THE OREGON PLAN *for Salmon and Watersheds*





Juvenile Salmonid Monitoring In Coastal Oregon and Lower Columbia Streams, 2012

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Oregon Plan for Salmon and Watersheds

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SUMMARY

This report provides analysis of data from juvenile salmonid surveys in 2012, comparisons with results from previous years, and information on trends in juvenile salmonid distribution and abundance. Distribution metrics are specific to species and include site occupancy (the percent of sites with fish present) and pool frequency (average percent of pools per site with fish) for each Monitoring Area (MA), Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS) in the project area. Abundance metrics are also specific to species and include the average density and population estimates in pools for each MA and ESU/DPS. Prior reports can be found at https://nrimp.dfw.state.or.us/crl/default.aspx?pn=WORP.

Oregon Coast Coho (OCC) ESU density estimates were lower than in 2011. Pool population estimates and site occupancies were similar to 2011. We observed a small, but positive trend in occupancy and pool population estimates for coho across the ESU from 1998-2012. Within the four coastal monitoring areas, density and occupancy estimates were higher than the average from 1998-2011 in the Mid Coast MA, similar to the average in the Umpqua and North Coast, and lower in the Mid South. Pooling of data into three year “brood groups” indicated the current group had higher combined population estimates than the earliest two groups but was similar to 2004-2006 and 2007-2009. Site occupancy was higher in the current brood group than in any other group.

Southern Oregon Northern California Coho (SONCC) ESU density and site occupancy estimates were the lowest recorded. Pool population estimates were similar to the average from 1998-2011. The current brood group had a higher population estimate than for 1998-2000, but the estimate was lower than all other brood groups. Site occupancy for current brood group was also lower than the other brood groups.

Lower Columbia River Coho (LCR) density and pool population estimates were similar to 2011 and to the average from 2006-2011. Site occupancy was slightly below the average recorded from 2006-2011.

Steelhead density, pool population, and pool occupancy estimates were similar to previous years in the Oregon Coast DPS. Site occupancies for the Oregon Coast DPS were the higher than average and similar to 2011.

In the Klamath Mountain Province (KMP) DPS, steelhead density and pool frequency estimates were the lowest recorded. Population estimates were similar to the average and to 2011. Site occupancy was similar to the average condition and to 2011, however the estimates for the past 3 years have been the 2nd, 3rd, and 4th lowest estimates, respectively.

Steelhead density estimates in the LCR and the Southwest Washington (SWW) DPSs were similar to each other and to the average and 2011 estimates for the DPSs. Site occupancy in the LCR was similar to 2011 and to the overall average. Site occupancy in SWW was higher than in 2011 and the overall average. Population estimates for both DPSs were similar to 2011 and to the overall average.

Analyses which included shallower pools produced higher site occupancies in the Umpqua, Mid Coast and LCR for coho and in the Umpqua and the KMP for steelhead. Pool population estimates also increased with the addition of the smaller pools and had proportionately smaller confidence intervals.

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 status and trends in abundance and distribution of juvenile coho salmon (*Oncorhynchus kisutch*) in coastal Oregon streams (Figure 1). Starting in 1998, the project surveyed 1^{st}-3^{rd} order (wadeable) streams within the rearing distribution of juvenile coho in the Oregon Coast Coho (OCC) and Southern Oregon Northern California Coho (SONCC) Environmental Significant Units (ESU). In 2002, we added surveys for juvenile steelhead (*Oncorhynchus mykiss*) in the Klamath Mountain Province (KMP) and Oregon Coast Distinct Population Segment (DPS), and expanded surveys to 4^{th} -6^{th} order (non-wadeable mainstem) streams for coho and steelhead. In 2006, surveys were initiated in the Oregon portions of the Lower Columbia River coho (LCR) ESU and steelhead DPSs. Surveys in 4^{th} to 6^{th} order streams were discontinued in 2009 for the Oregon Coast Coho ESU and in 2012 for the Lower Columbia Coho ESU.

A Generalized Random Tessellation Stratified design (GRTS, Stevens 2002) was used to select sampling locations (GRTS points) in a spatially balanced, random fashion. Sample sites were stratified by Monitoring Area (MA) and stream order (wadeable and non-wadeable) (Table 1). A detailed description of the sampling frames and survey designs are found in Jepsen and Rodgers (2004) and Jepsen and Leader (2007). The original 100k stream layer sampling frame for the Oregon Coast ESU was replaced by a 24k frame in 2007. The 24k frame considered a larger number of stream kilometers to be within the rearing distribution of coho and steelhead. Analyses for all years on the coast are now based on the 24k frame. In 2012 a 24k sampling frame was developed for the SONCC/KMP. This frame also includes a larger amount of stream kilometers in the rearing distribution than the former frame. Until the 2012 frame is verified by survey effort, and for comparison purposes, analyses in the SONCC/KMP will be based GRTS points and distribution within its former frame.

Field crews survey a one kilometer stream reach encompassing the selected GRTS points. Within this reach, all pools that are ≥20cm deep and ≥6 m^2 in surface area are snorkeled to identify and enumerate juvenile salmonids. 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.

Surveys were conducted during the minimum flow period from July to early October using a single pass of one to six snorkelers, depending on stream width. In each pool surveyors counted juvenile coho, Chinook, steelhead ≥90 mm, and cutthroat

≥90 mm. Presence was noted for dace, shiners, and trout <90 mm. Freshwater mussels 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 repeatability/precision approximately 15% of surveys in wadeable reaches are resurveyed.

Data are summarized and presented by ESU, MA, and/or DPS and by stream order (wadeable and non-wadeable). Cumulative Distribution Frequency graphs, variances, and confidence intervals were created using tools developed by the EMAP Design and Analysis Team (EPA 2009). When making year-to-year or year-to-average trend 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 pools. The resulting percent at each site is then averaged to obtain the estimated percent within the MA, ESU, or DPS.
- Fish density
  - The estimate of the number of fish per square meter of surface area of each pool. Density is calculated for each pool in a site and then averaged to produce the density for the site. The average of the site averages is the density estimate for each MA, ESU, or DPS
- 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 meter 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. 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 $\geq$0.7 coho/m^2 is also reported for each MA. A value $\geq$0.7 coho/m^2 is regarded as full seeding from Nickelson et al. (1992) who reported full seeding based on electrofishing removal estimates as 1.0 coho/m^2, and Rodgers et al. (1992) reported that snorkelers observed 70% of the coho in electrofishing removal estimates.

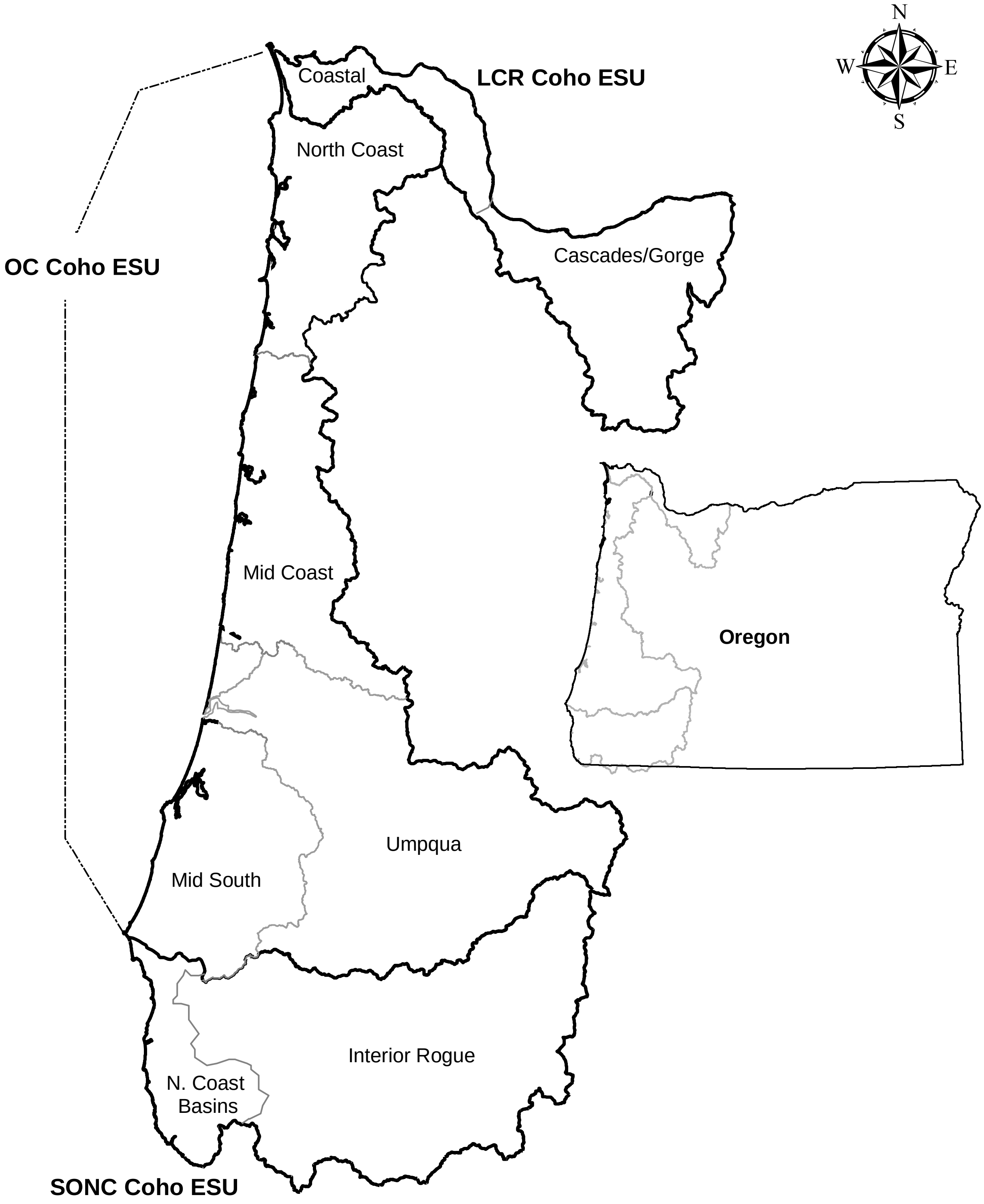


Figure 1. The spatial extent of the study area showing the Oregon portion of coho ESUs and the monitoring areas/strata within each ESU.

In 2012, the 15th season of juvenile coho monitoring in the OCC and SONCC ESUs was completed, yielding 15 years of distribution and abundance data. To facilitate our monitoring of coho distribution and abundance trends during this period, site occupancy and population estimate data were pooled for each three-year interval into five successive brood groups, based on the conventional three-year coho life cycle. Analyses based on these brood groups will provide information on distribution and abundance trends in addition to information provided from analyses on a year-to-year or year-to-average condition basis. Comparisons among brood groups (as opposed to individual cohorts or years), can assist analysis of long term monitoring of trends 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 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.

Steelhead data will be pooled in four-year intervals (based on the most common steelhead life cycle) following the 2013 field season. Coho data from the lower Columbia will be pooled following the 2014 field season.

RESULTS

Survey Effort and Resurveys

In 2012 we selected 574 sites for sampling within our frame with 68 of these sites being non-target, or outside the distribution of potential rearing habitat. Of the remaining 506 sites, 72% (363) were successfully snorkeled or electrofished (Table 1). Thirteen percent (65) of the target sites were not surveyed because of landowner access restrictions, 8% (43) were un-sampleable, 2% (9) were inaccessible, and 5% (26) were not visited due to time restrictions. 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 2012.

