THE OREGON PLAN *for Salmon and Watersheds*

Abundance Monitoring of Juvenile Salmonids In Coastal Oregon and Lower Columbia Streams, 2010

Report Number: OPSW-ODFW-2011-1

Juvenile Salmonid Monitoring in Coastal Oregon and Lower Columbia Streams, 2010

Oregon Plan for Salmon and Watersheds

Annual Monitoring Report No. OPSW-ODFW-2011-1

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SUMMARY

This report provides a summary of results from summer juvenile salmonid surveys conducted on the Oregon coast and lower Columbia River in 2010. Coho density metrics were higher in the Oregon Coast coho ESU than in the Southern Oregon Northern California coho ESU and the Lower Columbia coho ESU, which were similar. Occupancy metrics were highest in the Oregon Coast ESU, intermediate in the Southern Oregon Northern California coho ESU and lowest in the lower Columbia coho ESU.

Within the Oregon Coast Coho ESU the Mid South Monitoring Area metrics were similar to the average since 1998, while the North Coast and Mid Coast were higher and the Umpqua was lower. Juvenile steelhead estimates were comparable to previous years in all DPSs, with steelhead the most abundant and widespread in the Klamath Mountains Province.

As suggested by the results of the Smith River Verification Study in 2010 the maximum depth of survey pool size criteria was lowered from ≥40 cm to ≥20 cm. 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 did not produce significant differences in fish/m², pool occupancy or pool population estimates. Site occupancies increased slightly in the Mid-Coast MA and decreased in the Umpqua MA.

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. This report summarizes the data collected during the summer of 2010 and compares it to data previously collected. Data from past reports can be found at http://nrimp.dfw.state.or.us/crl/default.aspx?pn=WORP.

The project originally surveyed only 1st-3rd order (tributary) streams but was expanded in 2002 to include juvenile steelhead (*Oncorhynchus mykiss*) rearing areas and in 2006 to the Oregon portion of the Lower Columbia River coho evolutionarily significant unit (ESU) (Figure 1). The sampling frame is intended to encompass all non-tidal coho and steelhead rearing habitat. The original 100k stream layer frame was replaced by a 24k frame in 2007. A Generalized Random Tessellation Stratified design (GRTS, Stevens 2002) was used to create a spatially balanced, random point distribution. Sites were stratified by Monitoring Area (MA) and stream order (Table 1). A detailed description of the sampling frames and survey designs are found in Jepsen and Rodgers (2004) and Jepsen and Leader (2007). 4th-6th order (mainstem) streams are no longer being surveyed in the Oregon Coast coho ESU.

Field crews surveyed a 1 km reach of stream encompassing the GRTS point. In past years all pools meeting the size criteria of ≥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.) indicated that lowering the maximum depth threshold to ≥20 cm would allow surveyors to sample a larger and more consistent portion of the

