THE OREGON PLAN *for Salmon and Watersheds*

Juvenile Salmonid Monitoring In Coastal Oregon and Lower Columbia Streams, 2011

Report Number: OPSW-ODFW-2012-1

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Oregon Plan for Salmon and Watersheds

Annual Monitoring Report No. OPSW-ODFW-2012-1

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SUMMARY

This report provides a summary of results from juvenile coho and steelhead surveys conducted on the Oregon coast and lower Columbia River in 2011 and an analysis of these results relative to previous years. Distribution measures are given specific to species and include site occupancy (the percent of sites with fish present) and pool occupancy (average percent of pools with fish) for the Monitoring Area (MA), Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS). Abundance measures are also specific to species and include the average density of fish in pools for each MA, ESU and DPS and population estimates in pools extrapolated to MA, ESU and DPS scale. Prior reports can be found at http://nrimp.dfw.state.or.us/crl/default.aspx?pn=WORP.

Oregon Coast Coho (OCC) ESU density and pool population estimates for 2011 were higher than in 1998-2000, but similar to 2001-2010. Coho site occupancies in 2011 were the highest since sampling began in 1998. We observed a small, but positive trend in the site occupancy and pool population estimates for coho across the ESU from 1998 to 2011. Density and occupancy metrics were higher in each MA than the average condition from 1998 – 2010.

Southern Oregon Northern California Coho (SONCC) ESU density estimates in 2011 were similar to 2009-2010, but lower than the estimate for 2008. Pool population estimates were similar to the average from 1998-2010, but lower than in 2008. Pool occupancy was similar to the average from 1998-2010. Site occupancy in 2011 was slightly below the average from 1998-2010. No increasing or decreasing trends were detected for the ESU.

Lower Columbia River (LCR) coho density, pool population, and pool occupancy estimates for 2011 were similar to previous years. Site occupancy in 2011 was slightly below the average site occupancy from 2006 – 2010. No increasing or decreasing trends were detected for the ESU.

Coho density estimates were higher in the OCC than the SONCC and the LCR, which were similar. Occupancy metrics were highest in the OCC, intermediate in the SONCC, and lowest in the LCR.

Juvenile steelhead density, pool population and pool occupancy estimates from 2011 were comparable to previous years in all DPSs. Site occupancies for the Oregon Coast DPS in 2011 were the highest since sampling began. Steelhead were more abundant and widespread in the Klamath Mountains Province than the Oregon Coast, Southwest WA or Lower Columbia River DPSs, which had similar density metrics. Steelhead in the Oregon Coast DPS were more widespread then in either Columbia River DPSs.

In accordance with the findings of the Smith River Verification Study (Constable and Suring in prep.) we lowered our pool depth criteria to include pools that are ≥20 cm in maximum depth. This change was made in survey year 2010 and continued in 2011. Data which included these smaller pools was analyzed separately to facilitate the comparison of density and occupancy metrics to previous years. Analyses which

included smaller pools produced higher site occupancies for coho in the Mid Coast and Umpqua and for steelhead in the Mid Coast, Mid South Coast, Umpqua MAs and the Klamath Mountains and Southwest Washington DPSs. Pool population estimates also increased with the addition of the smaller pools.

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. Starting in 1998, the project surveyed 1st-3rd order (wadeable) streams within the rearing distribution of juvenile coho in the OCC and SONCC. In 2002, we added surveys for juvenile steelhead (*Oncorhynchus mykiss*) in the Klamath Mountain Province and Oregon Coast DPS, and expanded surveys to 4th -6th order (non-wadeable mainstem) streams for coho and steelhead. In 2006, surveys were initiated in the Oregon portions of the Lower Columbia River coho ESU and steelhead DPSs (Figure 1). We discontinued surveys in 4th to 6th order streams in the Oregon Coast Coho ESU in 2009.

The sampling frame encompassed all potential non-tidal coho and steelhead rearing habitat within wadeable streams in all ESUs, and within non-wadeable 4th to 6th order streams in the SONCC and Lower Columbia ESUs . The original 100k stream layer frame was replaced by a 24k frame in 2007 which increased the number of kilometers within the frame. A Generalized Random Tessellation Stratified design (GRTS, Stevens 2002) was used to select sample locations in a spatially balanced, random fashion. Sample site selections 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).

Field crews identified and enumerated juvenile salmonids in pools in a one kilometer stream reach encompassing the GRTS point. Previous to 2010 all pools larger than ≥6 m^2 in surface area and ≥40 cm in maximum depth were snorkeled. Results of the Smith River Verification study (Constable and Suring, in prep.) suggest 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 populations. The depth criterion was lowered in the 2010 field season and this protocol was continued in 2011. This report will analyze data from pools that met the ≥40 cm maximum depth requirement and perform a second analysis of pools meeting the ≥20 cm requirement. Surface area requirements were not changed.

Snorkeling was conducted during the minimum flow period from July to October using a single pass of one to six snorkelers, depending on stream width. In each pool we counted juvenile coho, Chinook, steelhead ≥90 mm, and cutthroat ≥90 mm. Presence was noted for dace, shiners, and trout <90 mm. 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. To assess repeatability and quality control supervisory staff resurveyed ≥10% of the wadeable sites in each MA.

Data are summarized and presented by stream order (wadeable and non-wadeable) and MA, ESU, or DPS for analysis. The following measures of fish distribution and abundance were calculated independently for juvenile 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.
- Pool occupancy
  - The average percent of pools that contain at least one fish. Pool occupancy 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.

The percent of sites with $\geq$0.7 coho/m^2 are also reported for each MA in the Oregon coast coho ESU. A value of 0.7 coho/m^2 is regarded as full seeding. Nickelson et al. (1992) reported full seeding based on electrofishing as 1.0 coho/m^2, and Rodgers et al. (1992) reported that snorkelers observed 70% of the coho counted by electrofishing. CDFs, variances, and confidence intervals were created using tools developed by the EMAP Design and Analysis Team (EPA 2009).

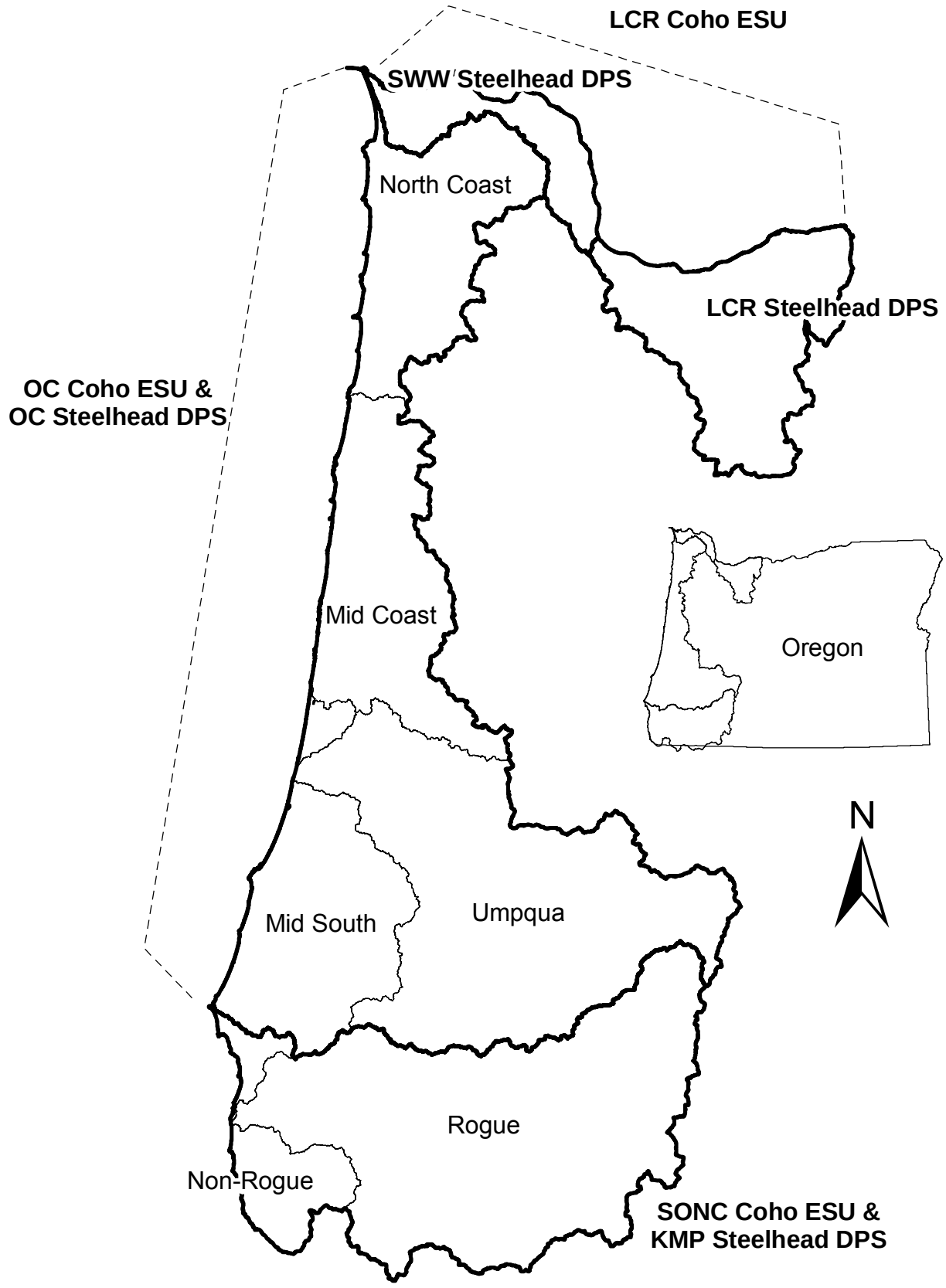

Figure 1. The spatial extent of the study area showing the Oregon portion of coho and steelhead ESU/DPSs, and the monitoring areas in the Oregon Coast and KMP/SONCC.