A total of 5,720 pools at 317 sites were snorkeled in 1st-3rd order reaches and 110 pools at 15 sites were snorkeled in 4th-6th order reaches. We electrofished 405 pools at 31 sites in 1st-3rd order reaches. The goal of a 95% confidence interval within ±30% of the density estimate was met for coho density estimates in all monitoring areas with the exception of the SONCC coho sites (Table 2).

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

ESU	Monitoring Area/ Stratum	Stream Order	Snorkeled	Electrofished	Target Non-response	Non-target
OCC	North Coast	1-3 Order	46	4	8	9
	Mid Coast	1-3 Order	45	0	12	5
	Mid South	1-3 Order	40	3	17	8
	Umpqua	1-3 Order	41	3	12	14
LCR	Coastal	1-3 Order	34	6	26	5
	Cascades/Gorge	1-3 Order	29	12	22	9
SONC	Interior Rogue	1-3 Order	48	1	20	15
	Interior Rogue	4-6 Order	10	0	11	0
	North Coast Basins	1-3 Order	34	2	11	5
	North Coast Basins	4-6 Order	5	0	2	0

Table 2 Distribution and density estimates for juvenile coho in 2012. 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	82%	58%	± 9%	22%	0.331	± 25%
Mid Coast	91%	80%	± 7%	24%	0.447	± 21%
Mid South	88%	73%	± 9%	10%	0.394	± 16%
Umpqua	73%	64%	± 10%	15%	0.349	± 30%
South Coast Coho	25%	16%	± 7%	0%	0.038	± 53%
Lower Columbia	45%	31%	± 6%	0%	0.069	± 25%

The confidence interval goal for steelhead density estimates in the Oregon Coast DPS was met in the North Coast, Mid-Coast, and Mid-South Coast MAs but not in the Umpqua MA where the target was exceeded by 4% (Table 3). In the Klamath Mountains DPS, neither the mainstem nor the tributary streams met the target, but tributary streams were much closer. The goal was reached in the SWW DPS but not in the LCR DPS.

Forty-two (13.1%) of the snorkeled sites in 1st-3rd order reaches were resurveyed by crew leaders. The significant relationship between coho counts in the original surveys and resurveys (Figure 2, top left panel, R^2=0.95) was similar to previous years (1999-2011, R^2=0.95) and indicates the counts are precise and repeatable. Resurvey counts of steelhead were more variable (R^2=0.77) than coho in 2012, and this was similar to past years (average 2002-2010, R^2=0.77). Resurveying also plays a role in the training process by detecting difficulties with fish ID or inconsistencies with survey protocol at the start of the field season. Resurvey data replaced data from one survey due to protocol inconsistencies early in the 2012 season. This site was not included in resurvey analysis.

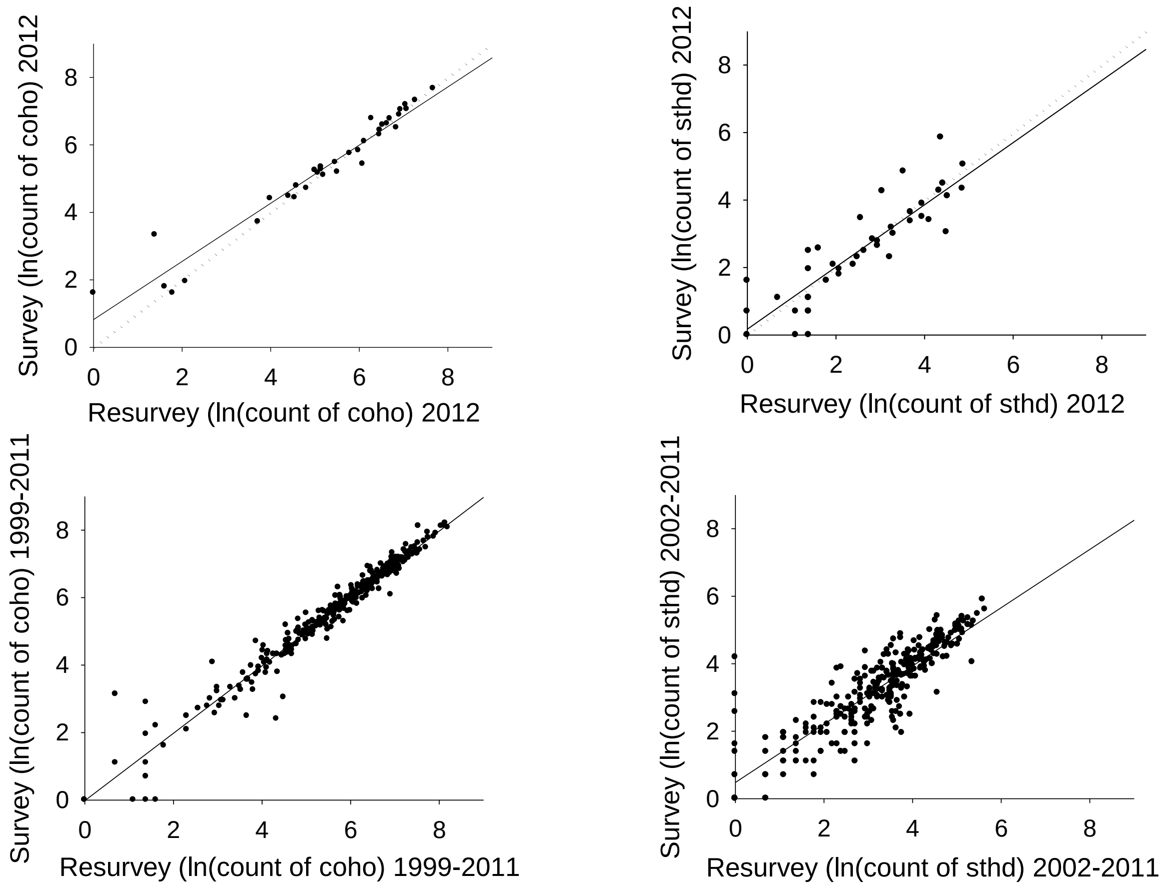


Figure 2. The relationship between original snorkel counts of juvenile coho and steelhead and resurvey counts in the same sites for 2012 (top panels, n=42) and for all years (bottom panels, n=369 and n= 315 for coho and steelhead, respectively). The dotted line for 2012 indicates a 1:1 relationship. Data are log transformed to satisfy regression assumptions.

Trends in Salmonid Distribution and Abundance

Oregon Coast Coho

In 2012, mean average pool density was 0.38 coho/m^2 and 18% of sites were fully seeded (Table 2). Densities at the MA level were highest in the Mid-Coast with the other MAs being similar to each other (Table 2). CDFs comparing average density, percent occupancy, and percent of sites fully seeded in 2012 to the average of these metrics from all previous years are shown in Figure 3. In the North Coast and Umpqua MAs, these metrics in 2012 were similar to the average condition from 1998 - 2011. In the Mid-Coast these metrics were greater than the average of all previous years. Mid-South Coast site occupancy was greater, median density was similar, and the percent of fully seeded sites was less than the average condition.

Density estimates and the percent full seeding are shown for each year in the four Oregon Coast Coho MAs in Figure 4. Densities in 2012 were similar to 2011 for the North Coast, Mid-Coast and Umpqua MAs, but with p-values of 0.07, 0.06, and 0.12, respectively. Density in 2012 was lower than in 2011 for the Mid-South Coast (p value <0.01). In 2012 the percent of sites that were fully seeded was less than in 2011 for the Mid-South Coast (p value <0.01), similar to 2011 for the North Coast and Umpqua, and higher than 2011 in the Mid-Coast (p value = 0.02).

For the ESU as a whole, densities and percent full seeding are shown for each year in Figure 5. Densities in 2012 were lower than in 2011 (p value = 0.02) but not significantly lower than the average condition from 1998-2011. The percent of sites fully seeded in 2012 was similar to 2011 and to the average. Pool frequency (not shown) in 2012 was similar to 2011. Pool frequency in 2012 was higher than on average for the ESU (p value = 0.02). Mean pool frequency was 69% for the ESU in 2012, with the Mid-Coast having the highest rate.

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 current brood group (2010-2012) had a combined pool population estimate that is similar to the two preceding groups, but this estimate is significantly higher than estimates for the first two brood groups (1998-2000 and 2001-2003). The pool population estimate for 2012 was similar to 2011.

Pool population estimates for the coastal MAs are shown in Figure 7. In all MAs, the combined 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. When comparing the current group to the 3rd group (2004-2006), the North Coast is lower, the Mid-Coast and Umpqua are similar and the Mid-South Coast is higher. Comparing the current group to the second group (2001-2003), the North Coast, Mid-Coast, and Umpqua are similar while the Mid-South Coast is higher.

Site occupancy estimates for the ESU are shown in Figure 8. The average percent of occupied sites in the ESU is higher in the current brood group than in any other group. Average site occupancies in the last three cohorts represented the 1st, 3rd, and 2nd highest estimates, respectively. The estimate for 2012 was similar to 2011. 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 coastal 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. In comparisons of the current group to the 3rd group, they are similar in all MAs, except in the Mid-Coast where the current group is higher. Comparing the current group to the second group, occupancies are higher in the current group in all MAs.

Regressions of site occupancy ($R^2 = 0.527$, p value= 0.002) and pool population estimates ($R^2 = 0.585$, p value= 0.001) with the survey year both exhibit a moderate increasing trend since sampling began in 1998. 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.

Southern Oregon Northern California Coho

For 2012 mean average density in pools was 0.038 fish/m^2 (Table 2). No sites were fully seeded. Coho occurred in 25% of the sites in the SONCC and mean pool frequency was 16%. Density and the percent of sites fully seeded in the ESU are shown in Figure 5. In 2012 the density, site occupancy, and percent of sites fully seeded were the lowest estimates recorded. Density estimates were lower than in 2011 (p value = 0.02) and lower than the average (p value <0.01). The percent of sites fully seeded in 2012 was lower than in 2011 (p value = 0.05) and lower than the average (p value <0.01). Pool frequency was also lower in 2011 (p value <0.01) and lower than the average for the ESU (p value <0.01).

Pool population estimates for the ESU are shown in Figure 6. Combined pool population estimates from the current brood group (2010-2012) are lower than those of the preceding two groups (2007-2009 and 2004-2006), 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 2012 is similar to the estimate for 2011, but this is partially due to the large standard of error in 2012.

Combined 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 2012 (not shown) was lower than in 2011 (p value <0.01) and all of the preceding years. The occupancy estimates for the past three years in the ESU have been the 1st, 5th, and 3rd lowest recorded.