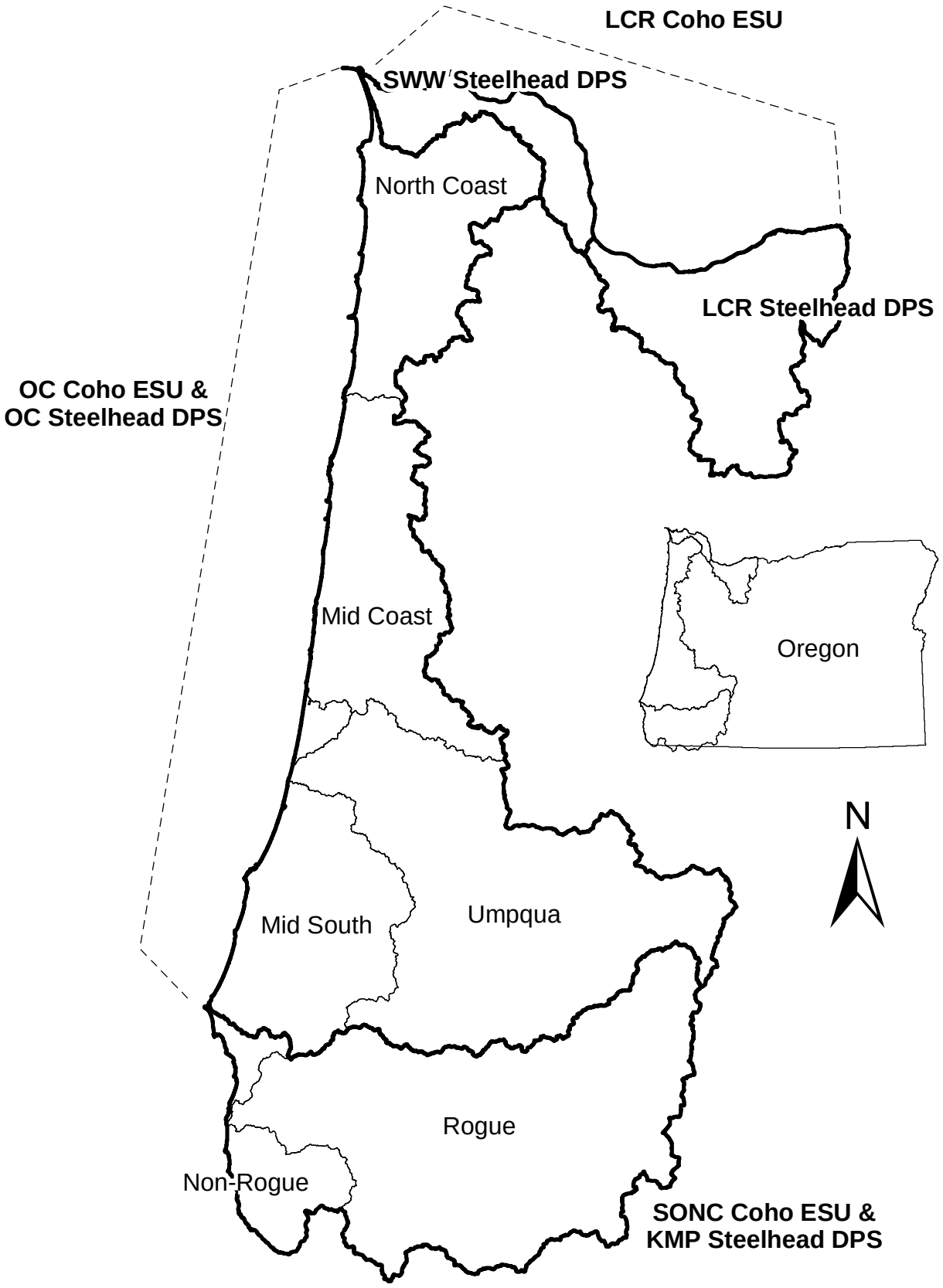


Figure 1. The spatial extent of the study area showing the Oregon portion of coho and steelhead ESU/DPSs as well as the monitoring areas in the Oregon Coast and KMP/SONC.

coho and steelhead summer rearing populations. The maximum depth criteria was lowered to this threshold for the 2010 field season. This report will analyze data from pools that met the ≥40 cm maximum depth requirement and perform an initial second analysis of pools that meet the new requirement.

Snorkeling was conducted during the minimum flow period from July to September using a single pass of one to six snorkelers, depending on stream width. In each pool counts were made of 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 presence for coho in each pool and steelhead and cutthroat at each site. To assess repeatability and quality control supervisory staff resurveyed ≥10% of tributary sites in each MA.

Data are summarized by MA and stream order for analysis. Average pool density and percent pool occupancy for each site is averaged by MA. The percent of sites with at least one fish and with >0.7 coho/m^2 are reported for each MA. 0.7 coho/m^2 is regarded as full seeding after Nickelson et al. (1992) who reported full seeding based on electrofishing as 1.0 coho/m^2 and Rodgers et al. (1992) who found 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).

Table 1. Site status by monitoring area and stream order. Target sites fell within rearing habitat; snorkeled and electrofished sites were successfully surveyed and non-response sites were not surveyed because of issues such as lack of landowner permission, site inaccessibility, or turbidity. Non-target sites are outside of coho and steelhead rearing habitat.

Monitoring Area	Stratum	Snorkeled	Electrofished	Target Non-response	Non-target
North Coast	1-3 Order	36	6	12	5
Mid Coast	1-3 Order	37	0	10	12
Mid South	1-3 Order	40	1	17	8
Umpqua	1-3 Order	34	5	8	14
Lower Columbia	1-3 Order Coastal	27	1	20	9
Lower Columbia	1-3 Order Cascade	26	3	14	6
Lower Columbia	4-6 Order Cascade	12	0	11	2
South Coast Coho	1-3 Order	32	0	9	0
Rogue Steelhead	1-3 Order	24	1	9	3
Rogue Steelhead	4-6 Order	12	0	5	0
Non-Rogue Sthd	1-3 Order	36	0	7	0
Non-Rogue Sthd	4-6 Order	4	0	4	0

RESULTS

Survey Effort and Resurveys

We snorkeled 5,549 pools at 292 sites in 1st-3rd order reaches and 123 pools at 28 sites in 4th-6th order reaches. In addition, we electrofished 262 pools at 17 sites in 1st-3rd order reaches. The 95% confidence interval for monitoring area density estimates for coho met the target of ±30% for the North Coast, Mid Coast, and Mid South Coast MA but not for the Umpqua, Lower Columbia or South Coast. Steelhead survey variance was similar to coho in the Oregon Coast MA and the goal of ±30% for the density estimate 95% confidence interval was met in the North Coast and Mid Coast but not in the Mid South Coast or Umpqua. The tributary streams in the KMP and Columbia MA were close to or met the target, but the mainstem reaches of these areas were far in excess of the 30% goal. Sixty five percent of the total selected sites were successfully surveyed (Table 1). Eight percent were not surveyed because of landowner access restrictions with the Mid South Coast and the Lower Columbia having the highest proportion of access denials.