RESULTS

Survey Effort and Resurveys

We selected 546 sites, of which 74 were non-target, or outside the distribution of potential rearing habitat. Of the remaining 472 sites, 70% (353) were successfully surveyed (Table 1). Thirty percent of the target sites were not surveyed because of landowner access restrictions or accessibility issues. Sites not surveyed within the potential rearing distribution are considered target sites, but non-response. Goals for survey effort were met in all MAs with the exception of sites below the Gold-Ray Dam site for steelhead, where site access was problematic. In Southern Oregon, the SONCC ESU was analyzed as a whole for coho. The Klamath Mountain Province DPS was analyzed as a whole for steelhead and as the Rogue and non-Rogue (primarily the Winchuck, Chetco, and Elk rivers – see Figure 1) strata. In coastal Oregon the coho ESU and steelhead DPS were analyzed as a whole and stratified into four monitoring areas (Figure 1).

A total of 5,750 pools at 298 sites were snorkeled in 1st-3rd order reaches and 187 pools at 31 sites were snorkeled in 4th-6th order reaches. We electrofished 344 pools at 24 sites in 1st-3rd order reaches. The 95% confidence interval for coho density estimates met the target of ±30% for the North Coast, Mid-Coast, and Umpqua MAs in the Oregon Coast ESU. The Mid-South MA was close to the target, but the Lower Columbia and South Coast exceeded the target (Table 2). Confidence intervals in the Lower Columbia were in excess of 90% of the estimate.

Table 1. Site status by monitoring area and stream order.

Monitoring Area	Stratum	Snorkeled	Electrofished	Target Non-response	Non-target
North Coast	1-3 Order	36	4	12	15
Mid-Coast	1-3 Order	45	0	6	7
Mid-South	1-3 Order	36	4	16	9
Umpqua	1-3 Order	37	4	12	13
Lower Columbia	1-3 Order Coastal	34	4	12	15
Lower Columbia	1-3 Order Cascade	25	5	17	4
Lower Columbia	4-6 Order Cascade	16	0	10	1
South Coast Coho	1-3 Order	28	2	9	2
Rogue Steelhead	1-3 Order	23	1	16	4
Rogue Steelhead	4-6 Order	10	0	2	0
Non-Rogue Sthd	1-3 Order	34	0	5	4
Non-Rogue Sthd	4-6 Order	5	0	2	0

Table 2. Distribution and density estimates for juvenile coho salmon in western Oregon streams summer 2011. Occupancy metrics are calculated from snorkeled and electrofished sites whereas density metrics are calculated from only snorkeled sites.

	Distribution			Density		
Monitoring Area	Site Occupancy	Mean Pool Occupancy	95% CI	Percent Sites ≥0.7 coho/m^2	Mean Average Pool Density (coho/m^2)	95% CI
1-3 Order Streams						
North Coast	85%	65%	± 11%	25%	0.476	± 0.133
Mid Coast	93%	79%	± 7%	9%	0.336	± 0.072
Mid South	95%	79%	± 9%	39%	0.699	± 0.221
Umpqua	80%	72%	± 9%	22%	0.477	± 0.126
South Coast Coho	60%	47%	± 13%	7%	0.188	± 0.078
Lower Columbia	44%	28%	± 7%	5%	0.188	± 0.181
4-6 Order Streams						
Lower Columbia	31%	16%	± 13%	0%	0.019	± 0.018

Variance of steelhead estimates was similar to coho in the Oregon Coast MAs. The goal of a 95% confidence interval within ±30% of the density estimate was met in the North Coast, Mid-Coast, and Umpqua but not in the Mid-South Coast. Tributary streams in the Klamath Mountains DPS met the target, but the mainstem reaches were far in excess of the goal. Tributary and mainstem streams in the Lower Columbia and Southwest Washington DPS failed to meet the target.

Thirty eight (12.7%) 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, R^2=0.98) was similar to previous years (average 1999-2010 R^2=0.95) and indicates the counts are precise and repeatable. Steelhead counts were more variable (R^2=0.79), and also similar to past years (average 2002-2010 R^2=0.74). Resurveying was also an important part of the training process, detecting fish ID or protocol problems. Resurvey data replaced data from three surveys due to protocol problems early in the season. These were not included in resurvey analysis.

Salmonid Distribution and Density

Oregon Coast Coho

In 2011, mean average pool density was 0.50 coho/m^2 and 24% of sites were fully seeded (had densities greater than 0.70 coho/m^2) (Table 2). Densities at the MA level were higher in the Mid-South than in the Mid-Coast, but the North Coast and Umpqua were similar to each other (Table 2). Occupancy and density estimates for 2011 were greater in all Coastal MAs compared to the average condition from 1998-2010, with the exception of fully seeded sites in the Mid Coast (Figures 3 and 4). Coho occurred in 88% of 1st-3rd order stream sites. Average pool occupancy was 74% with the Mid-Coast and the Mid-South Coast having the highest occupancy rates.

Densities and pool population estimates averaged for the ESU were similar to 2001–2010, but higher than 1998-2000 (Figures 5 and 6). Pool occupancies were similar to 2002-2010, but higher than in 1998-2001. Average site occupancy was the highest since sampling began (Figure 6). Site occupancies ($R^2 = 0.531$, p value= 0.003) and pool population estimates ($R^2 = 0.616$, p value= 0.001) show a moderate increasing trend since sampling began (Figure 7). The significance of this trend 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 2011 mean average density in pools was 0.188 fish/m^2, with 7% of sites fully seeded. Coho occurred in 60% of the sites in the SONCC and mean pool occupancy was 47% (Table 2).

Densities and pool population estimates in 2011 were similar to 2009 and 2010, but lower than the previous estimate for the brood cycle in 2008 (Figures 5 and 6). Pool occupancies were similar to previous years (Figure 5) but site occupancies were slightly lower (Figure 6).

No increasing or decreasing trend in abundance or distribution was detected for the ESU.

Lower Columbia Coho

The 2011 mean average density in pools was 0.188 fish/m^2, with only 5% of sites fully seeded (Table 2). Coho occurred in 44% of 1^{st}-3^{rd} order stream reaches with mean pool occupancy of only 28%. Density and pool population estimates in 2011 were similar to previous years (Figures 5 and 6). Pool and site occupancies were similar to previous years.

In the 4^{th} -6^{th} order (mainstem) streams coho occurred in 31% of the sites, mean pool occupancy was 16%, and mean average density was 0.019 fish/m^2. No mainstem sites were fully seeded. Although we exceeded our goal for sampled sites in the Lower Columbia, the variance for the density estimate nearly equaled the estimate.

No increasing or decreasing trend in abundance or distribution was detected for the Lower Columbia ESU.