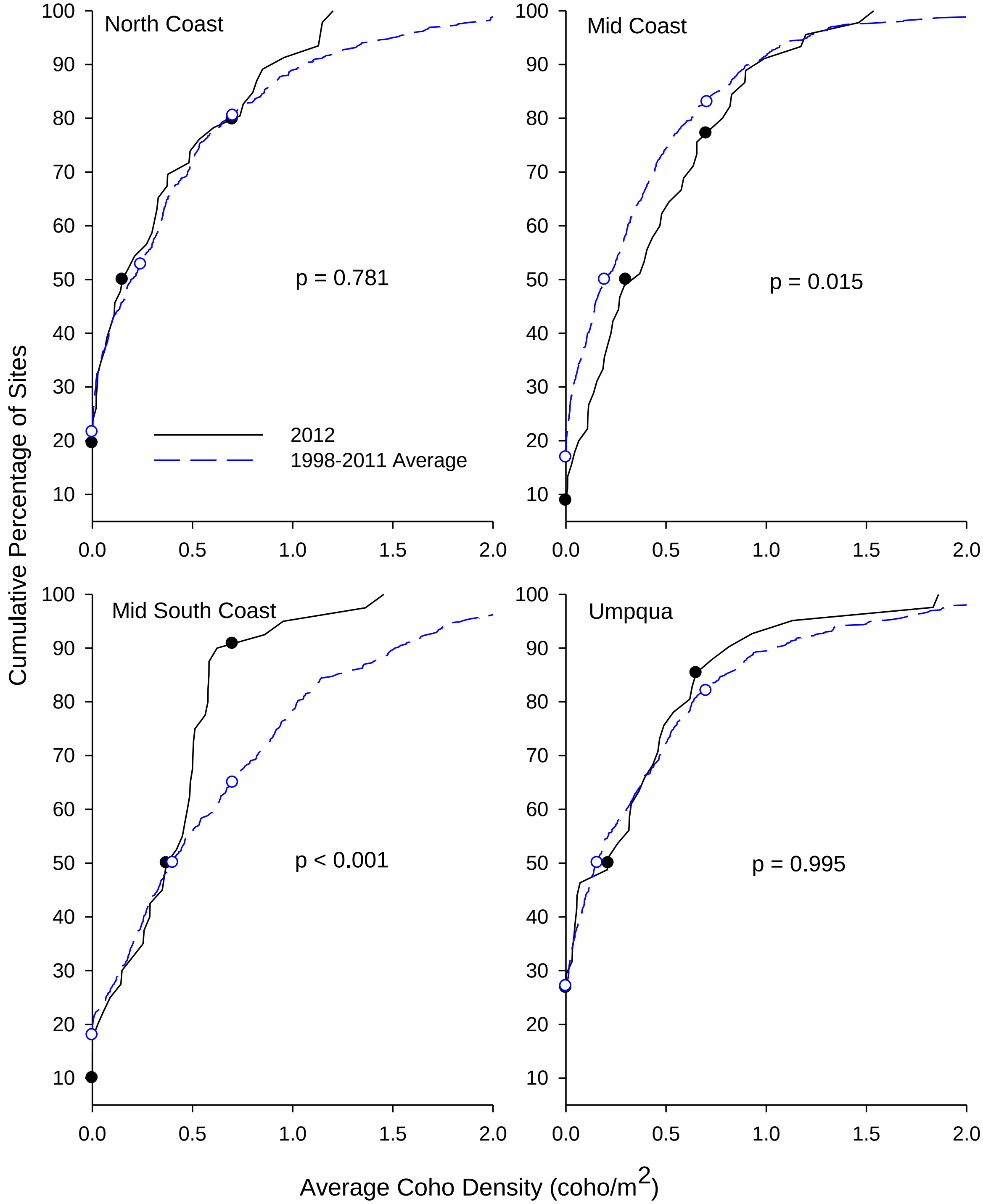
Regressions of both site occupancy and pool population estimates to survey year do not show detectable trend since the start of monitoring in 1998.

Lower Columbia Coho

The 2012 mean average density in pools was 0.069 fish/m^2 and coho occurred in 45% of 1st-3rd order stream reaches with a mean pool frequency of 31% (Table 2). No sites were fully seeded in the ESU. Density estimates and estimates of full seeding are shown in Figure 5. The 2012 density was similar to 2011, but this may be due to the large standard error in the 2011 estimate. Density in 2012 was not significantly lower than the average from 2006-2011. The percent of sites at full seeding was the lowest since 2008, which was also zero (Figure 5), but the estimate was not significantly lower than in 2011 (again, likely due to the large SE in the 2011 estimate) or than the average for the ESU. The percent of sites fully seeded was not significantly lower than in 2011 (but with a low p value of 0.07) and was similar to the average for the ESU.

Pool population estimates and site occupancies are shown in Figure 10. These metrics will be pooled into brood groups at the end of the 2014 field season when three brood groups (nine years of data) are available. The percent of occupied sites in 2012 was similar to 2011 and to the average for the ESU. Pool population estimates in 2012 were similar to 2011 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.



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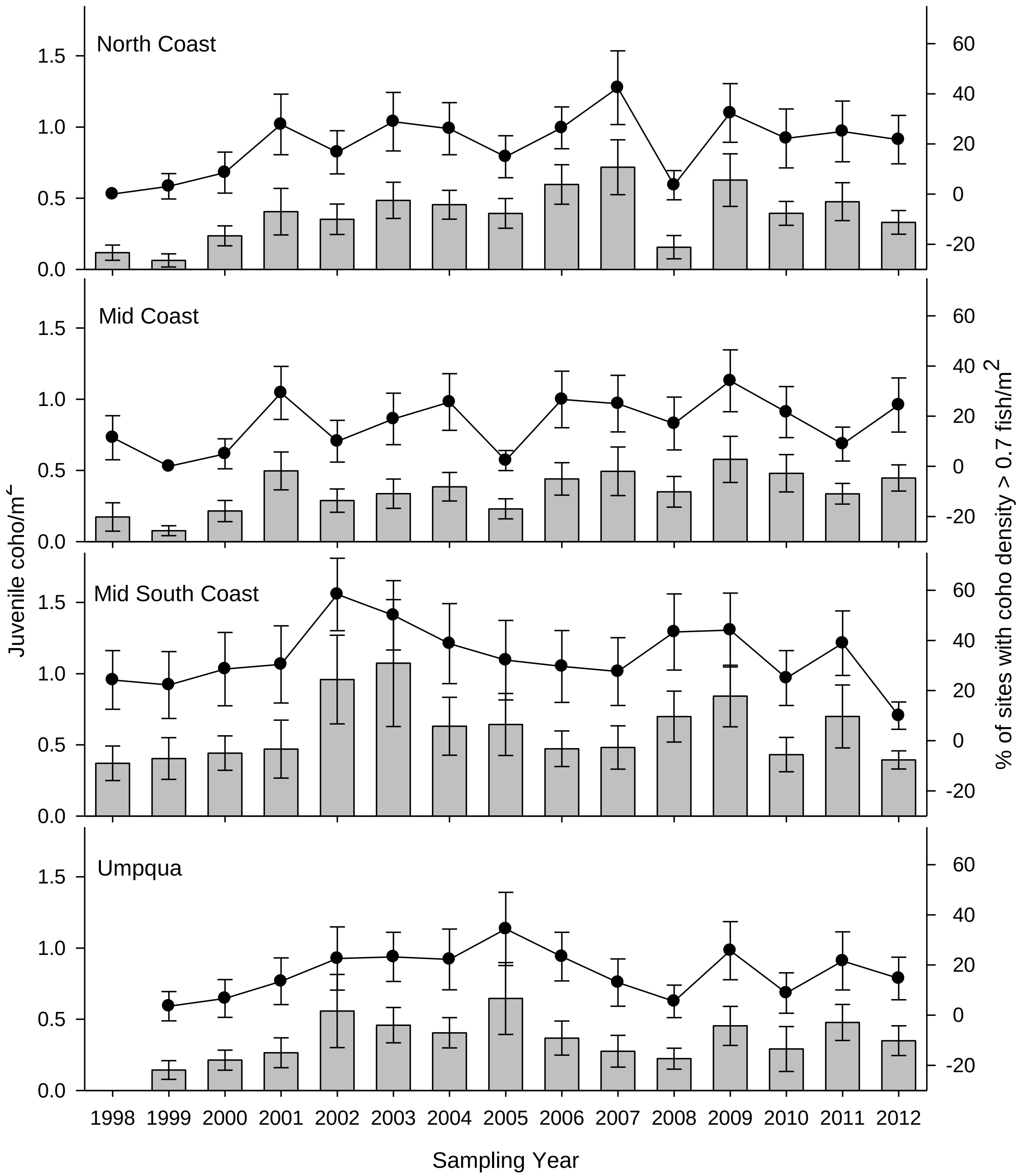
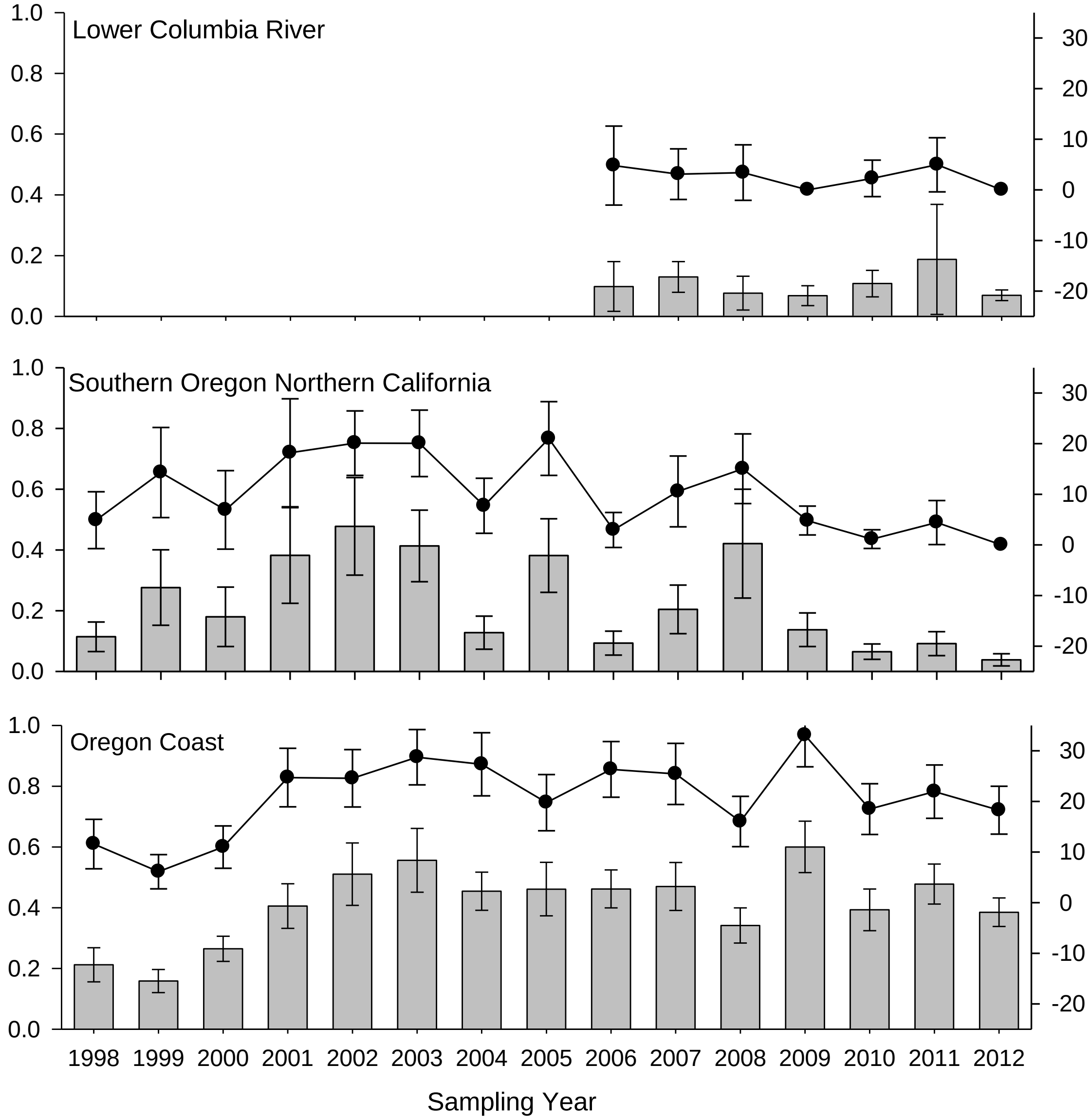


