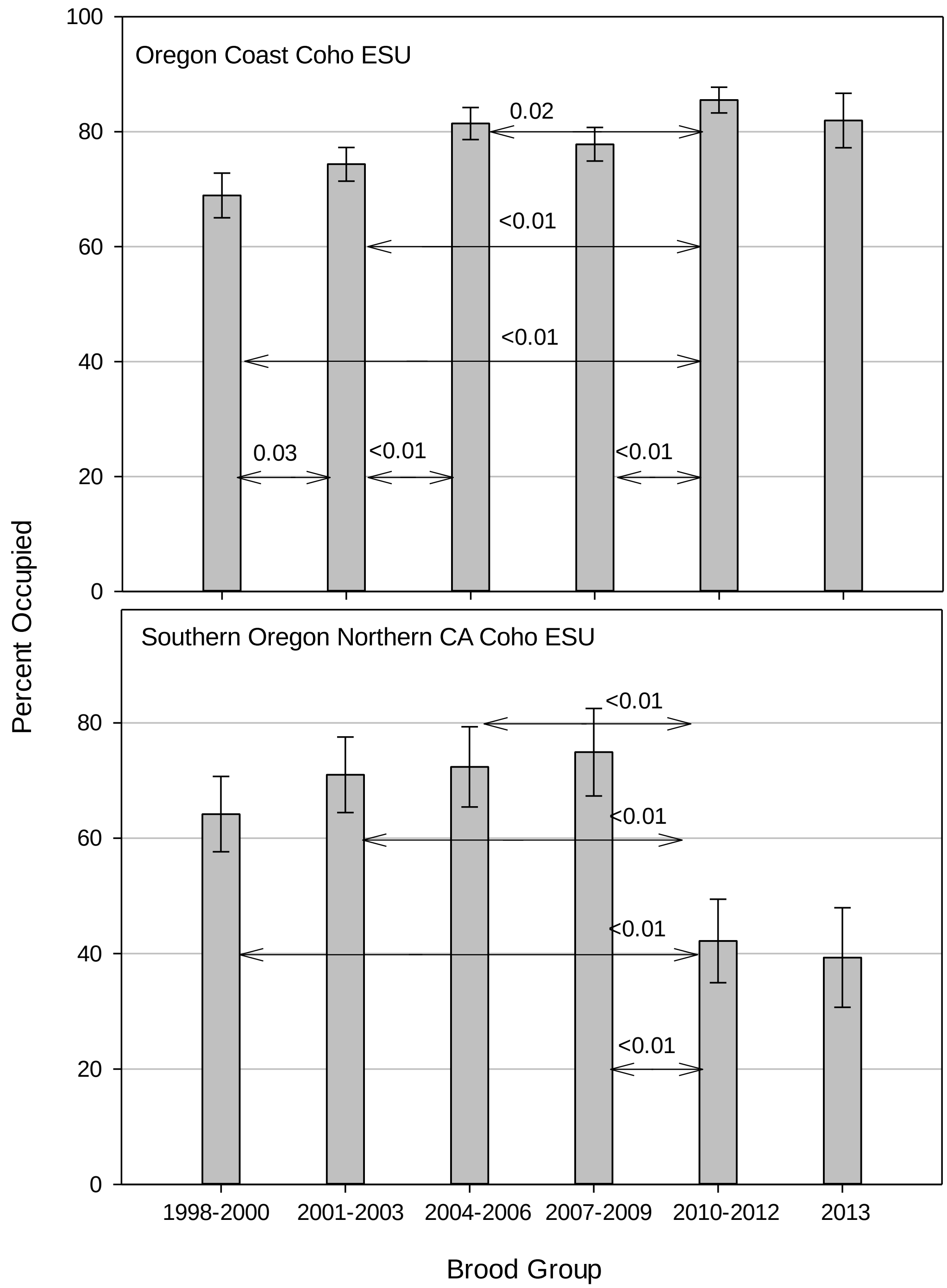

Figure 8. Trends in site occupancy of coho by brood group in the Oregon Coast Coho ESU (top panel) and Southern Oregon Northern California Coho ESU (bottom panel). Gray bars show the percent occupied (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow where there is a significant difference.