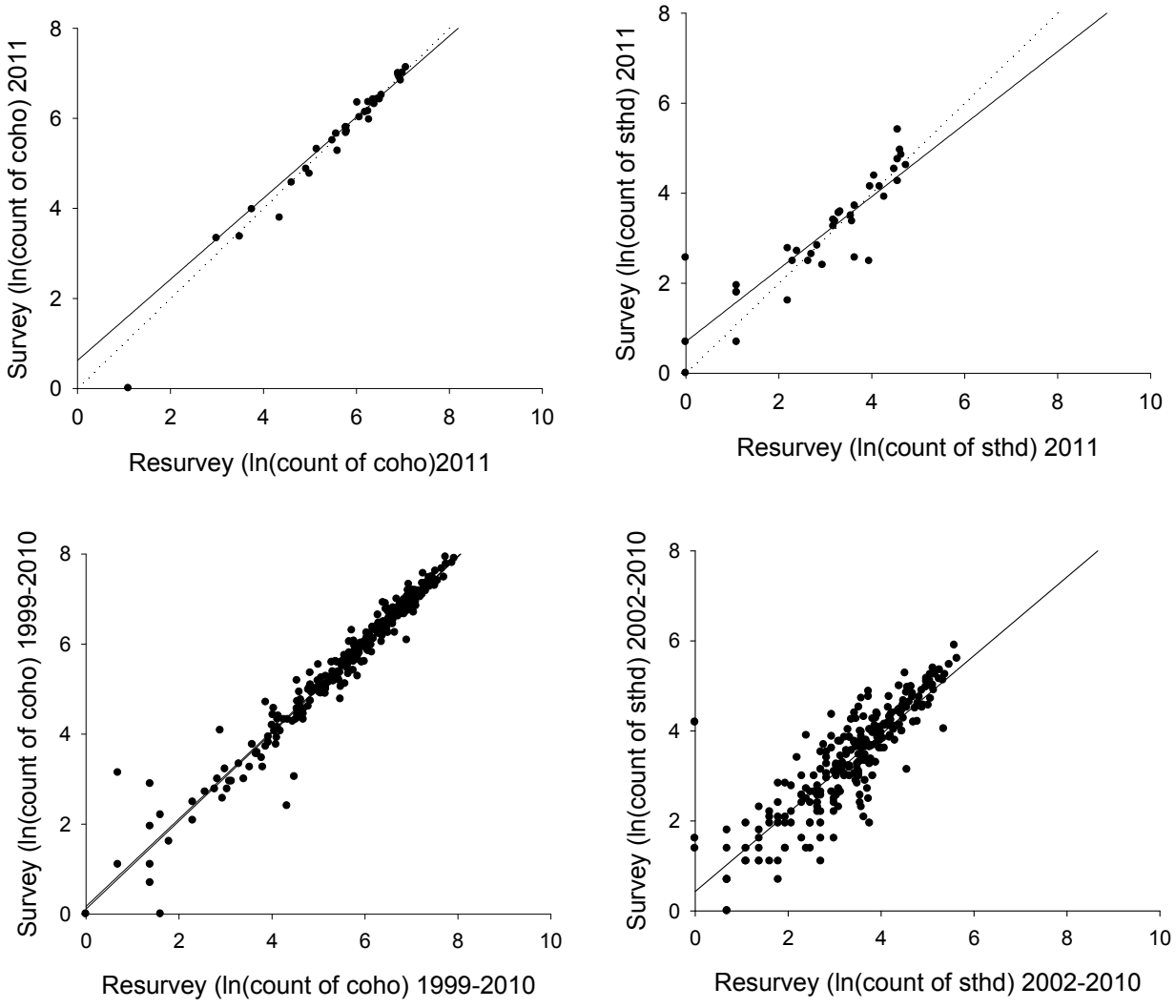

Figure 2. The relationship between the original snorkel counts for juvenile coho and steelhead in pools and the resurvey of the same sites in 2011 (top panels, n=38) and for all years (bottom panels, n=331 and n= 277 for coho and steelhead, respectively). The dotted line for 2011 indicates a 1:1 relationship. Data are log transformed to satisfy regression assumptions.

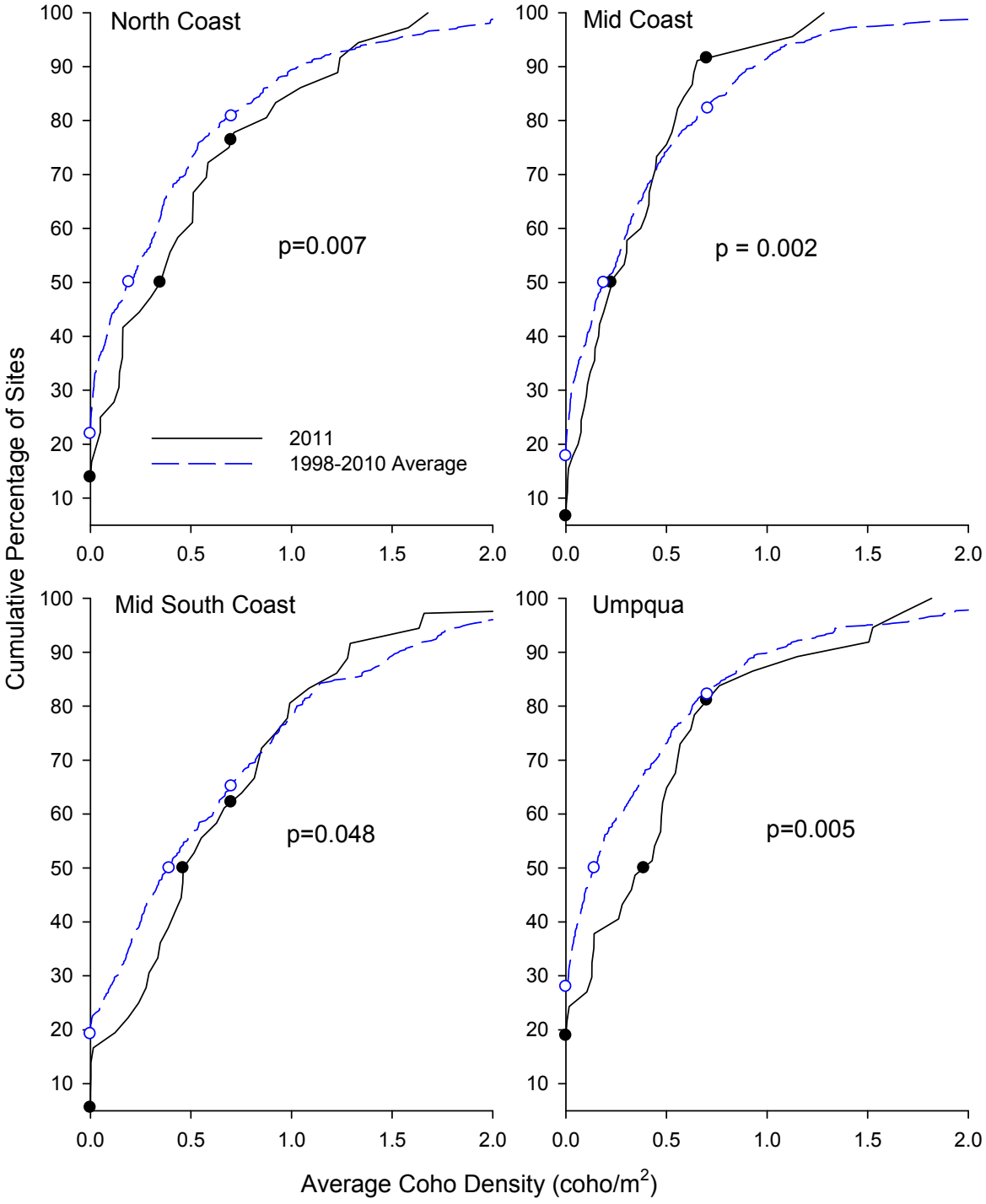

Figure 3. Average coho density CDFs from snorkeled tributary sites for the four monitoring areas of the Oregon Coast Coho ESU comparing 2011 with the average from 1998-2010. P values are for the comparison test of the two curves. The three points shown on the curves, from left to right, are the percentage of unoccupied sites, the median density, and the percentage of sites below full seeding.