Figure 4. Annual trends in density and full seeding for juvenile coho salmon in monitoring areas of the Oregon Coast Coho ESU, based on snorkel surveys in 1st-3rd order stream reaches. Panels are organized by monitoring strata. Gray bars are for mean average density (coho/meter^2) and black symbols are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



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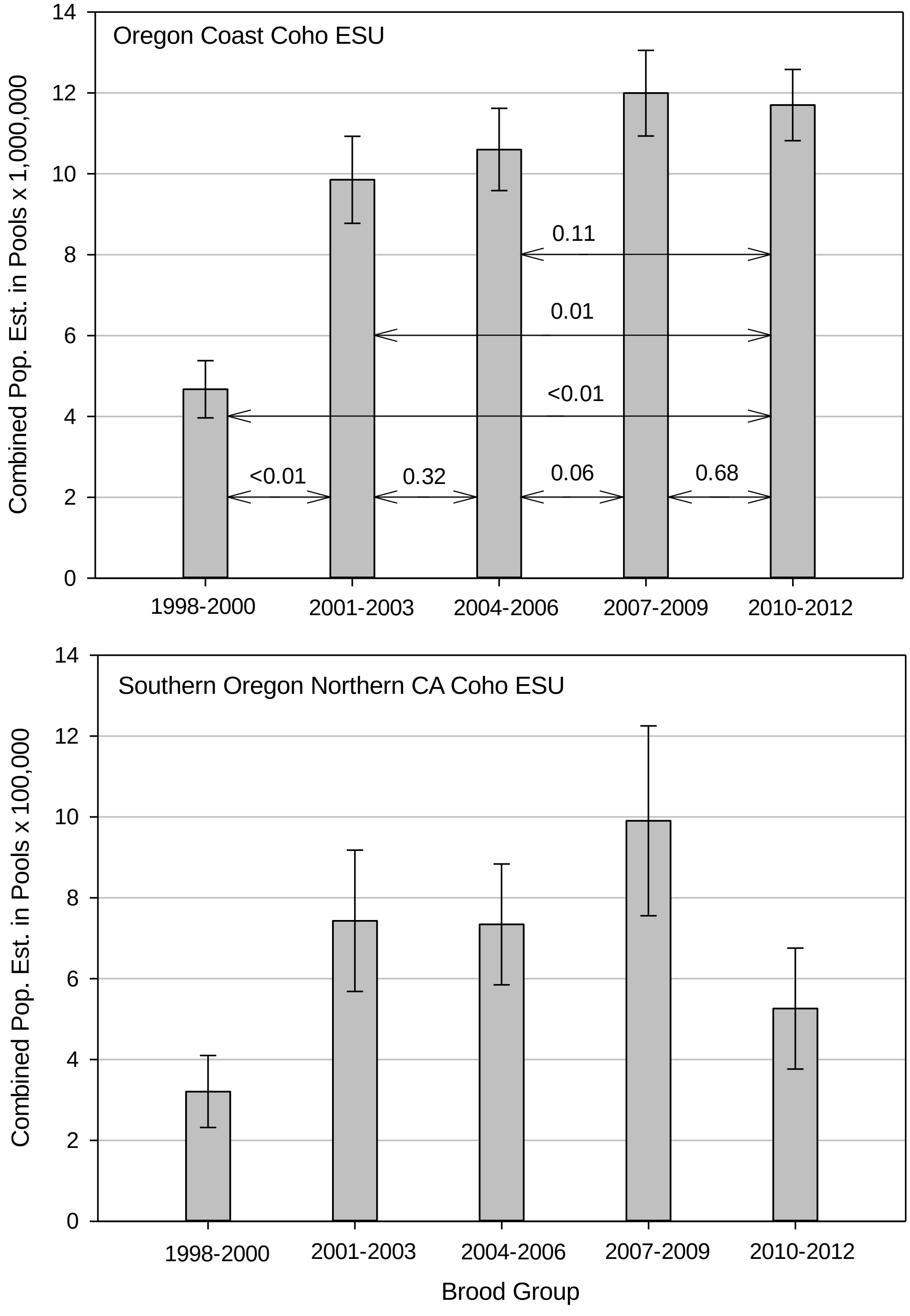

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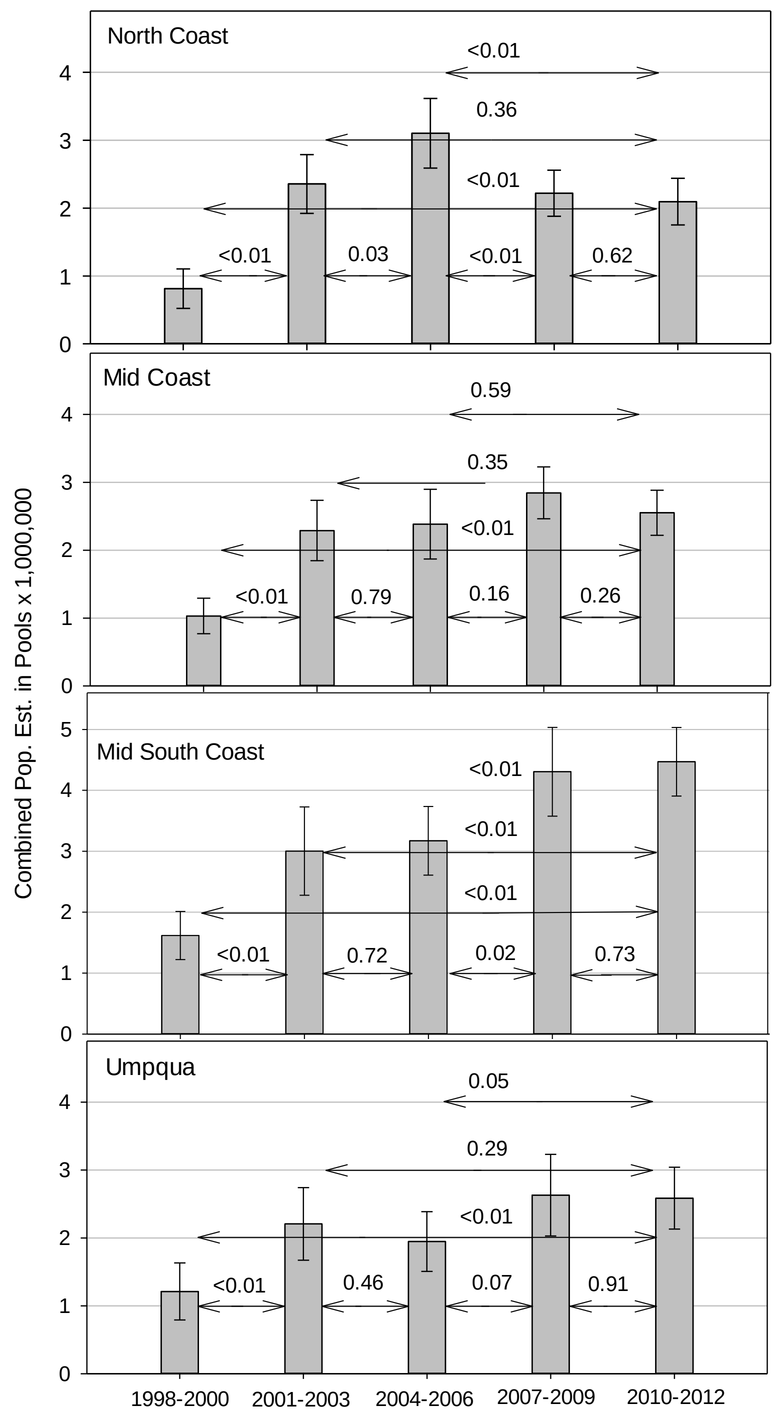

Figure 7. Trends in pool population estimates of coho by brood group in the four monitoring areas of the OCC ESU. Grey bars show the population estimate (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow.

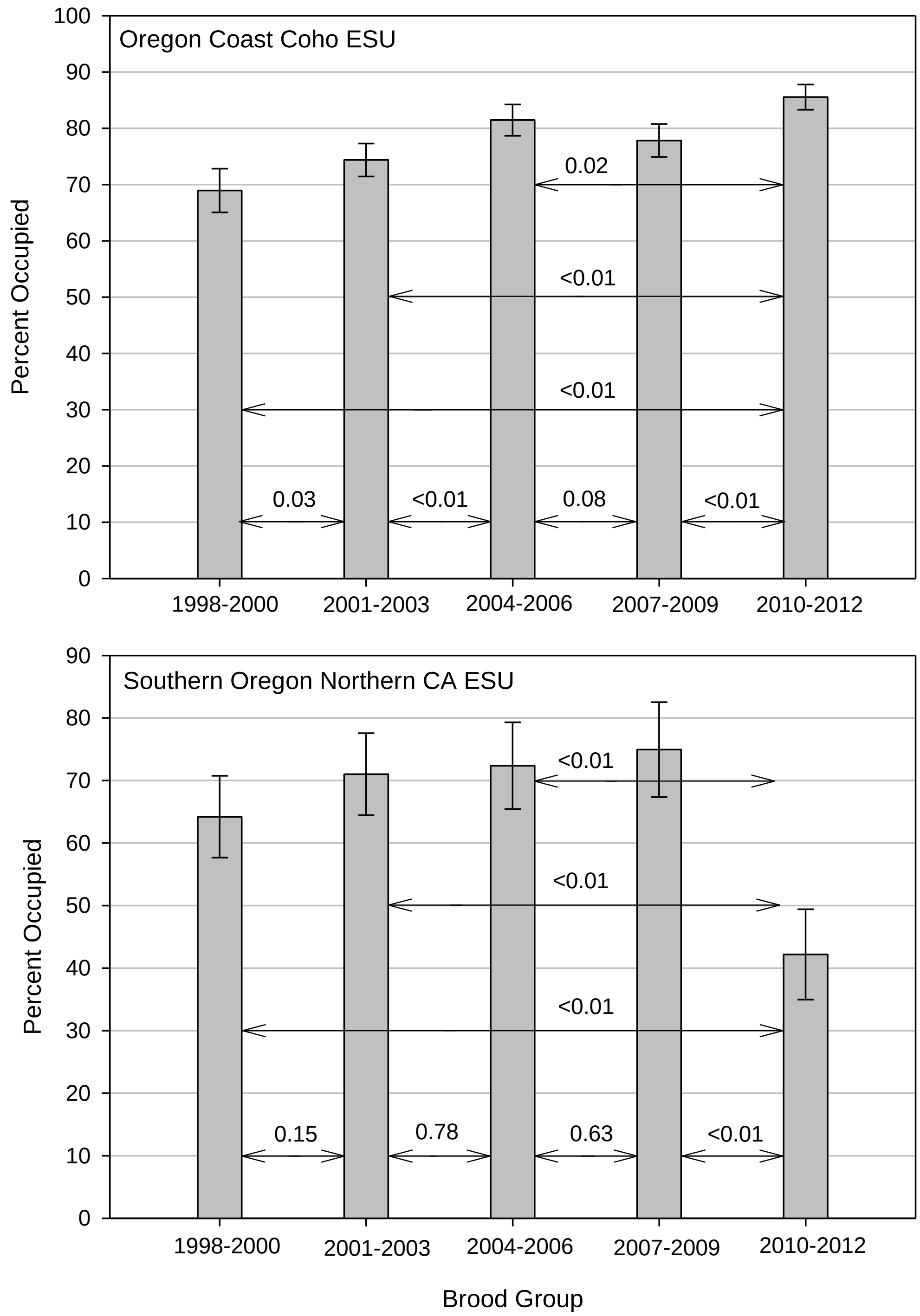

Figure 8. Trends in site occupancy of coho by brood group in the Oregon Coast Coho ESU (top panel) and Southern Oregon Northern California Coho ESU (bottom panel). Grey bars show the percent occupied (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical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