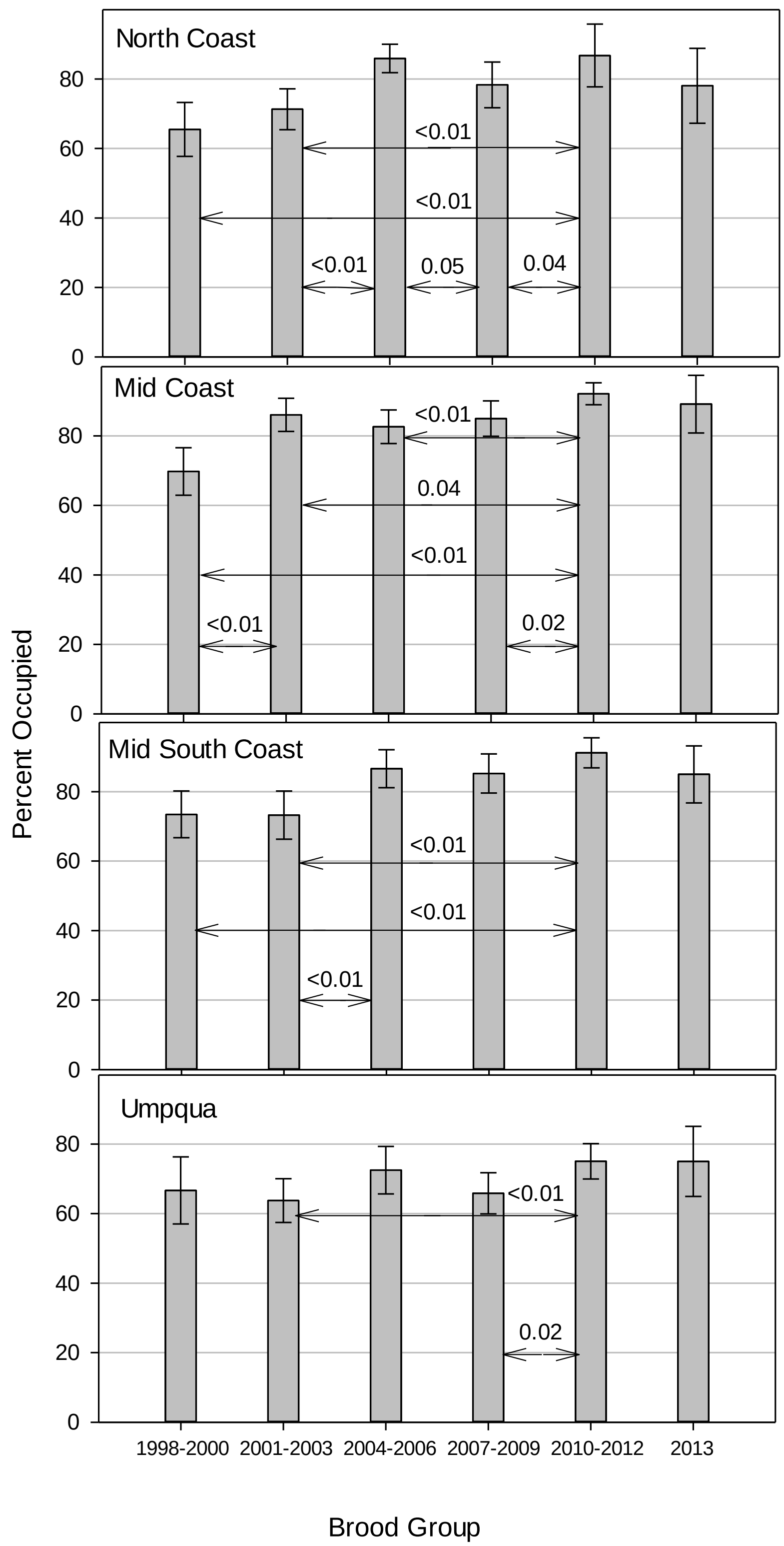

Figure 9. Trends in site occupancy of coho by brood group in the four Oregon Coast Coho Monitoring Areas. Gray bars show the percent occupied (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow where there is a significant difference.

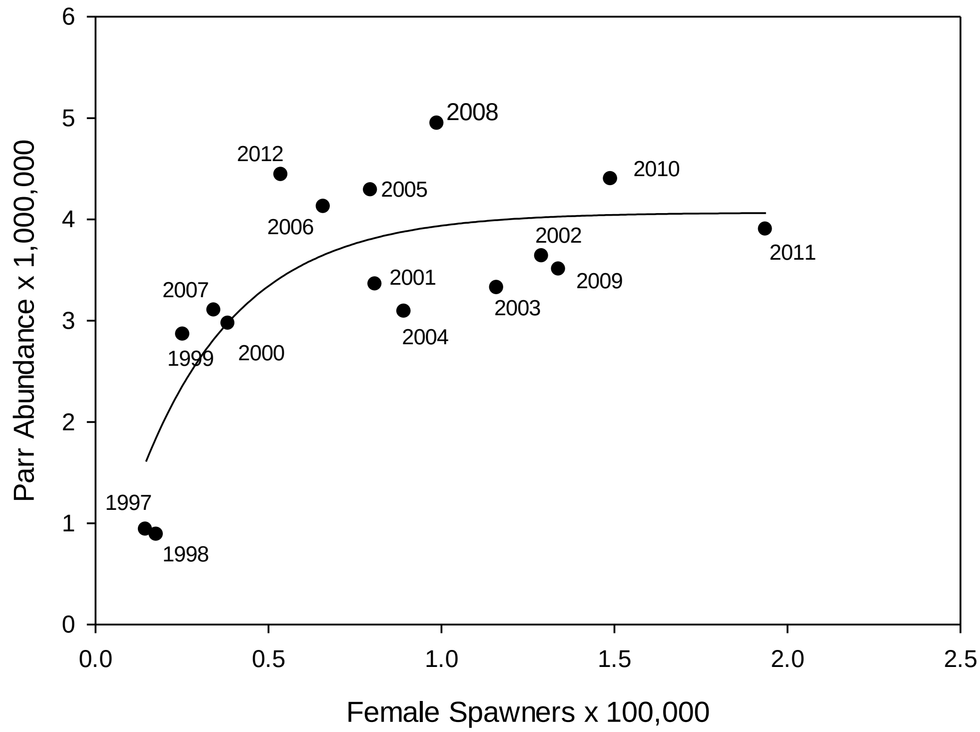

Figure 10. The relationship between parr abundance in pools and the number of female spawners which produced them. Parr numbers are from un-calibrated visual estimates in pools that met snorkeling criteria. Brood year is given for each data point.