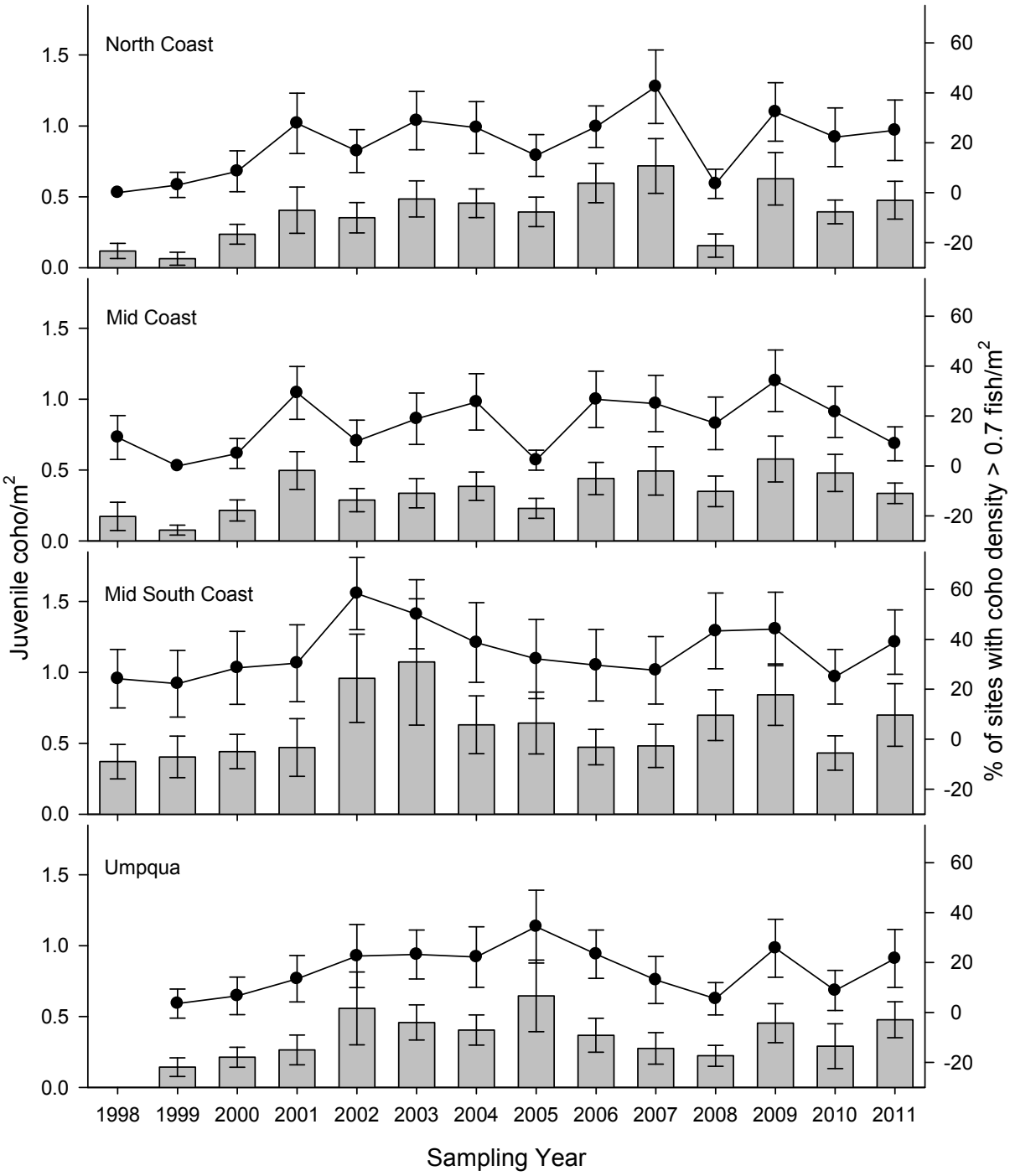

Figure 4. Annual trends in density and full seeding frequency for juvenile coho salmon in monitoring areas of the Oregon Coast Coho ESU, based on snorkel surveys in 1st-3rd order stream reaches. Panels are organized by monitoring strata. Gray bars are for mean average density (coho/meter^2) and black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

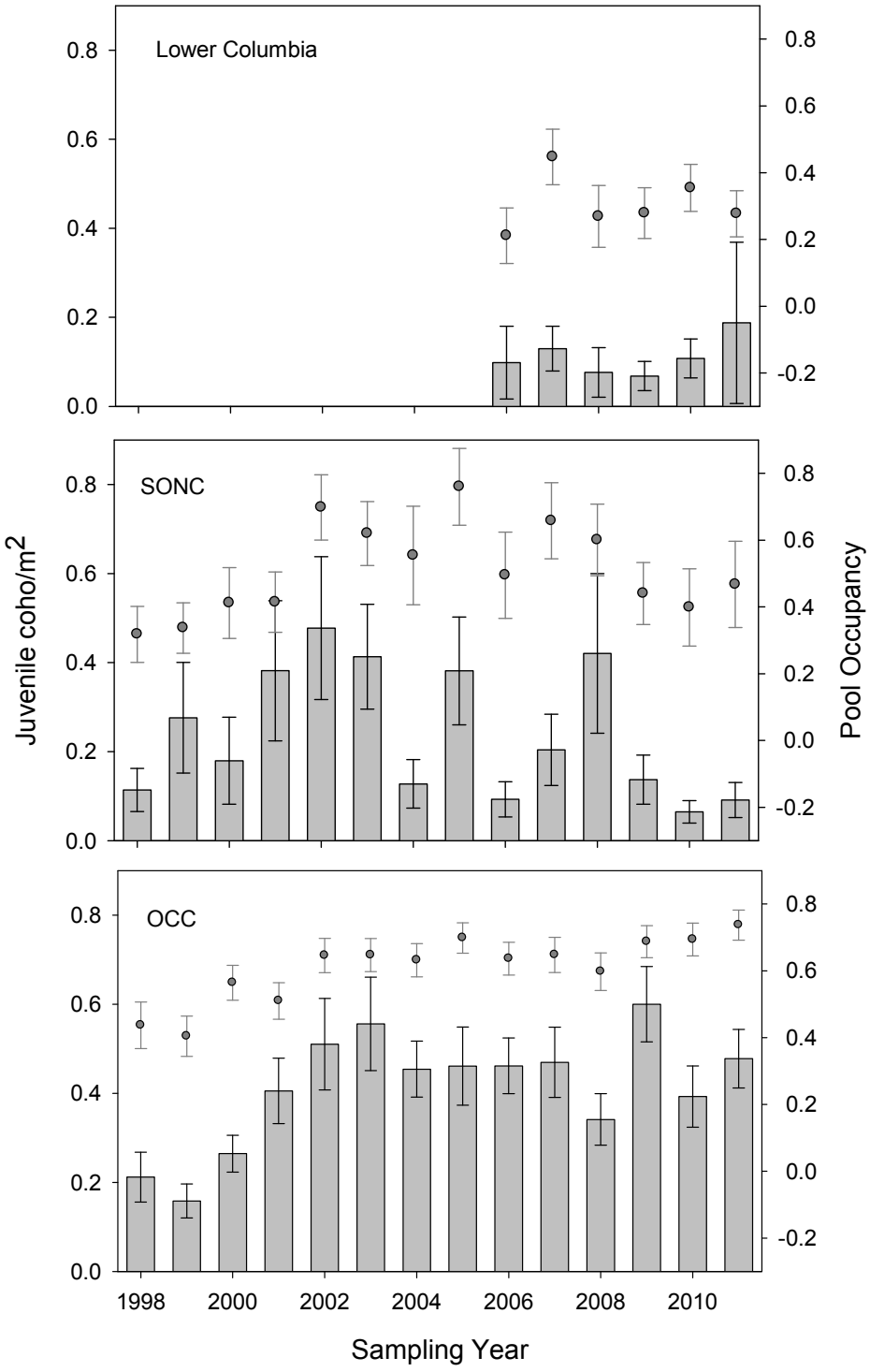

Figure 5. Annual trends in mean density (gray bars) and pool occupancy (grey dots) for juvenile coho salmon in three Oregon ESUs, based on surveys in 1st-3rd order stream reaches.