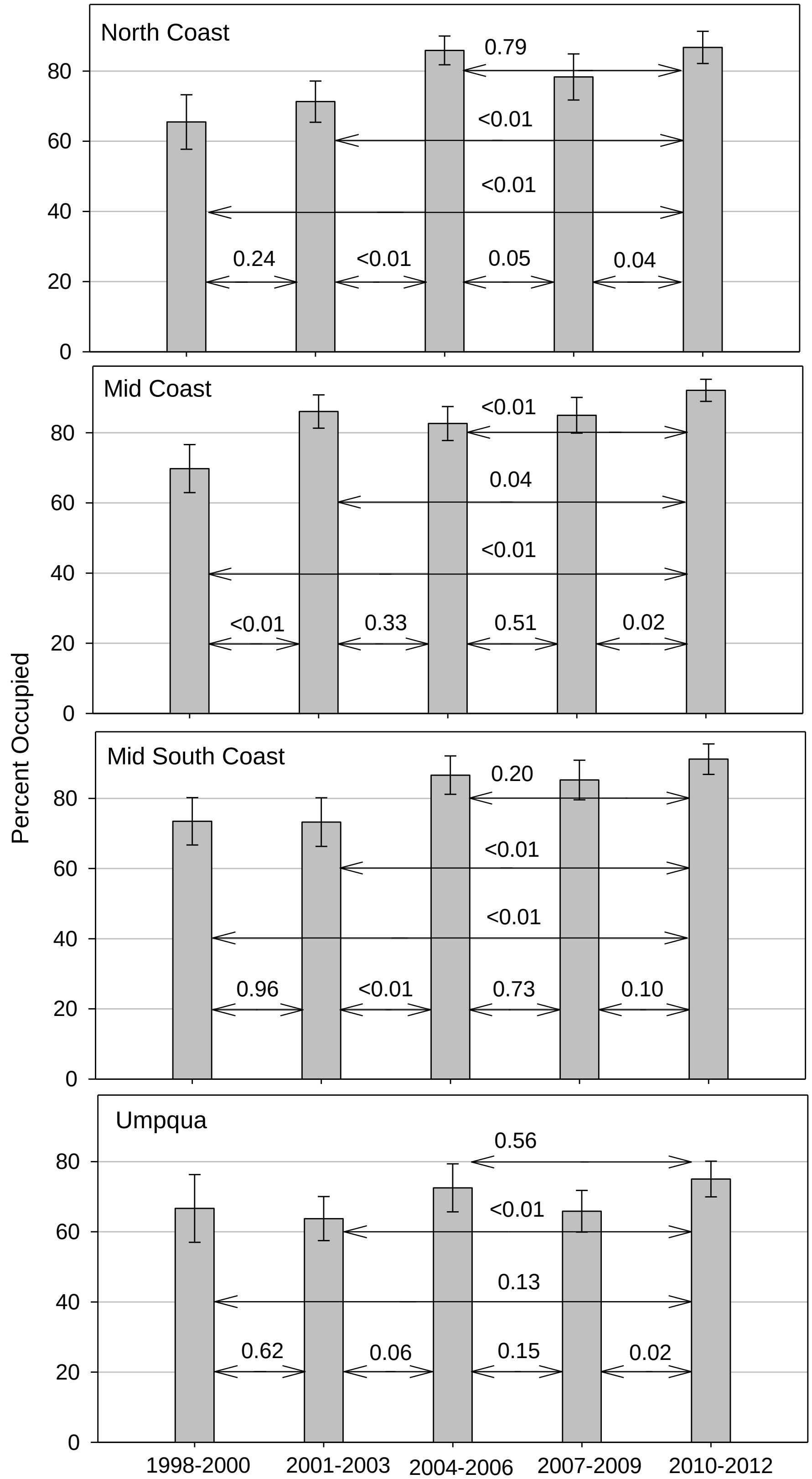

Figure 9. Trends in site occupancy of coho by brood group in the four Oregon Coast Coho Monitoring Areas. Grey bars show the percent occupied (with 95%CI) for the brood group, p values for comparisons among brood groups are given above each vertical arrow.

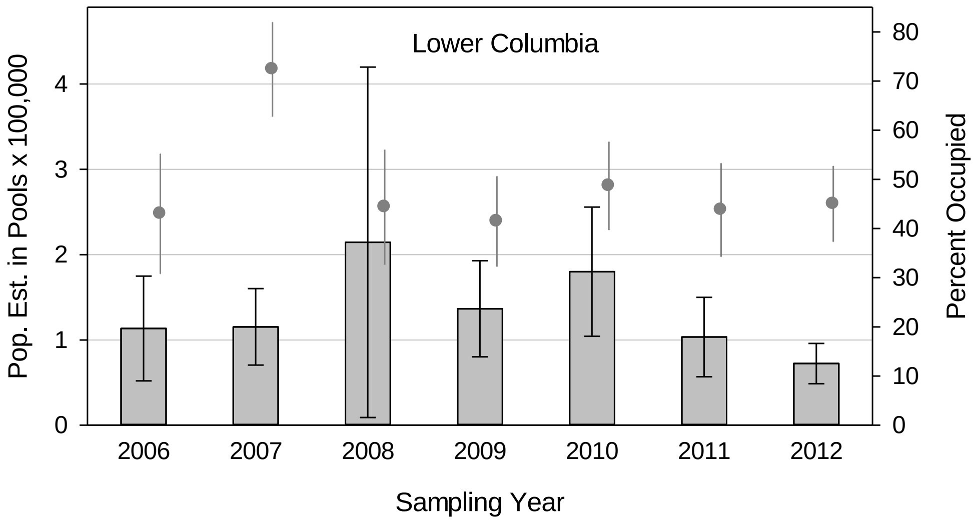

Figure 10. Trends in pool population estimates and site occupancy of coho by sampling year in the Lower Columbia River ESU. Grey bars show the population estimate (with 95% CI) for the year, grey dots (with 95%CI) show the percent of occupied sites.

Oregon Coast Steelhead

In the past three years, and for the majority of the monitoring, the North Coast MA had higher steelhead density estimates than other coastal MAs, but in 2012 density was highest in the Mid-Coast (Figure 11). For the first time pool frequencies were highest in the Mid-South Coast, but the metric was similar to the North Coast and Mid-Coast MAs. As in most previous years, the Umpqua had the lowest steelhead density for 2012. Pool frequency was also lowest in the Umpqua, as is typical.

For the DPS, densities in 2012 were similar to the average condition from 2002-2011 (Figure 12). Density for 2012 was similar to 2011 (p-value of 0.11). Pool frequencies were higher than the average (p value <0.01), and similar to the high estimate in 2011.

Pool population estimates were similar to the average and to 2011(Figure 13). Site occupancy (81%) was higher than the average (p value = 0.03) and similar to the record high estimate in 2011. No 4^{th}-6^{th} order streams were surveyed in the Oregon Coast DPS in 2012. 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 2012 density and pool frequency were the lowest recorded in the DPS (Figure 12). In the past three years densities have been the 1^{st}, 5^{th}, and 3^{rd} lowest recorded, respectively. Density in 2012 was lower than the average condition for the DPS (p-value<0.01) and lower than 2011 (p-value<0.01).

Pool population estimates in 2012 were similar to the average condition and to 2011 (Figure 13). Site occupancy was the second lowest recorded but similar to the average condition and to 2011. In the past three years site occupancies have been the 2nd, 3rd, and 4th lowest recorded.

Density and site occupancy were higher in the Non-Rogue portions of the DPS. In the Non-Rogue, density was similar to the average condition from 2002-2011.

In 4th-6th order streams density and pool frequency were lower than the average condition (p-value<0.01). Pool population estimates and site occupancy were similar to the average condition in the DPS.

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 2011 estimates.

Pool Frequencies in the two DPSs for 2012 were similar to the average since 2006 and similar to 2011(Figure 12). Site occupancy in LCR was similar to the average in and to 2011. In SWW, site occupancy in 2012 was similar to the average (but with a low p value of 0.08) and similar to 2011 (but with a low p-value of 0.06; Figure 13).

Pool population estimates in 2012 for LCR were similar to the average and to 2011 (Figure 13). In SWW, pool population estimates were similar to the average and to 2011.

Mainstem surveys were not conducted for either DPS in 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 2012. Distribution metrics are calculated from snorkeled and electrofished sites. Density metrics are calculated from snorkeled sites.

	Distribution			Density		
Monitoring Area	Site Occupancy	Mean Pool Frequency	CI Pct of Estimate	Mean Average Pool Density (sthd/m²)	95% CI	CI Pct of Estimate
1-3 Order Streams						
North Coast	82%	49%	12%	0.042	± 0.009	22%
Mid-Coast	91%	46%	14%	0.051	± 0.013	26%
Mid-South	93%	49%	12%	0.025	± 0.007	28%
Umpqua	64%	29%	25%	0.011	± 0.004	34%
KMP Rogue	83%	39%	16%	0.030	± 0.012	40%
KMP South Coast	96%	84%	7%	0.081	± 0.021	26%
Lower Columbia	61%	31%	27%	0.024	± 0.01	40%
Southwest WA	80%	40%	21%	0.024	± 0.007	30%
4-6 Order Streams						
KMP Rogue	90%	40%	45%	0.009	± 0.009	96%
KMP South Coast	100%	89%	13%	0.022	± 0.02	91%