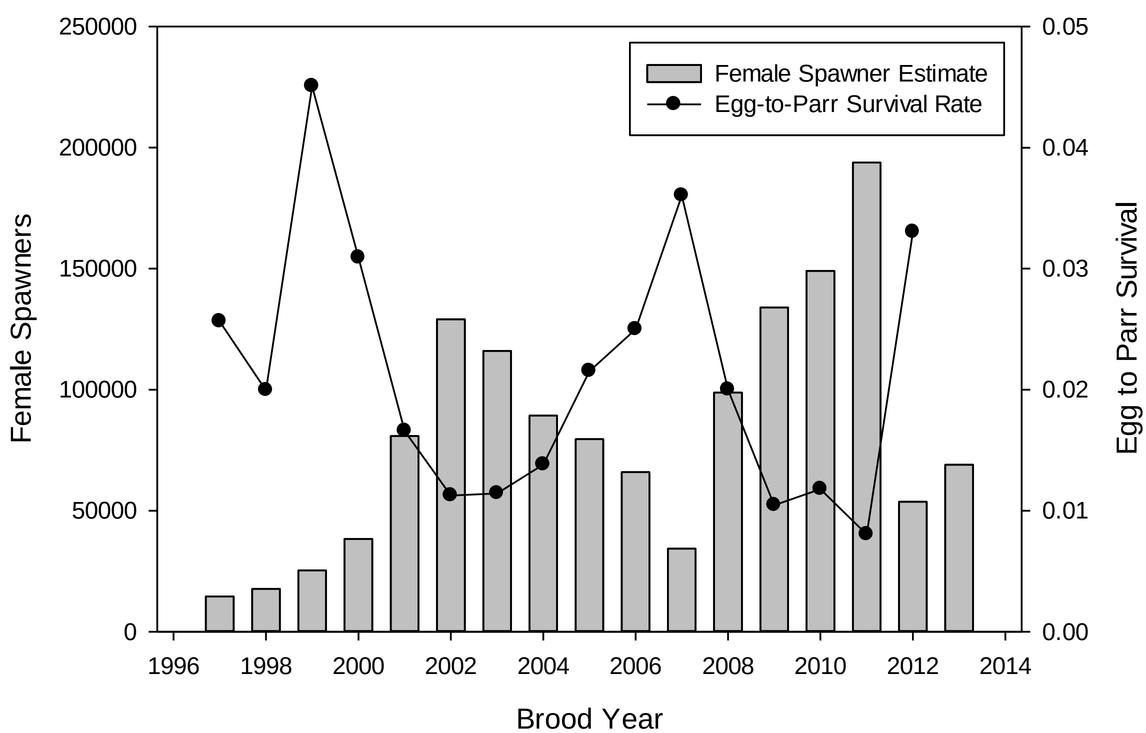

Figure 11. Percent egg-to-parr survival and the abundance of female spawners by brood year in the Oregon Coast Coho ESU.

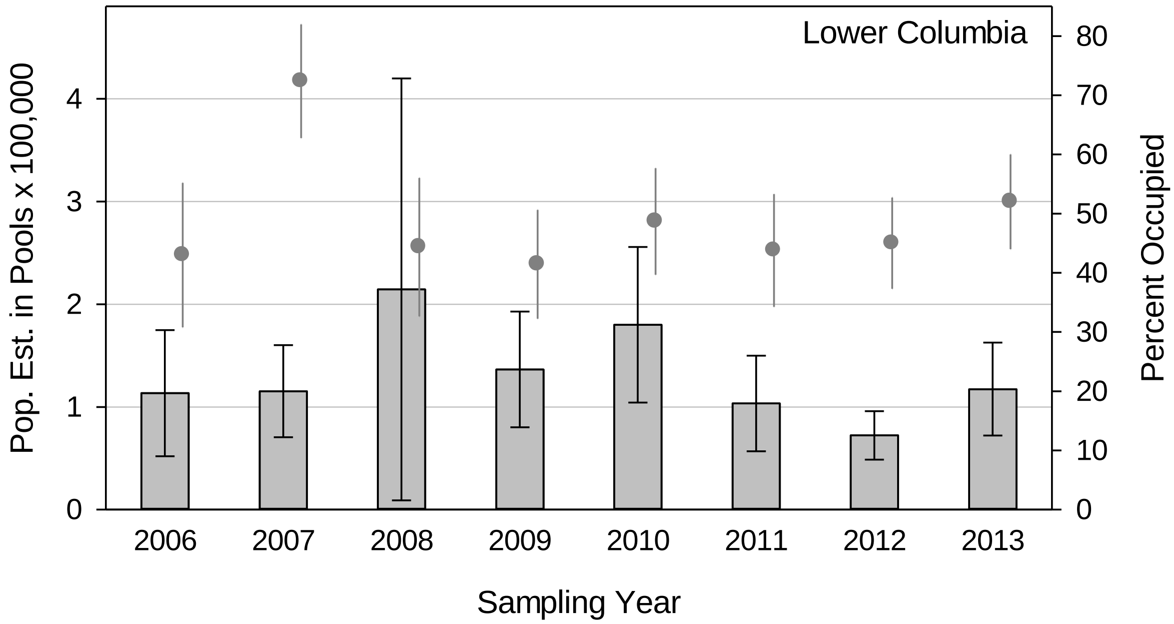

Figure 12. Trends in pool population estimates and site occupancy of coho by sampling year in the Lower Columbia River ESU. Gray bars show the population estimate (with 95% CI) for the year, gray dots (with 95%CI) show the percent of occupied sites.

Oregon Coast Steelhead

For the DPS, densities in 2013 were higher than average from 2002-2012 and higher than in 2012 (Figure 13). Pool frequencies were similar to the average for the DPS and to the 2012 estimate.