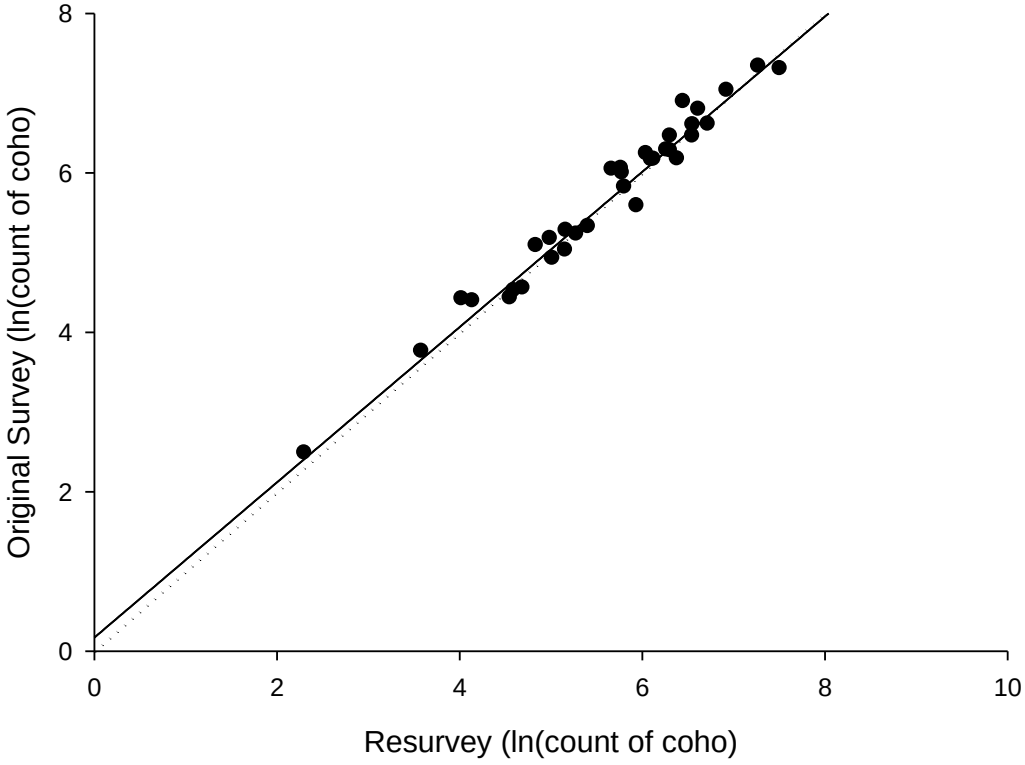
Forty (12.5%) of the snorkeled 1st-3rd order sites, comprising 872 pools, were resurveyed by crew leaders. The strong relationship between coho counts in the original surveys and resurveys (Figure 2, R^2=0.97) was similar to previous years (average 2002-2009 R^2=.98) and indicates the counts are precise and repeatable. Steelhead counts were more variable (R^2=0.85), and also similar to past years (average 2002-2009 R^2=0.86). Resurveying was also an important part of the training process, identifying fish ID or protocol problems.

Salmonid Distribution and Density

Oregon Coast Coho

Coho occurred in 87% of 1st-3rd order stream sites. Coho site occupancy in 2010 was higher in all Management Areas than average occupancy of the previous years (Table 2). Average pool occupancy was 71% and the Mid Coast and the Mid South Coast had high occupancy rates. Mean average pool density was 0.40 coho/m^2 and 20% of sites had densities greater than 0.70 coho/m^2. Densities at the MA level were similar.

Coho distribution and density were similar in the Mid South Coast and greater in the Mid Coast and North Coast and lesser in the Umpqua compared to the average condition from 1998-2009 (Figure 3). The North Coast and Mid Coast show an increasing trend since the beginning of monitoring whereas there is no trend apparent in the Mid South or Umpqua. The appearance of trend is linked to the increase in parental spawner abundance over this period. When the first four years of low spawner abundance are removed there is no trend in any MA (Figure 4). Coast-wide densities were lower than in 2009, but similar to 2001-2008 (Figure 5).