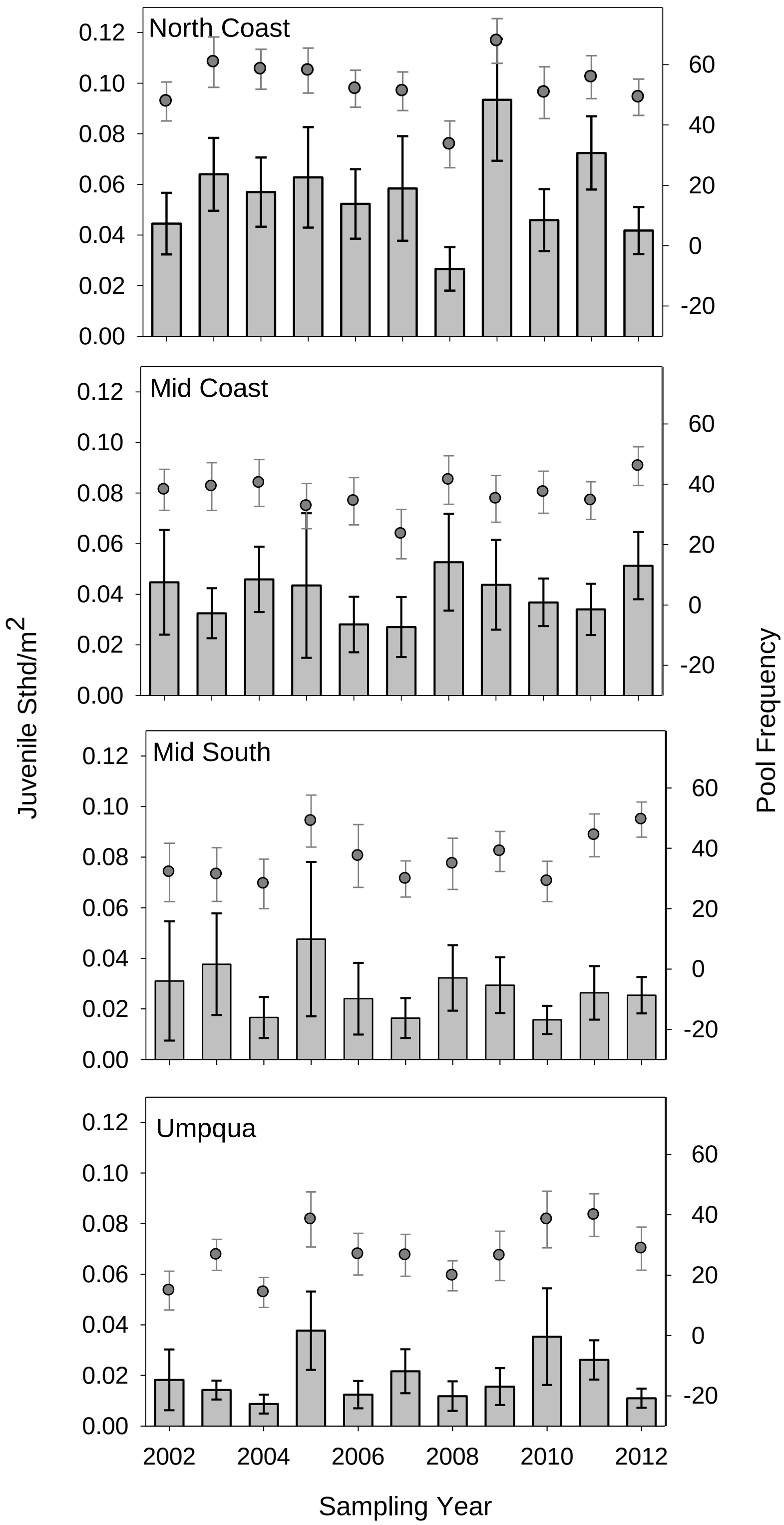

Figure 11. Annual trend in density and pool frequency for juvenile steelhead in the four Monitoring Areas of the Oregon Coast DPS, based on snorkel surveys in 1st - 3rd order streams. Panels are organized by monitoring strata. Gray bars are for mean density and dots are for mean percent pool frequency. Error bars are the 95% CI.

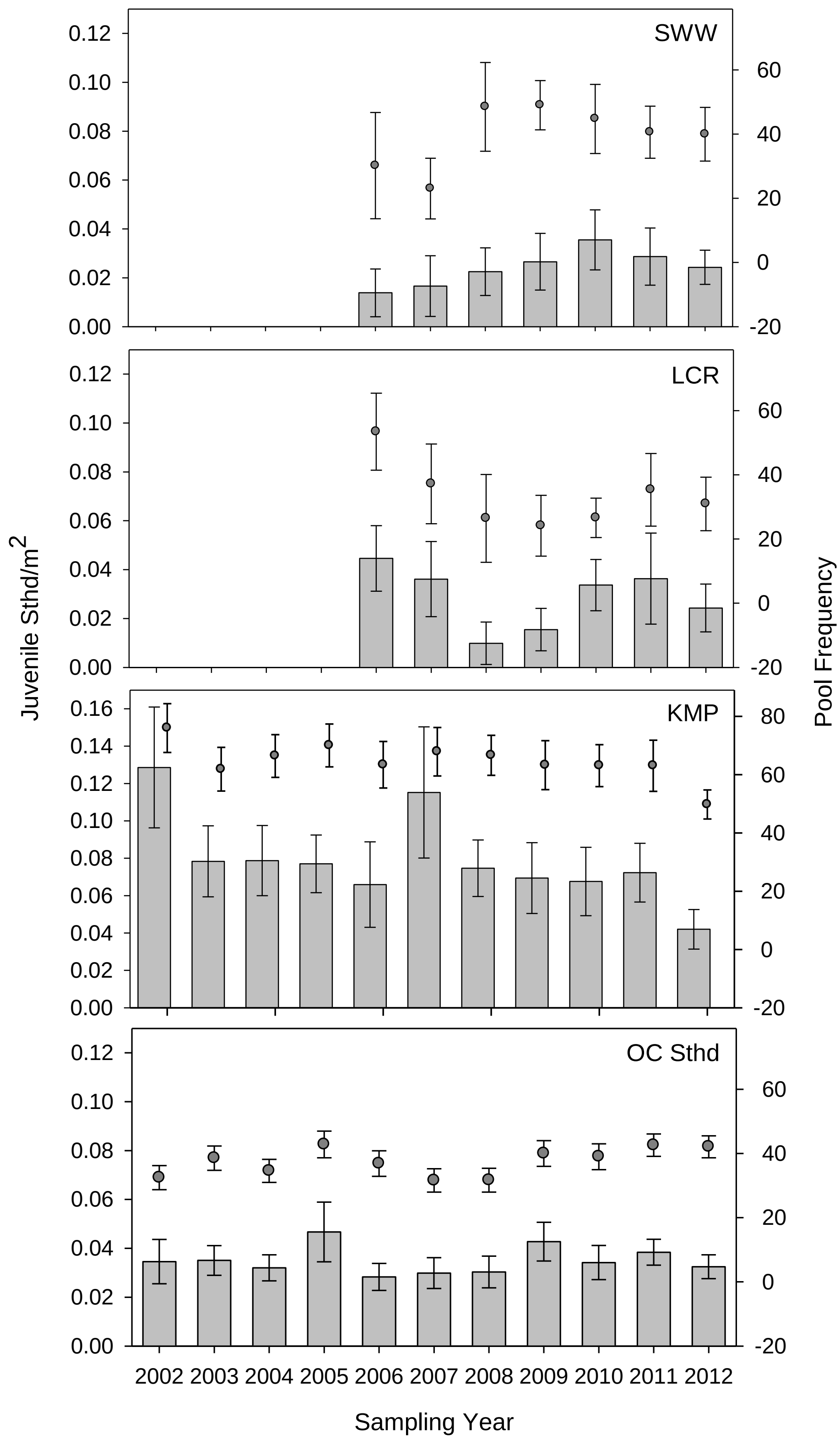

Figure 12. Annual trend in mean density (bars) and pool frequency (dots) metrics for steelhead in the four Coastal DPS Monitoring areas, based on snorkel surveys in 1st-3rd order streams. Error Bars are the 95% CI. Note density scale difference for the KMP.

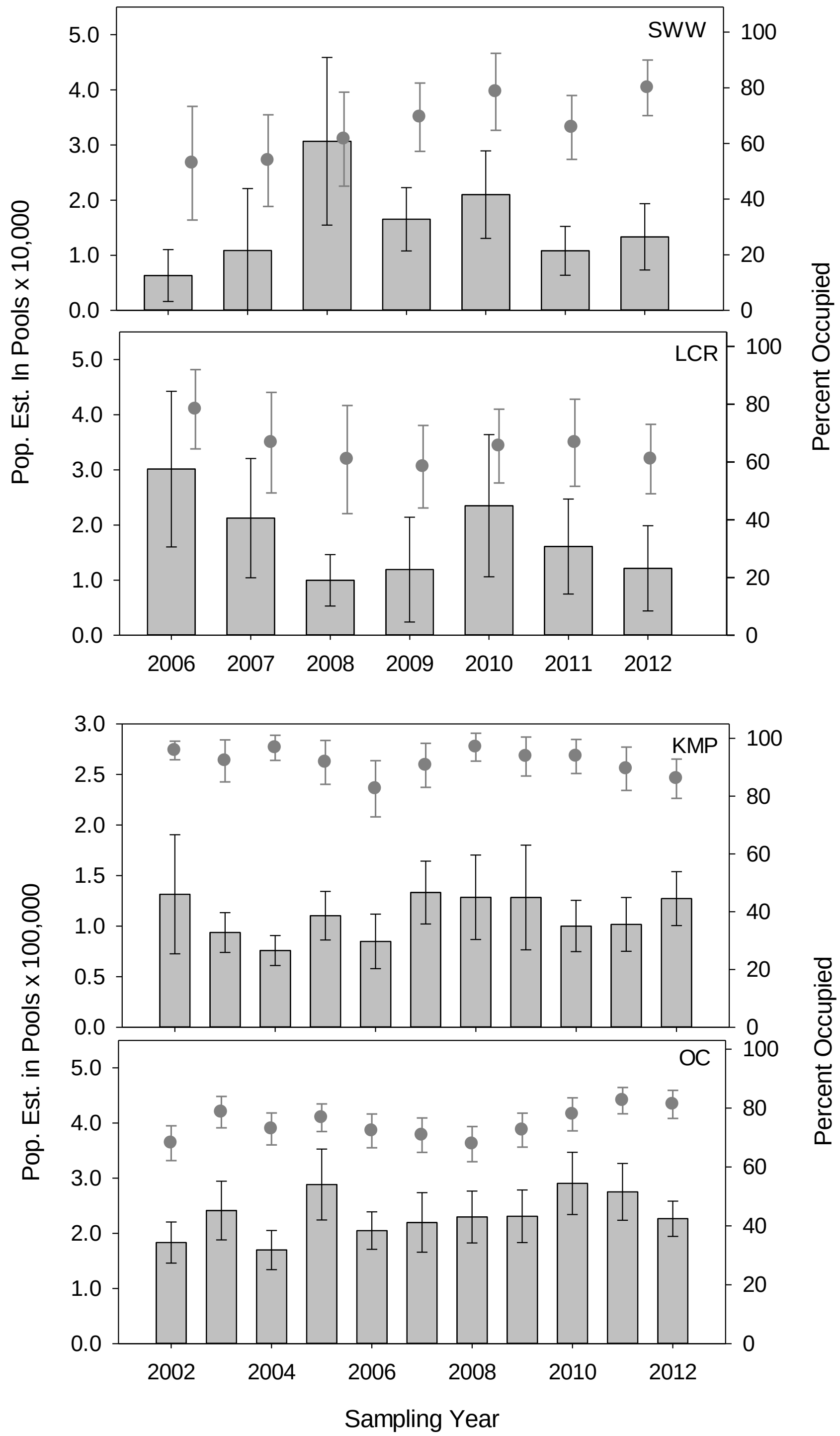

Figure 13. Annual trend in population estimates from pools (bars) and site occupancies (dots) metrics for steelhead based on surveys in 1st-3rd order streams. Note X and Y axis scale differences in upper and lower panels. Error bars are the 95% CI.

ESU/DPS Comparisons

Coho

The Oregon Coast Coho ESU had the broadest coho distribution (based on occupancy rates), (Figures 8 and 10) and the highest density estimates (Figure 5). The Lower Columbia River ESU was similar to the SONCC in density but occupancy estimates were lower in the SONCC. Population estimates in pools are not directly comparable because the number of stream kilometers differs among the ESUs.

Steelhead

In previous years the Klamath Mountain Province steelhead DPS had the broadest steelhead distribution and highest density estimates but in 2012 the density estimates were similar to the Oregon Coast. The coast DPS and the SWW DPS had similar site occupancy estimates. Pool frequency metrics were also similar on the coast, the KMP and in the SWW DPS. The LCR DPS had the lowest density, pool frequency, and site occupancy metrics. The Lower Columbia River and Southwest Washington DPS had similar density metrics.

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 73 % of the coho population and 78% of the steelhead population to be sampled by electrofishing with a yearly range of 61 - 82% for coho and 54 - 90% 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 2012 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 2,001 pools snorkeled and 173 pools electrofished in 1^{st}-3^{rd} order reaches. An additional 21 pools were snorkeled in side channel habitats of mainstem reaches. One site 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. Under the previous criterion these sites were considered non-target. With the new criterion, the status of these sites changed to target response and would add two successfully completed sites, for a total of 365 (Table 1).