Pool population estimates in 2013 were similar to the average. The 2013 pool population estimate was also similar to the 2012 estimate, but with a low p value of 0.06. Site occupancy was similar to the average and similar to the estimate in 2012. The last three years (2011-2013) have had the 3 highest steelhead site occupancies and the current steelhead brood group has a higher average occupancy estimate than the two earlier groups (Figure 16). No 4^{th}-6^{th} order streams were surveyed in the Oregon Coast DPS in 2013. Regressions of both year to pool population estimates and year to site occupancy showed no increasing or decreasing trend in steelhead abundance or distribution.

Klamath Mountain Province Steelhead

In 2013 steelhead density in the DPS was the lowest recorded, but similar to the second lowest estimate from 2012. Density was lower than average for the DPS. Pool frequency was the second lowest recorded, and similar to the lowest estimate in 2012. Pool frequency was lower than the average for the DPS.

Although density was lower, pool population estimates in 2013 were similar to the average condition and to 2012. Pool population estimates from the current brood group were similar to the two preceding groups (Figure 15). Site occupancy was the third lowest recorded and similar to the average condition and to 2012. The current brood group is similar to the two preceding groups (Figure 16).

Density and site occupancy were higher in the Non-Rogue portions of the DPS (Table 3). Due to budget restrictions, 4^{th}-6^{th} order streams were not surveyed in the DPS for 2013. No increasing or decreasing trends were detected in steelhead distribution or abundance.

Lower Columbia River/Southwest Washington Steelhead

The two steelhead DPSs in the Lower Columbia River had similar density estimates (Table 3). Densities were also similar to the averages for the DPSs and to their 2012 estimates.

Pool Frequencies in the two DPSs for 2013 were similar to the average since 2006 and similar to 2012 (Figure 13). Site occupancy (Figure 14) in LCR was similar to the average in and to 2012. In SWW, site occupancy in 2013 was similar to the average (but with a low p value of 0.07) and similar to 2012. Site occupancies for the SWW DPS in the past two years have been the first and second highest recorded.

Pool population estimates (Figure 14) for LCR and SWW were similar to the average and to 2012. No increasing or decreasing trend was detected in steelhead distribution or abundance for either DPS.

Table 3. Distribution and density estimates for juvenile steelhead in western Oregon streams in summer 2013. Distribution metrics are calculated from snorkeled and electrofished sites. Density metrics are calculated from snorkeled sites.

Monitoring Area	Site Occupancy	Mean Pool Frequency	95% CI	Mean Average Pool Density (sthd/m2)	95% CI
North Coast	78%	52%	± 16%	0.059	± 33%
Mid Coast	80%	40%	± 17%	0.064	± 31%
Mid-South Coast	85%	49%	± 17%	0.035	± 26%
Umpqua	75%	33%	± 17%	0.03	± 31%
KMP Rogue	83%	45%	± 13%	0.03	± 22%
KMP South Coast	97%	71%	± 12%	0.054	± 27%
Lower Columbia	68%	41%	± 24%	0.023	± 40%
Southwest WA	83%	36%	± 17%	0.022	± 37%