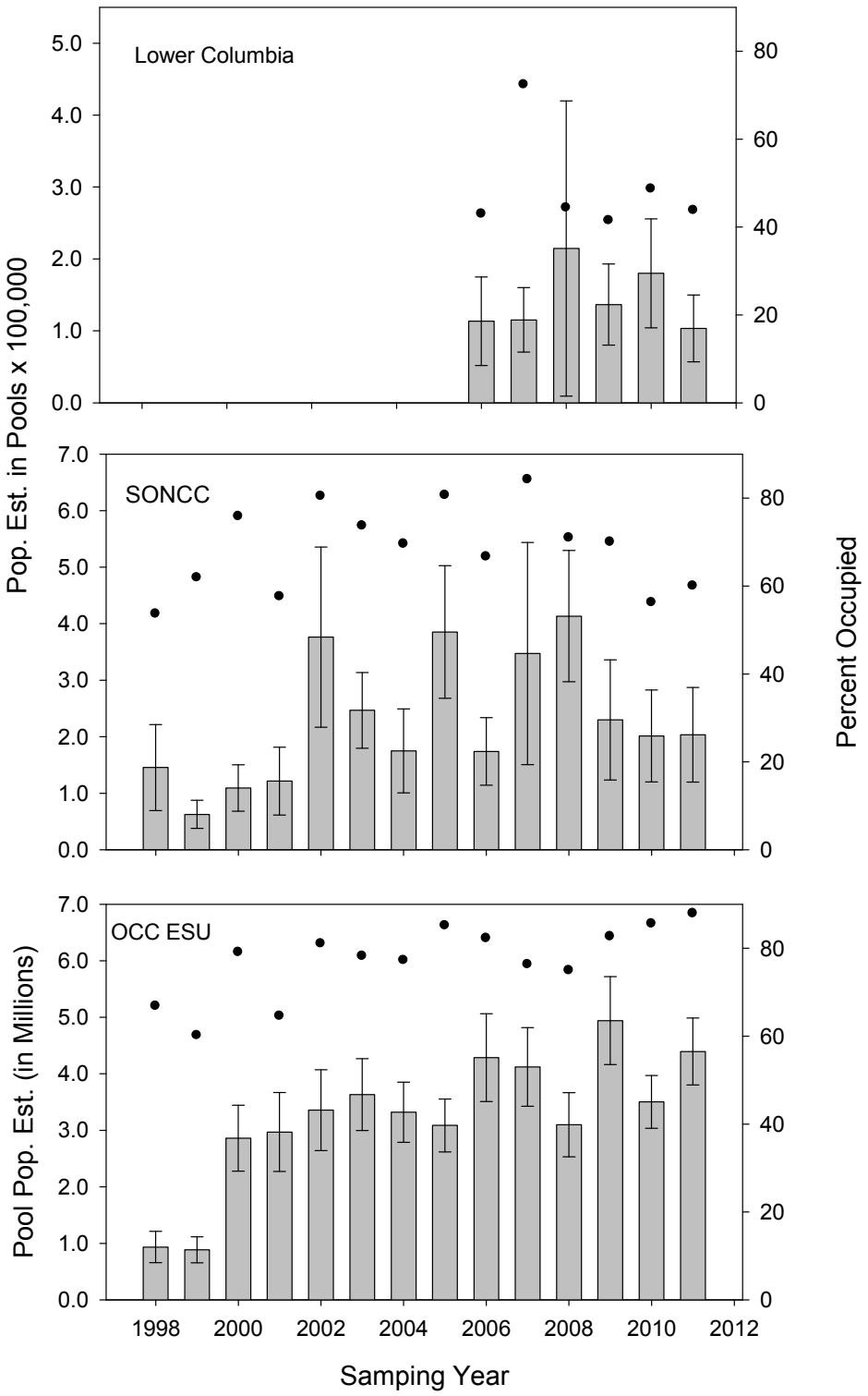

Figure 6. Annual trends in pool population estimates (gray bars) and site occupancies (black dots) for coho salmon in three Oregon ESUs, based on snorkel surveys in 1st-3rd order stream reaches. Note population estimate scale differences between the OCC and upper graphs. Population estimates are from un-calibrated snorkel counts in pools meeting size criteria (≥0.40m depth) and do not represent total population estimates.

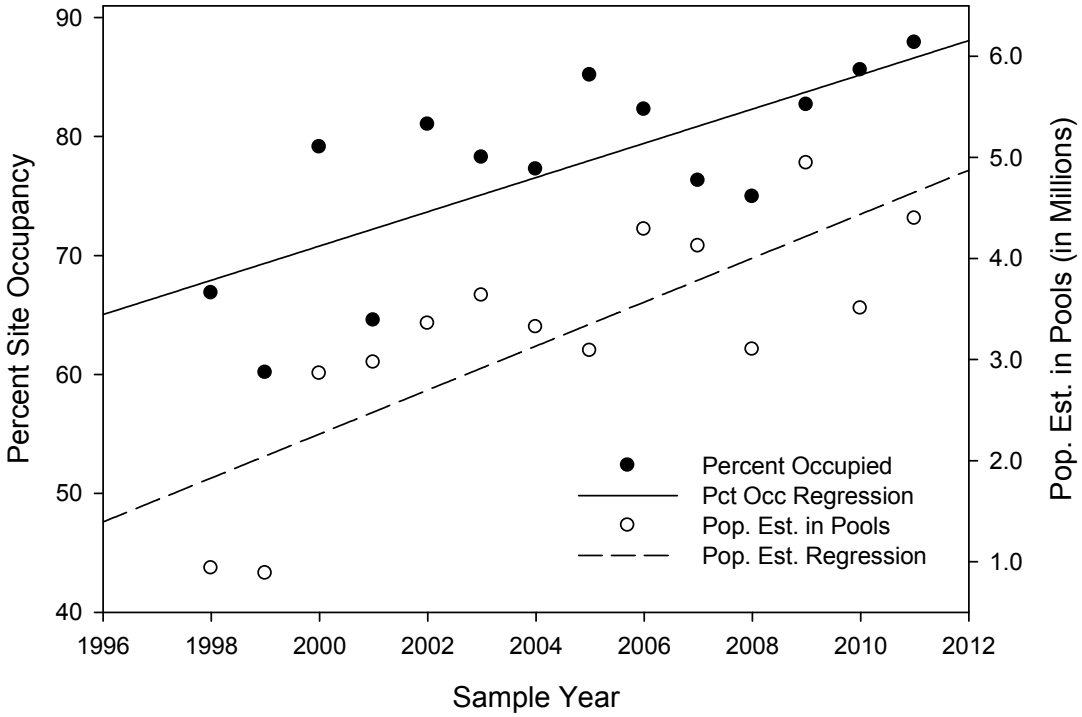

Figure 7. Trends in percent of sites occupied (black dots) and pool population estimates in the Oregon Coast Coho ESU.

Oregon Coast Steelhead

Similar to previous years, in 2011 the North Coast had higher site and pool occupancies and density estimates compared to other coastal MAs (Figure 8). The Umpqua had the lowest steelhead pool occupancy and density metrics from 2002-2010, but in 2011 these metrics in the Umpqua were similar to the Mid Coast and Mid South Coast.

Densities, pool occupancies, and population estimates in pools for 2011 were similar to past years (Figures 9 and 10). Site occupancy (83%) was the highest since steelhead sampling began (Figure 10). No 4^{th}-6^{th} order mainstem streams were surveyed in the Oregon Coast DPS in 2011. No trends were detected in steelhead occupancy or abundance.

Klamath Mountain Province Steelhead

In 2011 steelhead occurred in 91% of 1^{st}-3^{rd} order sites and 100% of 4^{th}-6^{th} sites of the Oregon portion of the Klamath Mountain Province steelhead DPS. Density averaged 0.066 fish/m^2 in tributary reaches and 0.027 fish/m^2 in mainstem reaches. The Rogue had higher tributary densities than the South Coast (non-Rogue) MA. Densities, pool occupancies, population estimates in pools, and site occupancies were similar to past years (Figures 9 and 10). No increasing or decreasing trends were detected in steelhead distribution or abundance.

Lower Columbia River/Southwest Washington Steelhead

The Oregon portion of the two steelhead DPSs had similar density and occupancy metrics (Table 3). Very few steelhead were observed in the lower Columbia River non-wadable sites. Densities, pool population estimates, site occupancies and pool occupancies were similar to past years (Figures 9 and 10). No increasing or decreasing trend was detected in steelhead distribution or abundance for either DPS.

ESU/DPS Comparisons

Coho

The Oregon Coast Coho ESU had the broadest coho distribution (based on occupancy rates) and highest density estimates with the Southern Oregon Northern California ESU intermediate between the OCC and LCR ESUs. The Lower Columbia River ESU was similar to the SONCC in density but occupancy estimates were much lower (Figure 5).

Steelhead

The Klamath Mountain Province steelhead DPS had the broadest steelhead distribution and highest density estimates (Figures 9 and 10). The Oregon Coast, Southwest Washington and Lower Columbia DPSs had similar average pool occupancy and density estimates for steelhead but the Oregon Coast had higher site occupancies. The Lower Columbia River and Southwest Washington DPS had similar occupancy and density metrics. Population estimates in pools are not directly comparable because the number of stream kilometers differs among the four DPS.

Table 3. Distribution and density estimates for juvenile steelhead in western Oregon streams in summer 2011. Distribution metrics are calculated from snorkeled and electrofished sites whereas density metrics are calculated from only snorkeled sites.