Distribution

Juvenile salmonids were not observed in either of the two sites for which all pools were <40cm in depth. However, lowering the pool depth criterion to ≥20cm allowed surveyors to observe coho and steelhead in several sites where they would not have been under the previous criterion. In these sites coho and/or steelhead were in pools that were <40cm in depth, but not in pools that were ≥40cm in depth. For coho, this occurred in three sites in the Umpqua MA, one site in the Mid Coast, and one site in the Lower Columbia. Using the lower depth criteria would increase site occupancy rates in these areas, over the estimates given in Table 2. For steelhead this phenomenon occurred in one site in the Umpqua and one site in the KMP, where site occupancies also increased over the estimates given in Table 3. 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. Mean pool frequency decreased by three in the Mid-South Coast, by two in the Mid Coast and by 1 or less in the remaining MAs/ESUs.

Differences in pool frequency were more pronounced for steelhead. Pool frequencies decreased by nine in the Mid-South, eight in the Mid Coast, six in the North Coast, and four in the Umpqua. Pool frequencies decreased by three or less in the Lower Columbia and in the KMP.

Density

Coho density estimates decreased in most management areas when the lower depth criterion was applied. For the Oregon Coast ESU, densities decreased in the North Coast by 3%, in the Mid Coast by 2%, and in the Mid South by 4%. In the Umpqua, densities increased by 9%. In the LCR densities increased by 3% and in the SONCC they decreased by 8%.

Steelhead density estimates also decreased with the lower depth criterion. For the Oregon Coast DPS densities decreased by 11% in the North Coast MA, 20% in the Mid Coast, 12% in the Mid South, and 2% in the Umpqua. In the KMP densities decreased by 7% in the Rogue and by 3% in the Non-Rogue portions of the DPS. In the Lower Columbia River DPS densities decreased by 13% and in the Oregon portions of the SWW DPS densities decreased by 10%.

Pool Population Estimates

Pool population estimates with the different depth criteria from WORP surveys in 2012 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 smaller pools produces, on average, a 13% larger population estimate for coho ($p = 0.039$) and a 6% larger population estimate for steelhead ($p= 0.043$). As in 2011, the increase in pool population estimates from including smaller pools were most pronounced in the Mid Coast and Umpqua MAs for coho and in the Mid Coast for steelhead. A majority of coho and steelhead reared in pools ≥40cm deep.

Thus far the trend for the coho population in each MA and ESU estimated by surveys in pools ≥40cm in depth has been similar to the trend estimated by surveys in pools ≥20cm in depth (Figure 14). Population estimates including pools that met the 20cm depth criterion produced proportionally smaller 95% confidence intervals for all coho and steelhead estimates except those made for coho in the SONCC, where the difference was less than 1%.

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	2012 Coho Estimates				
	Pools ≥ 20cm Max Depth		Pools ≥40cm Max Depth		Difference
	Estimate	95% CI	Estimate	95% CI	
North Coast	622,807	±31%	577,017	±33%	7.4%
Mid Coast	1,283,990	±21%	1,009,801	±23%	27.2%
Mid South Coast	1,711,089	±26%	1,595,194	±28%	6.8%
Umpqua	1,066,080	±25%	716,040	±29%	32.8%
SONCC	126,955	±69%	121,780	±69%	4.1%
Lower Columbia	76,131	±32%	72,323	±33%	5.0%

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	2012 Steelhead Estimates				
	Pools ≥ 20cm Max Depth		Pools ≥ 40cm Max Depth		Difference
	Estimate	95% CI	Estimate	95% CI	
North Coast	53,147	±19%	49,309	±20%	7.2%
Mid Coast	91,186	±22%	76,011	±26%	16.6%
Mid South Coast	66,794	±24%	64,541	±25%	3.4%
Umpqua	41,293	±42%	36,549	±46%	11.5%
KMP Rogue	55,533	±28%	54,911	±28%	1.1%
KMP South Coast	73,665	±29%	72,298	±29%	1.9%
Lower Columbia DPS	12,462	±61%	12,147	±64%	2.5%
Southwest WA DPS	13,481	±44%	13,339	±45%	1.1%

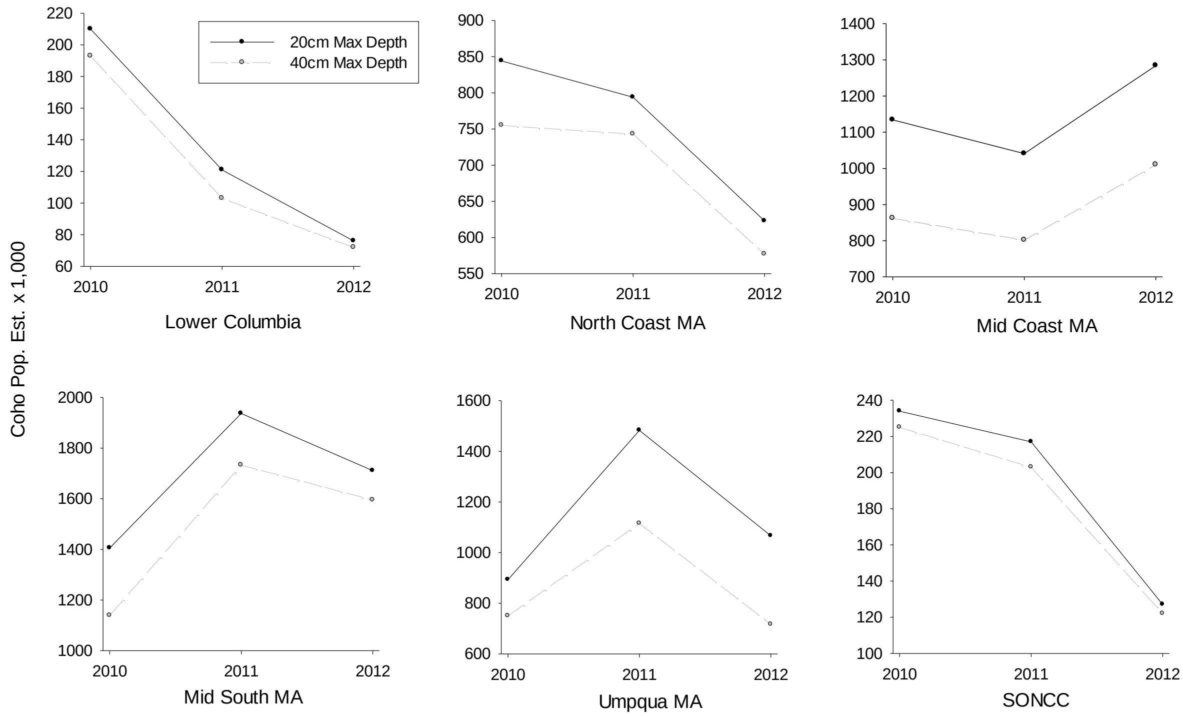

Figure 14. Trends in the coho rearing population from 2010 to 2011 based on the ≥20cm pool depth criteria (solid black line) and the ≥40cm pool depth criteria (dashed grey line).

Effects of new depth criteria on observer consistency

Including pools with the lower depth criterion had little effect on variability between surveys and resurveys for coho and produced only a slightly weaker relationship between original survey and resurvey counts of steelhead.

Table 6**.** Resurvey and original survey counts of steelhead and coho in all pools, pools meeting the former maximum depth criteria and pools <40 cm that meet the 2010 depth criteria.

Species	All Pools ≥20cm			Pools ≥40 cm Max. Depth			Pools ≥20 cm Max. Depth and <40 cm Max. Depth		
	Survey	Resurvey	Pct	Survey	Resurvey	Pct	Survey	Resurvey	Pct
Coho	19,054	18,878	99.1	16,400	16,253	99.1	411	403	98.1
Sthd	1,499	1,305	87.5	1,436	1,227	85.4	10	8	80.0

We resurveyed 189 additional pools under the new depth protocol. Resurvey counts in pools that were under 40cm deep were less precise than resurvey counts in pools that were ≥ 40cm in max depth (Table 6). Resurveys in pools that were both

≥20cm and <40cm deep had a strong relationship between original and resurvey counts for coho (R^2 = 0.94). Steelhead showed a much weaker survey-resurvey relationship in these pools (R^2 = 0.28). However, the precision of resurveys when all pools are included (all pools ≥20cm) is only slightly less than the precision in pools ≥40cm (Table 4). When all pools are included into survey-resurvey comparisons, the relationship is similar, for both coho (R^2 = 0.95) and steelhead (R^2 = 0.77), to the relationships when the pools less than 40cm are excluded (R^2 = 0.97 for coho and 0.78 for steelhead). These results are very similar to those in 2011 and 2010.

Cutthroat Distribution

Abundance metrics are not reported for cutthroat due to the variability in counts of cutthroat from surveys and resurveys of the same stream reach. Data from the Smith River Verification Study (Constable and Suring, in prep.) indicated a poor relationship between diver counts and electrofishing removal estimates of cutthroat in pools. However, the Smith Study and resurvey data from WORP indicates that visual counts are an adequate method of determining site occupancy for cutthroat. Electrofishing (average = 74.9 percent occupancy for all years) and snorkeling (average = 77.6 percent occupancy for all years) produced similar estimates of cutthroat site occupancy in the Smith Study and only 2.7% of resurveys from WORP (n= 473) found cutthroat in a site where the original survey did not.

Trends in cutthroat trout site occupancy are given for each of the four coastal MAs in Figure 15 and for the ESUs in Figure 16. In the North Coast MA, occupancy was lower in 2012 than the average (p value = 0.02) but the estimate was similar to 2011. In the Mid Coast and Mid South Coast, occupancy for 2012 was similar to both the average and to the estimate in2011; this was true for the Umpqua as well but the comparison of 2012 to the average condition had a low p value of 0.08. The Umpqua had lower average percent occupancy than the three other MAs, which were similar.

In the LCR and the OCC ESUs cutthroat occupancy in 2012 was similar to the average condition and to 2011. In the SONCC, cutthroat occupancy was not significantly higher in 2012 than the average condition but with a low p value = 0.09. The 2012 estimate for the SONCC was similar to 2011. The OCC had the highest average cutthroat occupancy and the SONCC was the lowest.