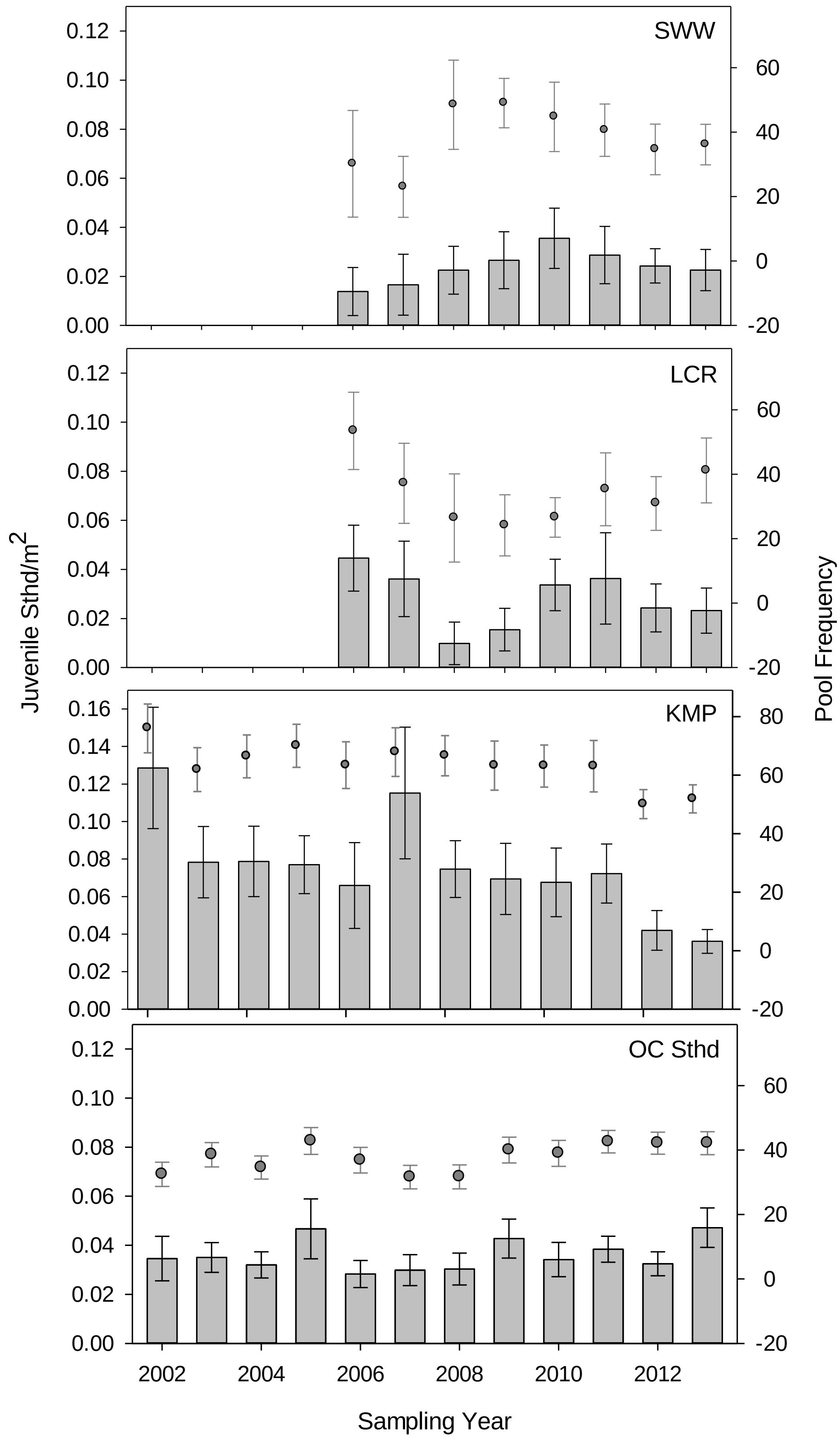

Figure 13. Annual trend in mean density (bars) and pool frequency (dots) metrics for steelhead in the four Coastal DPS Monitoring areas, based on snorkel surveys in 1st-3rd order streams. Error Bars are the 95% CI. Note density scale difference for the KMP.

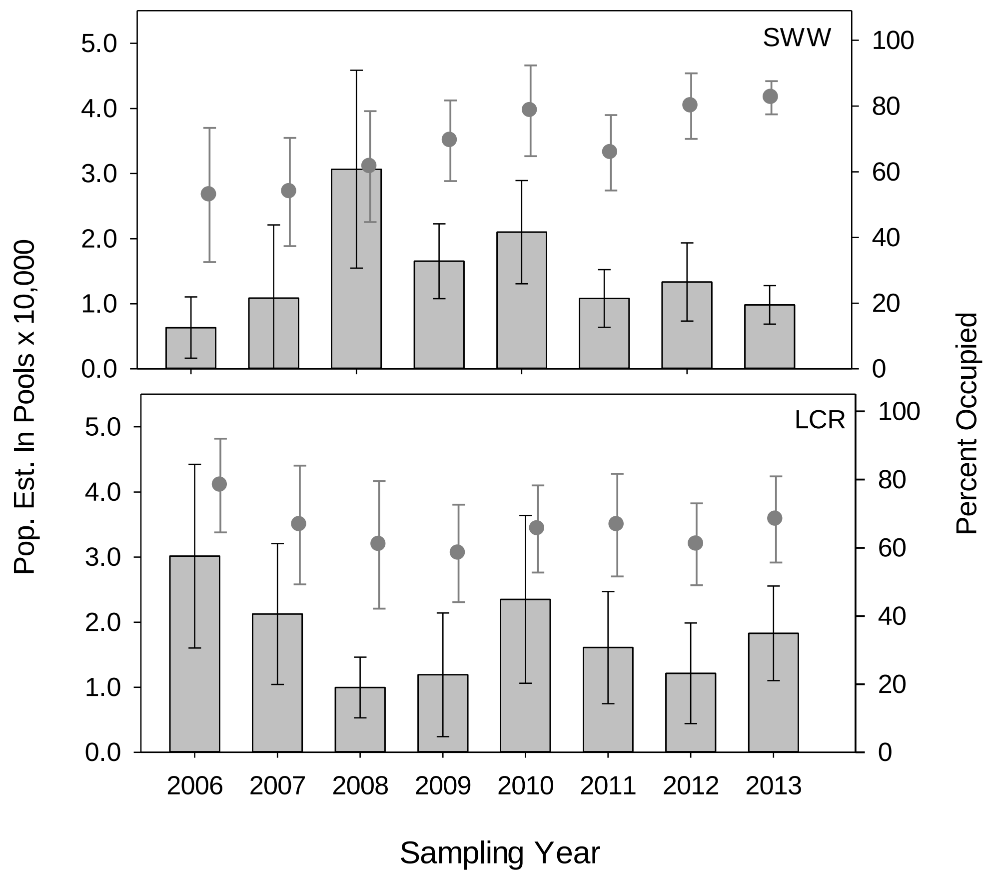

Figure 14. Annual Trend in population estimates from pools (gray bars) and site occupancy (dots) metrics for steelhead based on surveys in 1^{st}-3^{rd} order streams in the two lower Columbia River DPS. Error bars show the 95% CI.