	Distribution			Density		
Monitoring Area	Site Occupancy	Mean Pool Occupancy	95% CI	Mean Average Pool Density (sthd/m2)	95% CI	CI Pct of Estimate
1-3 Order Streams						
North Coast	88%	56%	± 7%	0.072	± 0.014	20.00%
Mid Coast	80%	35%	± 6%	0.034	± 0.01	29.90%
Mid South	80%	44%	± 7%	0.026	± 0.011	40.20%
Umpqua	83%	40%	± 7%	0.026	± 0.008	29.70%
KMP Rogue	85%	61%	± 13%	0.089	± 0.024	26.40%
KMP South Coast	97%	66%	± 7%	0.042	± 0.01	24.80%
Lower Columbia	67%	35%	± 11%	0.036	± 0.019	51.30%
Southwest WA	66%	41%	± 8%	0.029	± 0.012	40.80%
4-6 Order Streams						
KMP Rogue	100%	87%	± 13%	0.029	± 0.018	55.80%
KMP South Coast	100%	86%	± 16%	0.025	± 0.016	63.30%
Lower Columbia	75%	41%	± 17%	0.003	± 0.002	84.70%

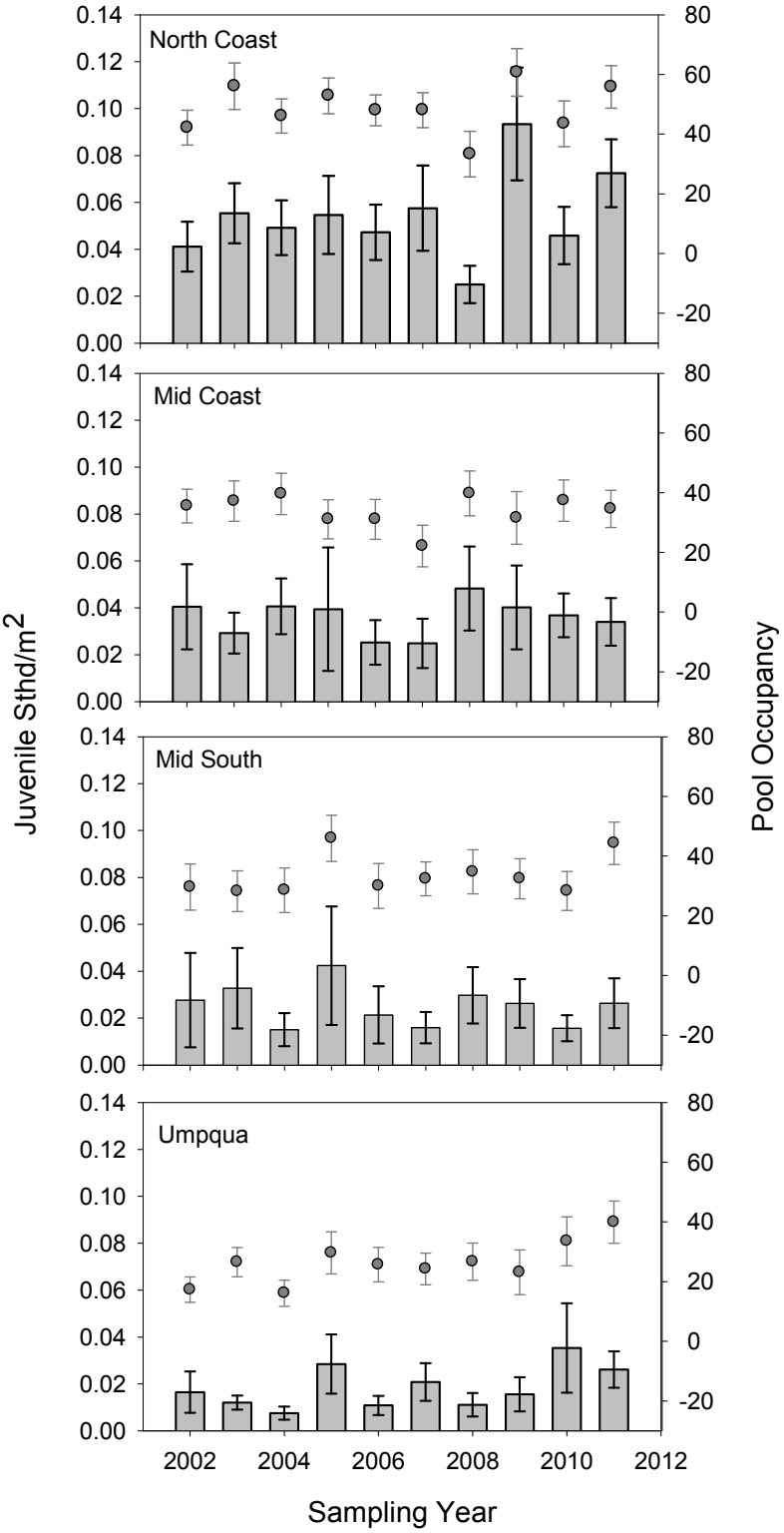

Figure 8. Annual trend in density and percent pool occupancy metrics for juvenile steelhead in the four Monitoring Areas of the Oregon Coast steelhead DPS, based on snorkel surveys in 1st-3rd order stream reaches. Panels are organized by monitoring strata. Gray bars are for mean density (sthd/meter^2) and dots are for mean percent pool occupancy.

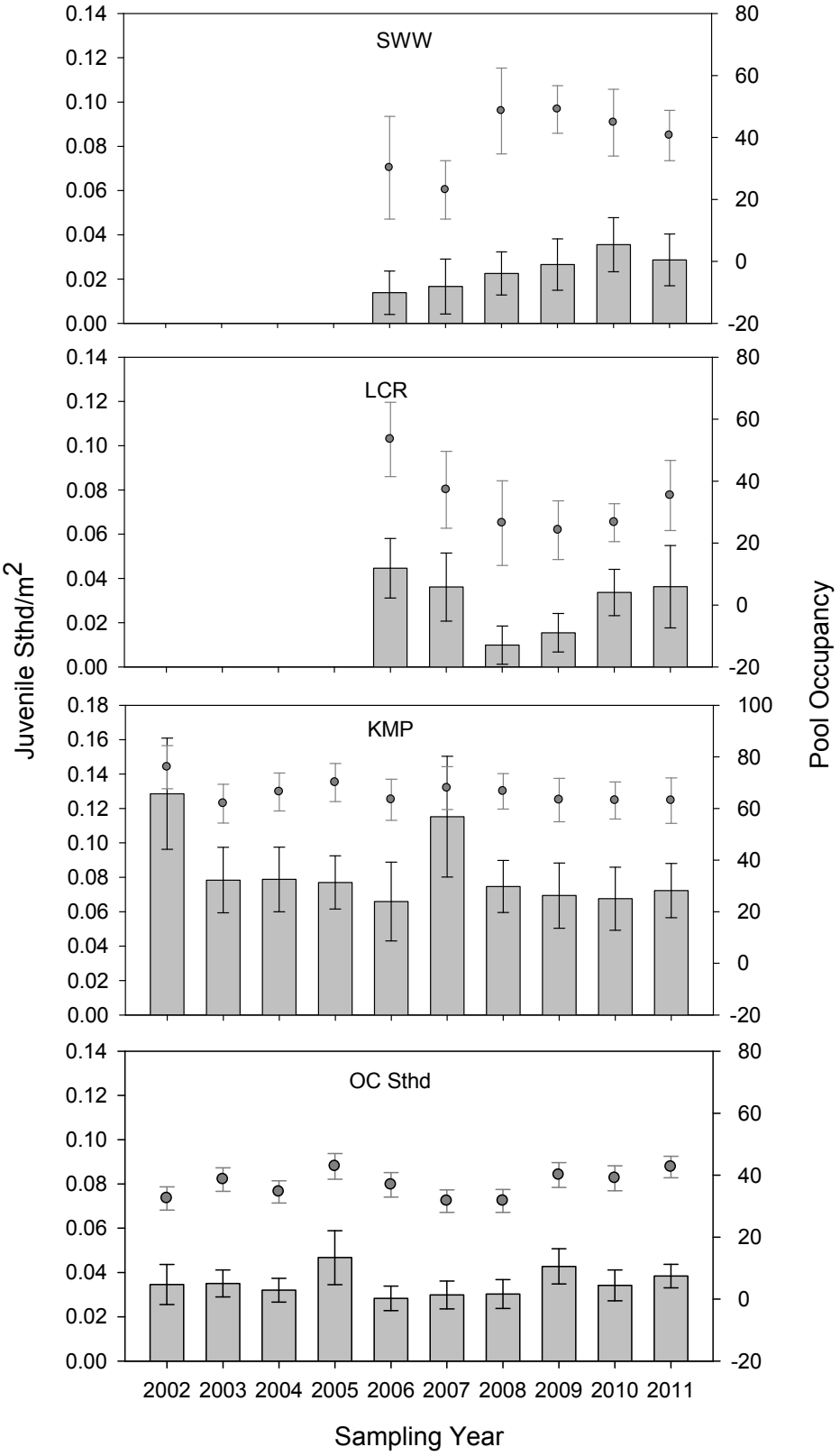

Figure 9. Annual trend in mean density (gray bars) and pool occupancy frequency (black dots) metrics for steelhead in four Monitoring areas in the Oregon Coast DPS, based on snorkel surveys in 1st-3rd order streams.