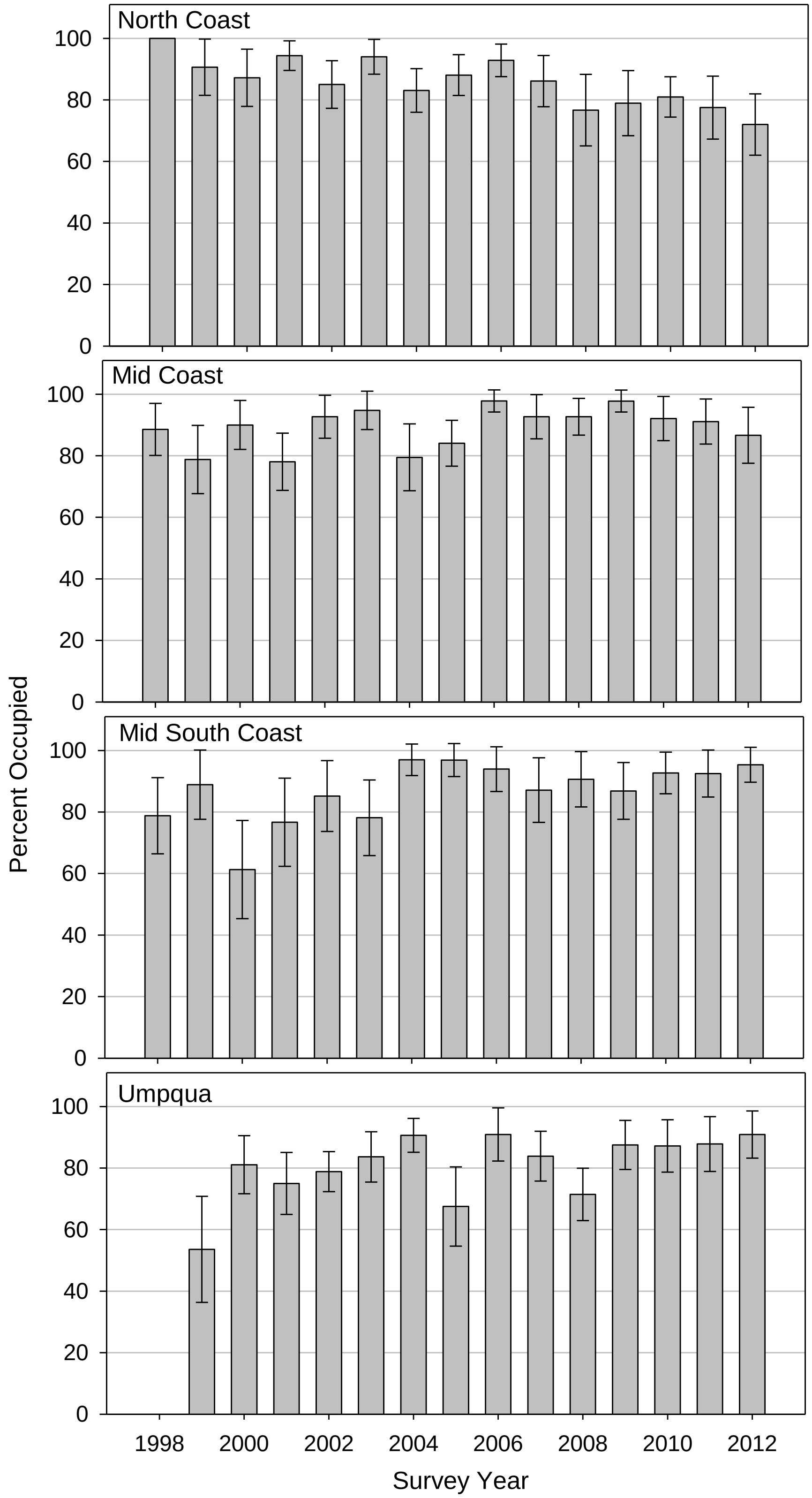

Figure 15. Annual trends in cutthroat site occupancy based on surveys in 1st -3rd order streams for the four MAs in the Oregon Coast Coho ESU.

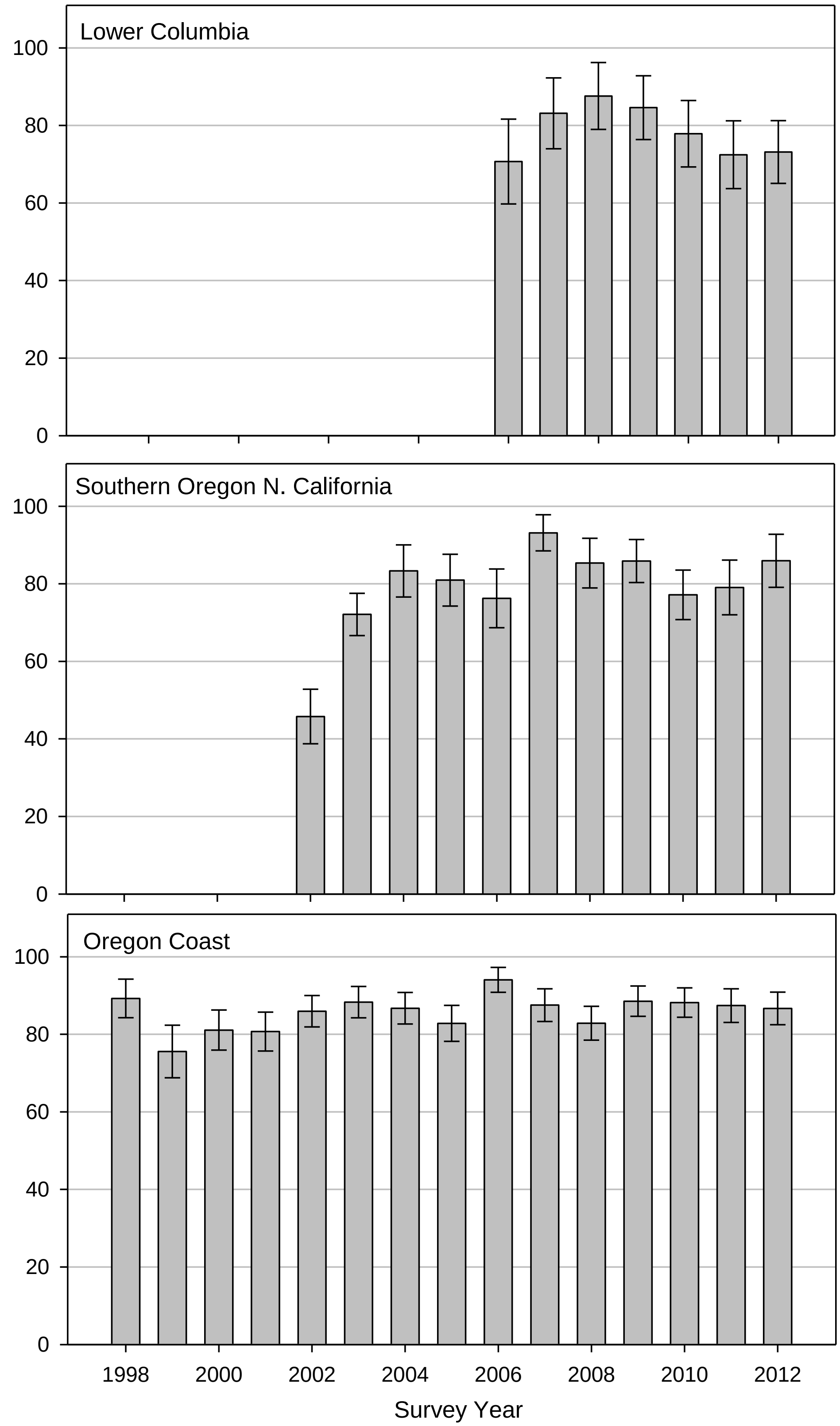

Figure 16. Annual trends in cutthroat site occupancy based on surveys in 1st -3rd order streams for the three Western Oregon coho ESUs.

Beaver Occupancy

As part of survey protocol crews have noted the presence or absence of beaver activity at each site since 2000. Beaver activity is indicated by any sign of beaver at the site such as dams, scat, chewed sticks, or felled trees. The number of sites with beaver activity is divided by the total number of successfully surveyed sites to generate the percent of sites with beaver activity for each year.

The OCC ESU had, on average, the highest percent of sites with beaver activity (51%) and ranged from 40% in 2009 to 61% in 2006 (Figure 15). In 2012 surveyors observed beaver activity in 57% of the sites for the ESU, higher than average and the highest percent since 2007. Within the ESU, the Mid Coast MA typically has the highest percent of sites with beaver activity and the Umpqua typically has the lowest.

The SONCC typically has had the lowest average percent (21%) of site with beaver activity and ranges from 17%-31%. In 2012 surveyors observed beaver activity in 26% of the sites in the SONCC. The percent of beaver activity for the LCR was slightly lower than the OCC, averaging 46% with a range of 33-56%. In 2012 beaver activity was observed in 46% of the sites.

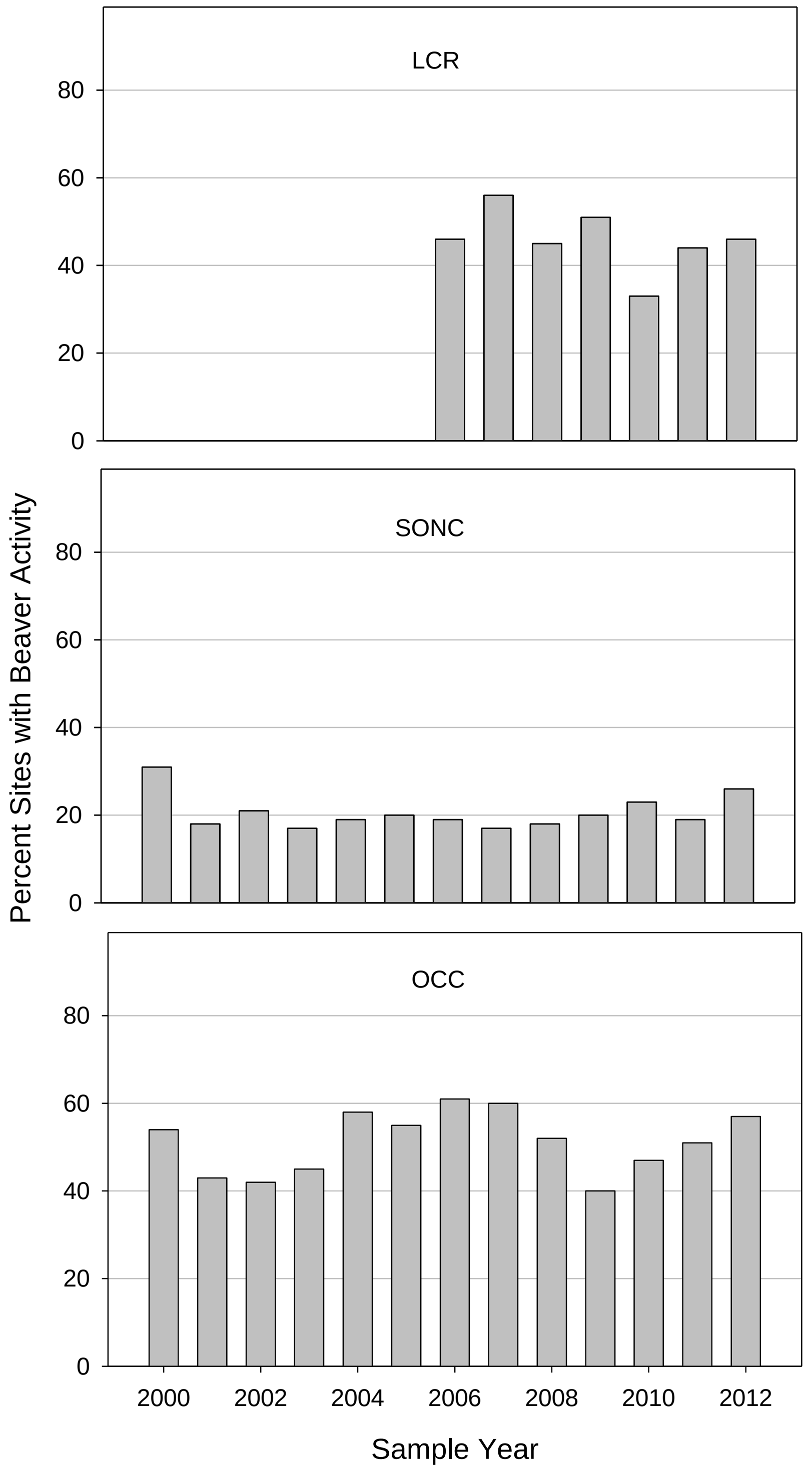

Figure 17. Yearly percent of sites with beaver activity in three coho ESUs within the study area.

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