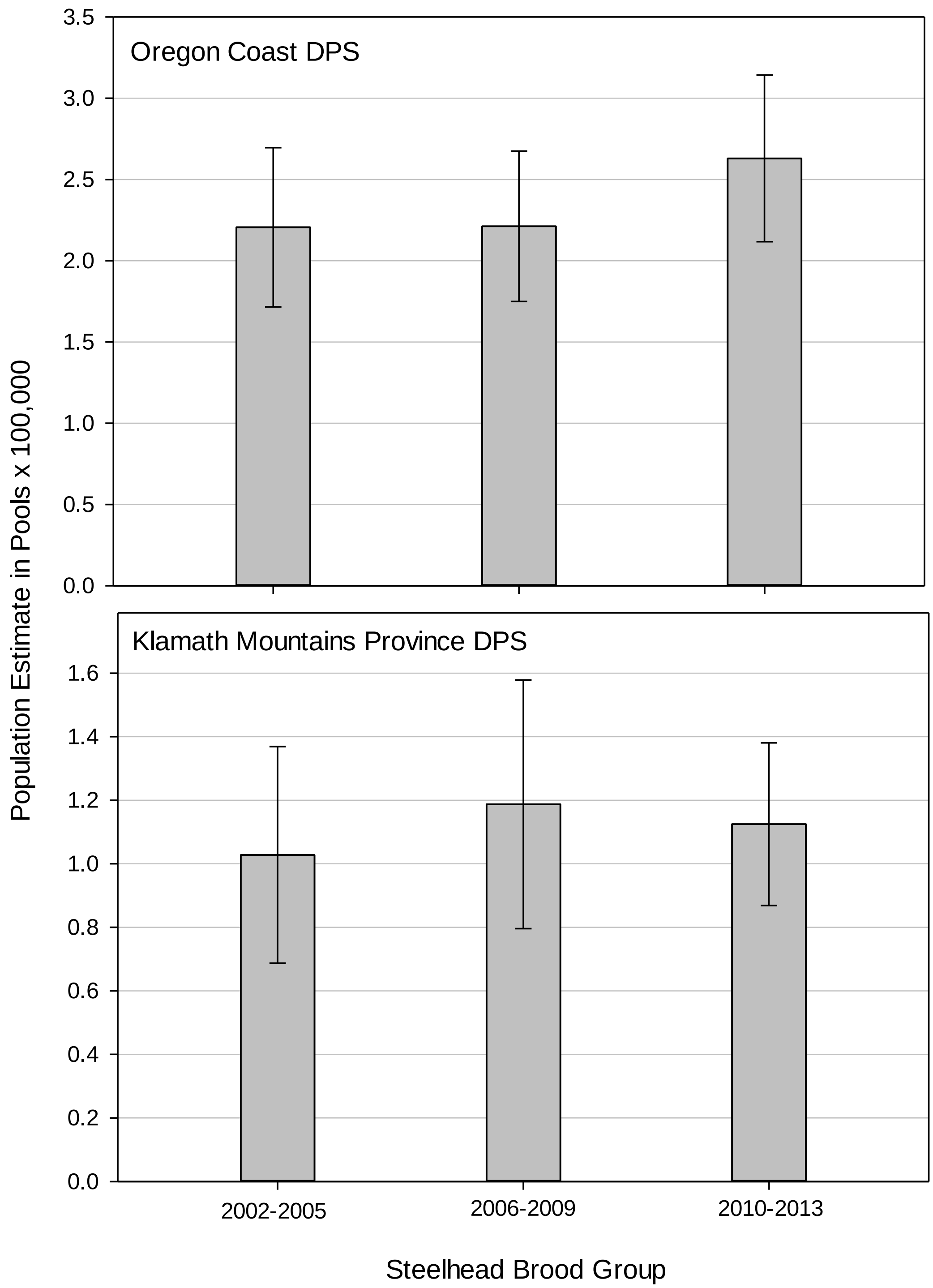

Figure 15. Trends in pool population estimates of steelhead juveniles by brood group in the Oregon Coast DPS (top panel) and the Klamath Mountains Province DPS (bottom panel). Gray bars show the population estimate with the 95% CI for the brood group.