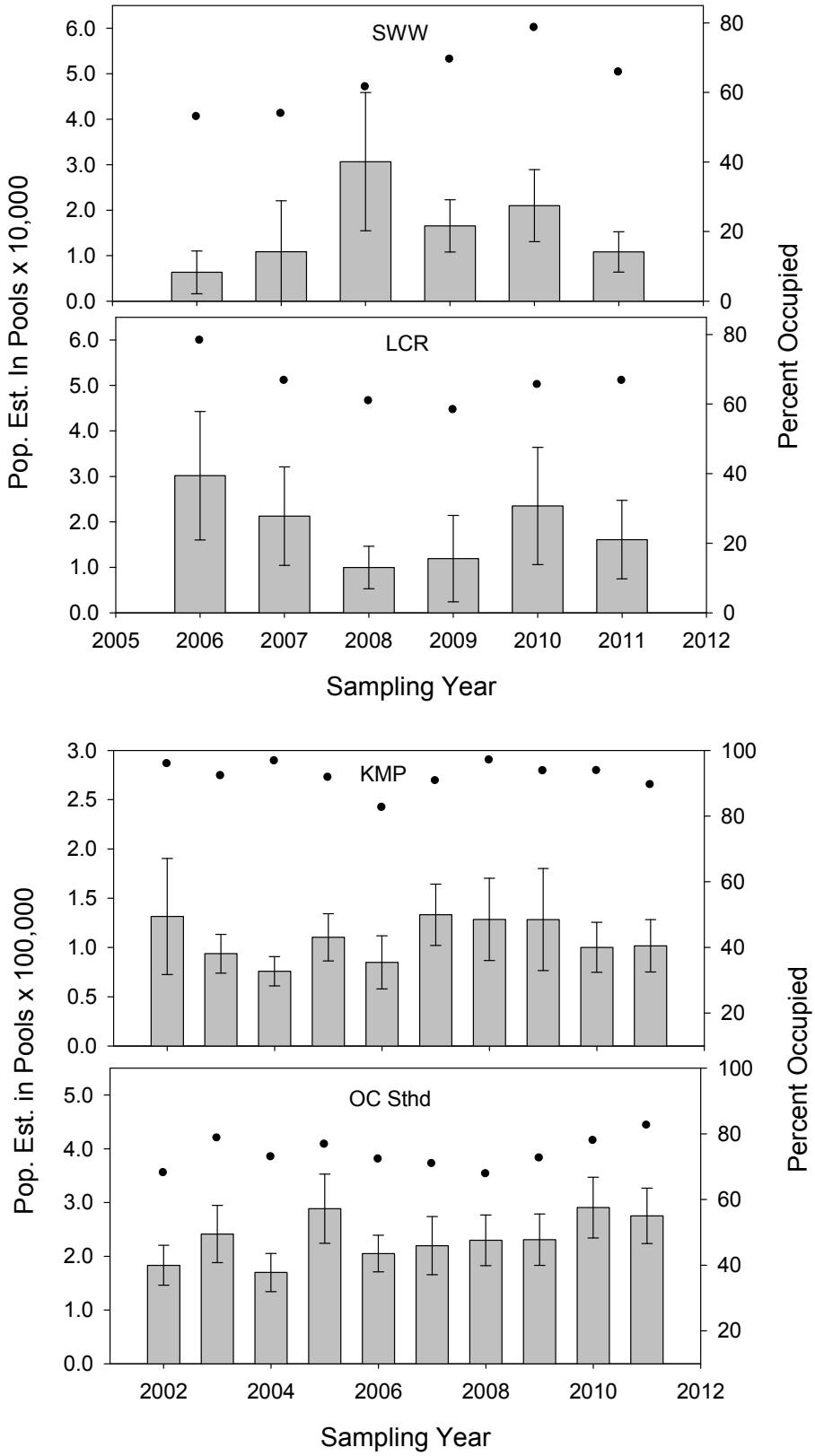

Figure 10. Annual trend in population estimates from pools (gray bars) and site occupancies (black dots) metrics for steelhead based on surveys in 1st-3rd order streams. Note X and Y axis scale differences in upper and lower panels.

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 do not meet the 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 48% of the coho population and 69% of the steelhead population in the Smith study basin. The yearly difference ranged from 32% to 61% for coho and 49% to 91% 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 $R^2 = 0.918$, $p= 0.001$). 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 65 - 81% 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 $R^2 = 0.971$, $p< 0.001$ and for steelhead $R^2 = 0.932$, $p< 0.001$).

The proportion of juvenile coho in pools 20-40 cm deep relative to pools ≥40 cm deep varied annually during the 6 year study period. In some years, small pools contributed the majority of coho in pools. However, the Smith River study did not include snorkel estimates in pools below 40 cm in depth and we are 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 2011 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 for pools resulted in an additional 1,694 pools snorkeled in 1st-3rd order reaches. An additional 128 pools were electrofished in 1st-3rd order reaches. Two sites in the Lower Columbia and one in the Mid-South Coast contained only pools that were ≥20 cm in max depth but <40 cm. 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 three successfully completed sites, for a total of 356 (Table 1).

Occupancy

Lowering the pool depth criterion to ≥20cm allowed surveyors to observe coho and steelhead in several sites where they would not have been observed under the previous criterion. Site occupancies for coho increased in the Umpqua and Lower Columbia and steelhead site occupancies increased in the Mid Coast, Mid South Coast,

Umpqua and the Klamath Mountains Province DPS and the Oregon side of the Southwest Washington DPS.

One site in the Mid-South and two sites on the Lower Columbia did not have pools that were ≥40cm, but did have pools that were ≥20cm. In these three sites one the site on the Mid-South and one site on Lower Columbia sites contained coho. Additionally, in one site in the Umpqua and one site in the Lower Columbia coho were observed in pools that were ≥20cm in max depth but were not observed in pools that were ≥40cm in max depth. This increased site occupancies by 3% in the Umpqua and by 1% in Lower Columbia. In all other areas site occupancies were not significantly changed.

The three sites that did not have pools ≥40cm in depth did not contain steelhead but at several sites (two in the Mid Coast, one in the Mid South Coast, two in the Umpqua, one in the KMP Rogue, and one in the Lower Columbia DPS) steelhead were observed in pools that were ≥20cm in max depth but were not observed in pools that were ≥40cm in max depth. This increased site occupancies by 4% in the Mid Coast, 5% in the Umpqua, 3% in the Southwest WA tributary sites and 1% in the Mid South and KMP. Site occupancies were not significantly changed in other areas.

The average pool occupancy for coho was lower when the depth criteria was lowered to include pools 20 to 40 cm deep compared to pool occupancy for pools ≥40cm, though not significantly. Mean pool occupancy decreased in all monitoring areas by under 3% (of the estimate from pools meeting the 40cm depth criterion), except for sites in the SONCC which increased by approximately 0.5%.

Although not statistically significant, differences in pool occupancies were more pronounced for steelhead. Pool occupancies decreased by less than 10% in all monitoring areas except for the Mid South, where they decreased by 16% and the Umpqua where they decreased by 17%.

Density

Coho density estimates decreased by approximately 10% in most management areas when the lower depth criterion was used because shallow pools generally had lower densities. However, density estimates in pools ≥20 cm deep (fish per m² of pool surface area) had overlapping confidence intervals with estimates for ≥40cm.

Steelhead density estimates decreased by less than 10% (of the estimate from pools meeting the ≥40cm criterion) in most management areas, although larger decreases occurred in the Mid South, Umpqua, and Southwest WA DPS. Tributary site densities decreased in the Mid Coast by 12%, in the Mid South Coast by 27%, in the Umpqua by 21%, and in the Southwest WA DPS by 17%. Densities in 4-6th Order Streams were not affected.

Pool Population Estimates

Pool population estimates with the different depth criteria from WORP surveys in 2011 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 of the estimates from pools ≥40cm and pools ≥20cm indicate that including the smaller pools produces, on average, a 16% larger population estimate for coho ($p = 0.026$) and a 6% larger population estimate for steelhead ($p= 0.010$). 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 11). 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 Lower Columbia.

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.

	2011 Coho Estimates				
	Pools ≥20cm Max Depth		Pools ≥40cm Max Depth		
Monitoring Area	Estimate	95% CI	Estimate	95% CI	Difference
North Coast	793,918	±28%	742,914	±30%	6.50%
Mid Coast	1,040,575	±25%	802,427	±27%	23.10%
Mid South Coast	1,937,008	±22%	1,733,106	±21%	10.60%
Umpqua	1,482,785	±25%	1,115,480	±27%	24.80%
SONCC	216,818	±40%	203,452	±41%	6.20%
Lower Columbia	120,996	±49%	103,458	±45%	14.50%

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.