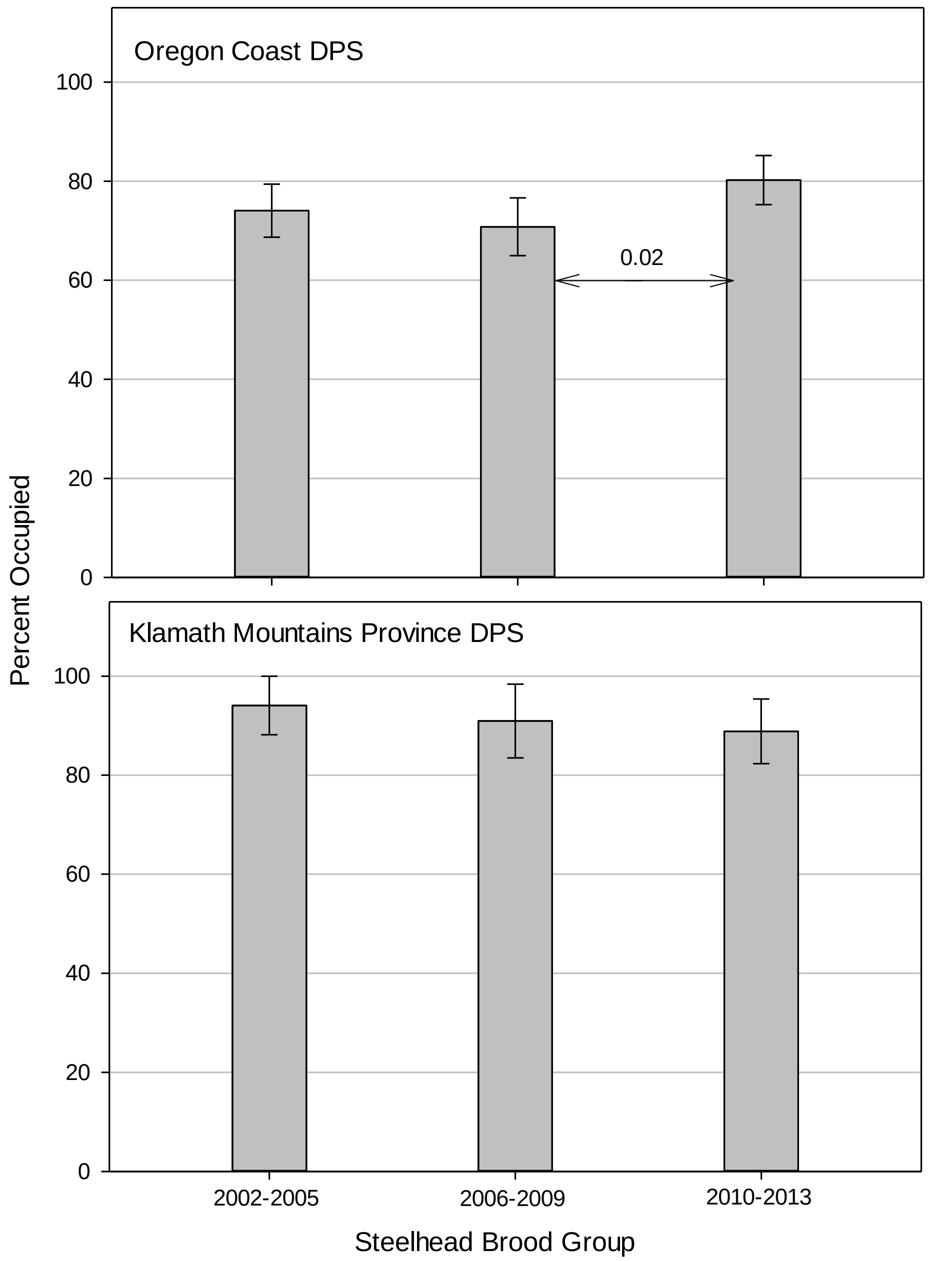

Figure 16. Trends in site occupancy for steelhead by brood group in the Oregon Coast DPS (top panel) and Klamath Mountains Province DPS (bottom panel). Gray bars show the percent occupied (with 95% CI) for each brood group, p values for comparison are given above the vertical arrows when there is a significant difference.

ESU/DPS Comparisons

Coho

The Oregon Coast Coho ESU had the broadest coho distribution (based on occupancy rates, Figures 8 and 12) and the highest density estimates (Figure 5). The Lower Columbia River ESU had a lower density estimate than the SONCC, and occupancy estimates were higher in the SONCC. Population estimates in pools are not directly comparable because the number of stream kilometers differs among the ESUs.

Steelhead

In most previous years the Klamath Mountain Province DPS had the highest density estimates, but in 2013 the estimate was similar to the Oregon Coast. Density for the coast and KMP were slightly higher than in the SWW and LCR. The coast and SWW had similar site occupancy estimates, the KMP was higher than these estimates and the LCR was lower. This pattern was similar for pool frequency metrics, with the coast and SWW being similar, the KMP being highest and the LCR being lowest. Population 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, in prep.) indicated a large portion of the summer coho and steelhead rearing populations are often found in pools that did not meet the pre 2010 snorkeling criterion of ≥40 cm in maximum depth. Data from removal estimates (electrofishing with block nets) shows pools ≥40cm max depth contained an average of 46% of the coho population and 68% of the steelhead population in the study area. The yearly difference ranged from 31% to 61% for coho and 49% to 82% for steelhead. Population estimates in pools ≥40 cm (based on removal estimates and expanded to the basin) related moderately to total population estimates (for coho $R^2 = 0.791$, $p = 0.007$; for steelhead relation was stronger ($R^2 = 0.918$, $p = 0.001$). Lowering the maximum depth criterion to ≥20 cm allowed an average of 74 % of the coho population and 79% of the steelhead population to be sampled by electrofishing with a yearly range of 61 - 82% for coho and 54 - 91% for steelhead. Population estimates from pools ≥20 cm had a strong and significant relationship with total population 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 ≥20 cm in 2010. This change will be monitored for survey effort, accuracy and repeatability, and influences on occupancy, density and population estimates. Results from 2013 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 criteria resulted in an additional 1,820 pools snorkeled and 126 pools electrofished in 2013. Two sites in the Lower Columbia and one site in the SONCC did not have pools that were ≥40 cm in depth, but did have pools that were ≥20 cm in max depth. With the new criterion, the status of these sites would change from non-target to target (Table 1).

Distribution

A single coho was observed in one of the three sites for which all pools were <40cm in depth. Steelhead were not observed in this site. In the other two sites only steelhead were observed. Lowering the depth criterion also allowed surveyors to observe salmonids in several sites where they would not have been observed under the previous criterion. In these sites salmonids were in pools that were <40cm in depth, but not in pools that were ≥40cm in depth. For coho, this occurred in six sites. For steelhead this occurred in eight sites. Using the lower depth criteria increased site occupancy estimates in these areas, over those given in Table 2 (for coho) and Table 3 (for steelhead). Site occupancies were not significantly changed in other areas.

The average pool frequency for coho decreased when depth criteria was lowered to include more shallow pools. The decrease in pool frequency was more pronounced for steelhead, but averaged under a 10% decrease.

Density

Coho density estimates decreased in most management areas when the lower depth criterion was applied. In most cases this was a less than 10% decrease, but in the SONCC the density estimate decreased by 16% and in the Mid South Coast MA the density estimate increased by 25%.

Steelhead density estimates also decreased with the lower depth criterion. For the Oregon Coast DPS, densities decreased by approximately 15%. In the KMP densities decreased by less than 10% and in the LCR and SWW the decrease was under 5%.

Pool Population Estimates

Pool population estimates with the different depth criteria from surveys in 2013 are displayed for coho in Table 4 and steelhead in Table 5. These estimates represent the number of fish in pools from un-calibrated visual counts and should not be interpreted as total population estimates. Paired t-tests from pools ≥40cm and pools ≥20cm indicate that including the more shallow pools produces, on average, a 15% larger population estimate for coho ($p = 0.041$) and a 6% larger population estimate for steelhead ($p= 0.039$). These results are consistent with those from 2012. As in 2012 and 2011, the increase in pool population estimates was most pronounced in the Mid Coast for both coho and steelhead. The majority of coho and steelhead in 2013 were observed in pools ≥40cm deep.

Results of resurveys from 2010-2012 indicate that including pools between the ≥40cm depth criteria and the ≥20cm depth criteria has little impact of the variability of coho and steelhead counts between surveyors.

Thus far the yearly variability for the coho population in each MA and ESU estimated by surveys in pools ≥40cm in depth has tracked with the variability estimated by surveys in pools ≥20cm in depth (Figure 17). Population 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 population 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 ≥20 cm and those using a maximum depth of ≥40 cm.

Monitoring Area	2013 Coho Estimates				
	Pools ≥ 20cm Max Depth		Pools ≥40cm Max Depth		Difference
	Estimate	95% CI	Estimate	95% CI	
North Coast	506,411	±29%	459,220	±29%	9.30%
Mid Coast	1,423,582	±25%	1,117,548	±29%	21.50%
Mid South Coast	2,658,104	±26%	2,192,920	±29%	17.50%
Umpqua	786,927	±26%	666,602	±27%	15.30%
SONCC	163,363	±49%	132,795	±51%	18.70%
Lower Columbia	125,802	±39%	117,372	±39%	6.70%

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

Monitoring Area	2013 Steelhead Estimates				
	Pools ≥ 20cm Max Depth		Pools ≥ 40cm Max Depth		Difference
	Estimate	95% CI	Estimate	95% CI	
North Coast	56,024	±31%	52,914	±33%	5.60%
Mid Coast	135,671	±39%	117,147	±43%	13.70%
Mid South Coast	84,001	±33%	76,866	±36%	8.50%
Umpqua	48,050	±27%	45,460	±28%	5.40%
KMP Rogue	47,986	±22%	45,169	±24%	5.90%
KMP South Coast	76,445	±29%	75,826	±29%	0.80%
Lower Columbia DPS	18,651	±40%	18,283	±40%	2.00%
Southwest WA DPS	10,265	±29%	9,824	±30%	4.30%

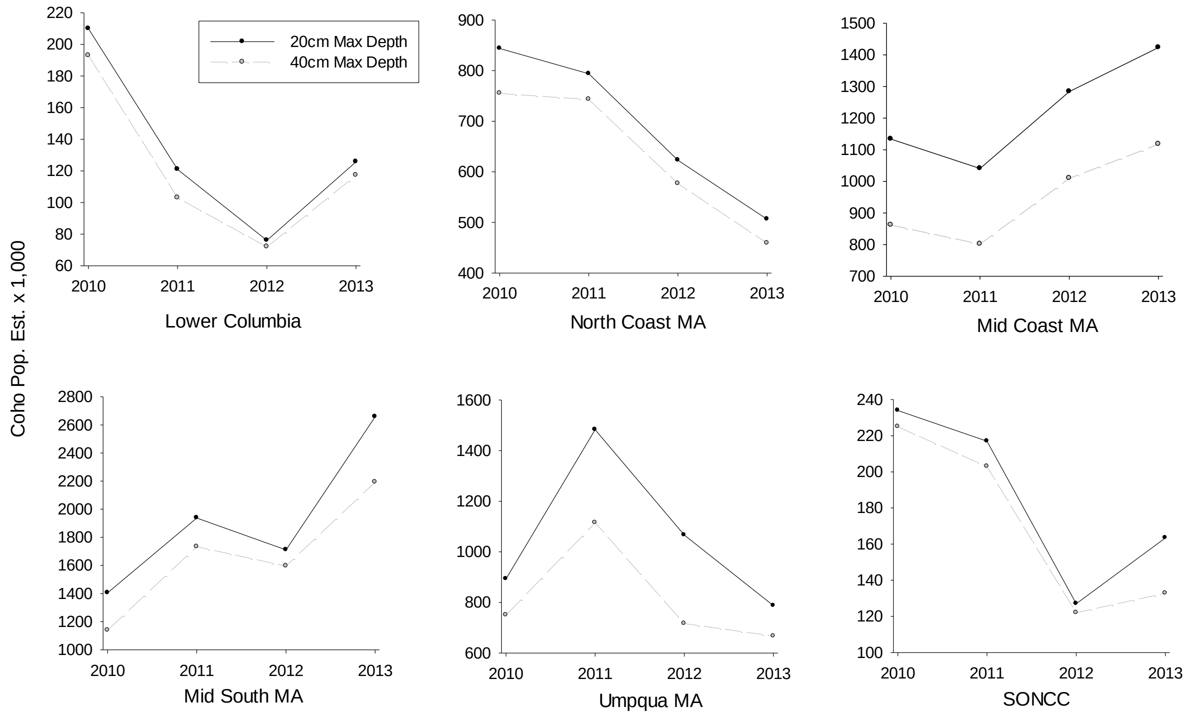

Figure 17. Trends in the coho rearing population from 2010 to 2013 based on the ≥20cm pool depth criteria (solid black line) and the ≥40cm pool depth criteria (dashed grey line).

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