	2011 Steelhead Estimates				
	Pools ≥20cm Max Depth		Pools ≥40cm Max Depth		
Monitoring Area	Estimate	95% CI	Estimate	95% CI	Difference
North Coast	101,638	±36%	97,859	±38%	3.80%
Mid Coast	61,490	±35%	52,865	±39%	14.10%
Mid South Coast	63,840	±29%	62,044	±29%	2.90%
Umpqua	68,928	±34%	62,369	±37%	9.60%
KMP Rogue	50,630	±34%	48,419	±36%	4.40%
KMP South Coast	53,888	±32%	53,220	±33%	2.30%
Lower Columbia DPS	16,878	±52%	16,102	±53%	4.60%
Southwest WA DPS	11,558	±38%	10,815	±41%	6.50%

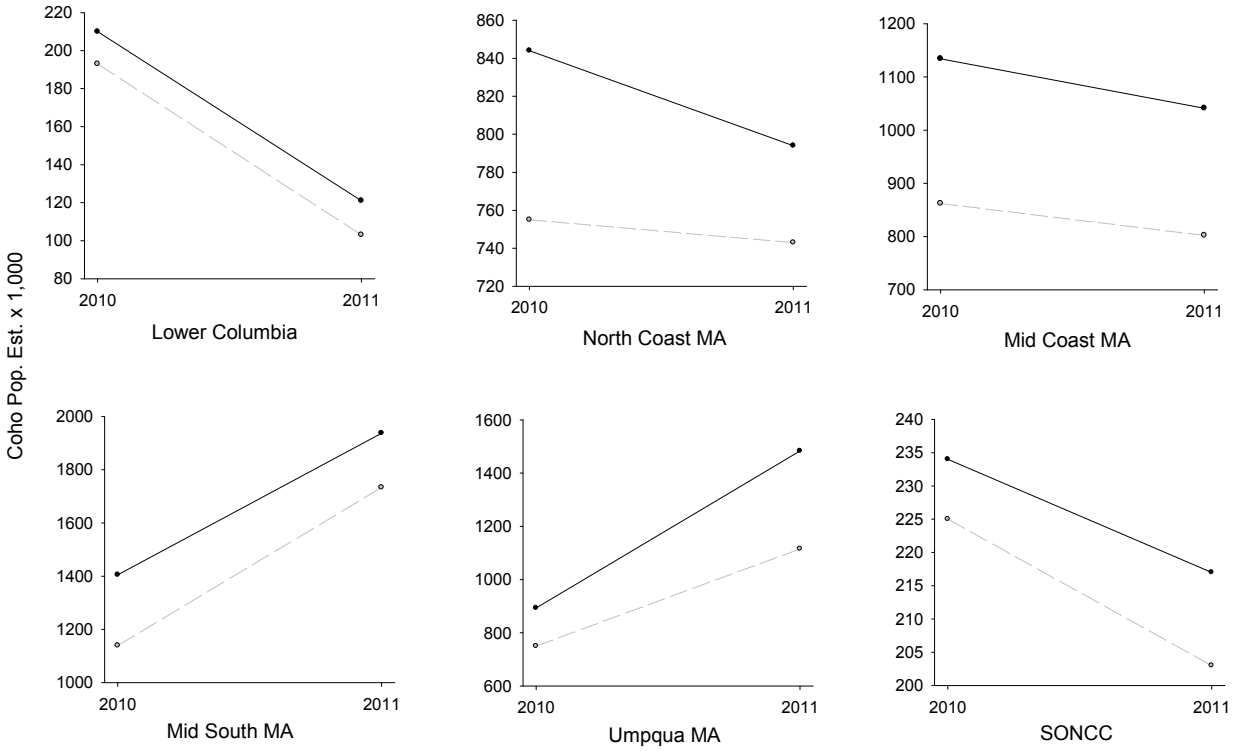

Figure 11. Trends in the coho rearing population from 2010 to 2011 based on the ≥20cm pool depth criteria (solid black line) and the ≥40cm pool depth criteria (dashed grey line).

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.

We resurveyed 122 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 under 40cm had a strong relationship between original and resurvey counts for coho (R^2=0.96) but not as strong as the relationship for pools that were ≥40cm (R^2=0.98). Steelhead showed a much weaker survey-resurvey relationship (R^2=0.27) in pools below 40cm than in pools ≥40cm (R^2=0.79). However, the precision of resurveys when all pools are included (all pools ≥20cm) is only slightly less than the precision only in pools ≥40cm (Table 4). When pools <40 cm in depth are included into survey-resurvey comparisons the relationship is similar (R^2=0.98) for coho and slightly weaker for steelhead (R^2=0.76) to the relationships when they are excluded.

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.

	All Pools ≥20cm			Pools ≥40 cm Max. Depth			Pools ≥20 cm Max. Depth and <40 cm Max. Depth		
Species	Survey	Resurvey	Pct	Survey	Resurvey	Pct	Survey	Resurvey	Pct
Coho	20,435	20,338	99.5	16,778	16,762	99.9	1,697	1,536	90.5
Sthd	1,981	1,665	84	1,858	1,546	83.2	73	57	78.1

Beaver Occupancy

Summary

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 11). The SONCC had the lowest average percent (20%) and ranged from 17%-31%. The LCR was slightly lower than the OCC, averaging 46% with a range of 33-56%.

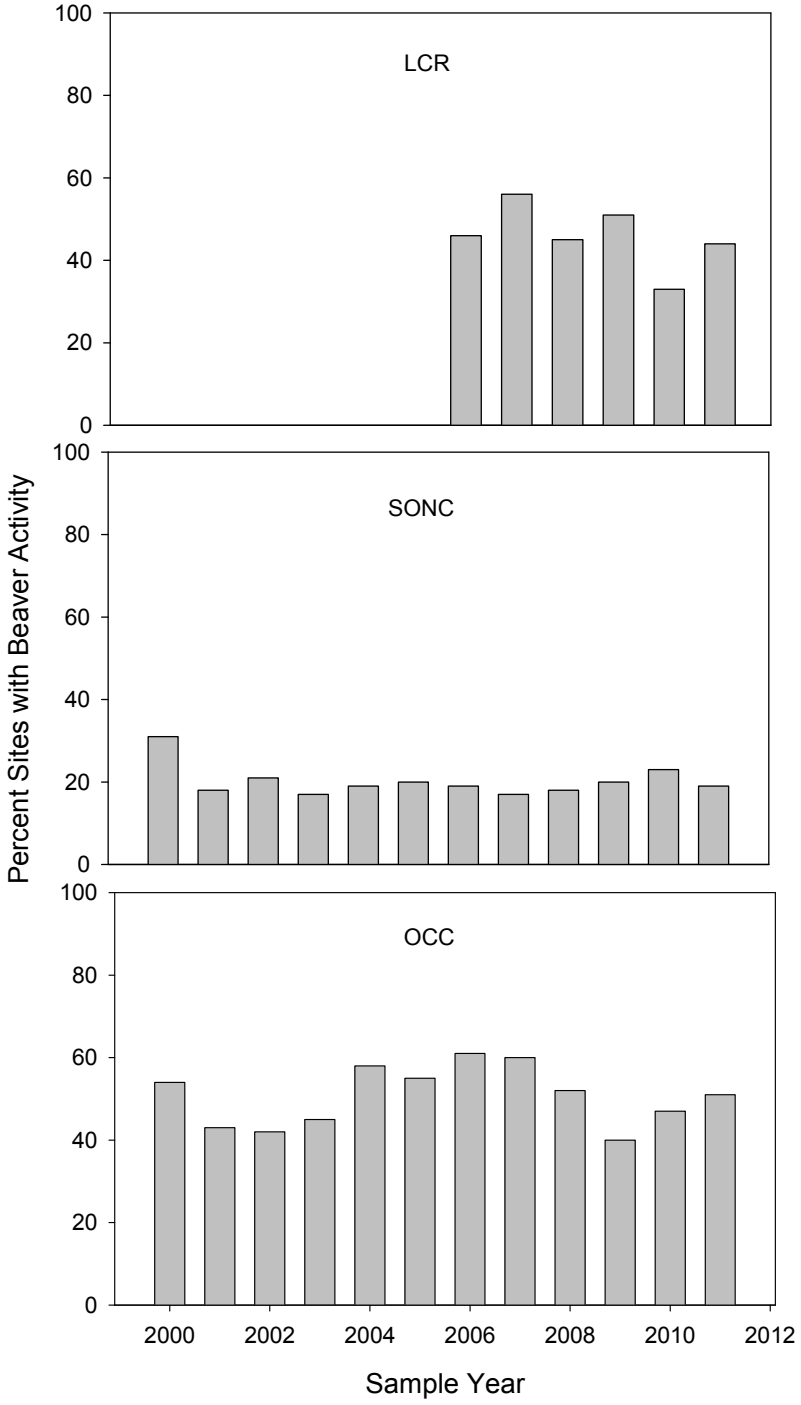

Figure 12. Yearly percent of sites with beaver activity in three coho ESUs within the study area.

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