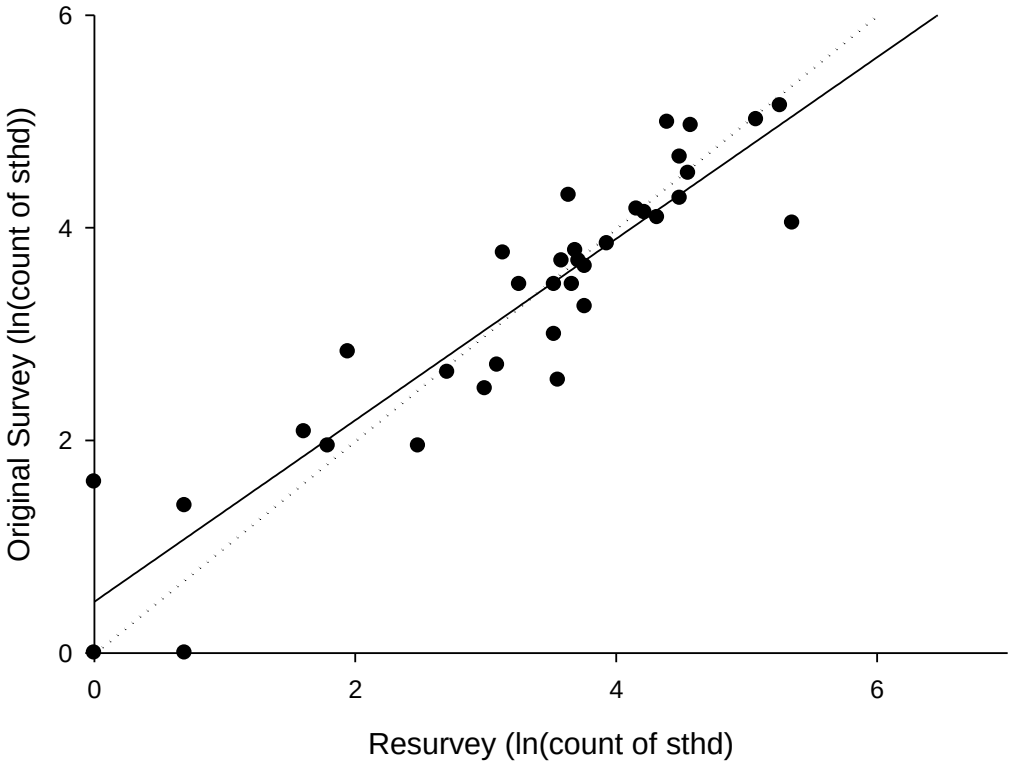


Figure 2. The relationship between the original snorkel counts for juvenile coho and steelhead in pools and the resurvey of the same sites in 2010 (n=40). The dotted line indicates a 1:1 relationship. Data are log transformed to satisfy regression assumptions.

Table 2. Distribution and density estimates for juvenile coho salmon in western Oregon streams summer 2010. 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	Percent Sites >0.7 coho/m^2	Mean Average Pool Density (coho/m^2)	95% CI
1-3 Order Streams						
North Coast	93%	73%	± 9%	22%	0.394	± 0.083
Mid Coast	92%	79%	± 9%	22%	0.480	± 0.131
Mid South	90%	78%	± 9%	25%	0.431	± 0.121
Umpqua	72%	53%	± 11%	9%	0.291	± 0.158
South Coast Coho	56%	40%	± 12%	3%	0.109	± 0.063
Lower Columbia	49%	35%	± 7%	2%	0.108	± 0.044
4-6 Order Streams						
Lower Columbia	33%	22%	± 14%	8%	0.127	± 0.092

Southern Oregon Northern California Coho

Coho occurred in 56% of the sites in the SONC and mean pool occupancy was 40% (Table 2). The average coho density in pools was 0.11 fish/m^2 with one site (3%) supporting >0.7 fish/m^2. Densities in 2010 were lower than past years, while pool occupancies were similar (Figure 5).

Lower Columbia Coho

Coho occurred in 49% of 1^{st}-3^{rd} order stream reaches, mean pool occupancy was only 35%, and mean average density was 0.108 fish/m^2 (Table 2). One site (2%) exceeded an average density of 0.7 fish/m^2. In the 4^{th} -6^{th} order streams coho occurred in 33% of the sites, mean pool occupancy was 22%, and mean average density was 0.127 fish/m^2. One site exceeded an average density of 0.7 fish/m^2. This site was atypical of mainstem habitat and contained only one pool. The majority (78%) of the coho in 4^{th} -6^{th} order streams were found in side channels or braids. Densities in 2010 were similar to past years (Figure 5).

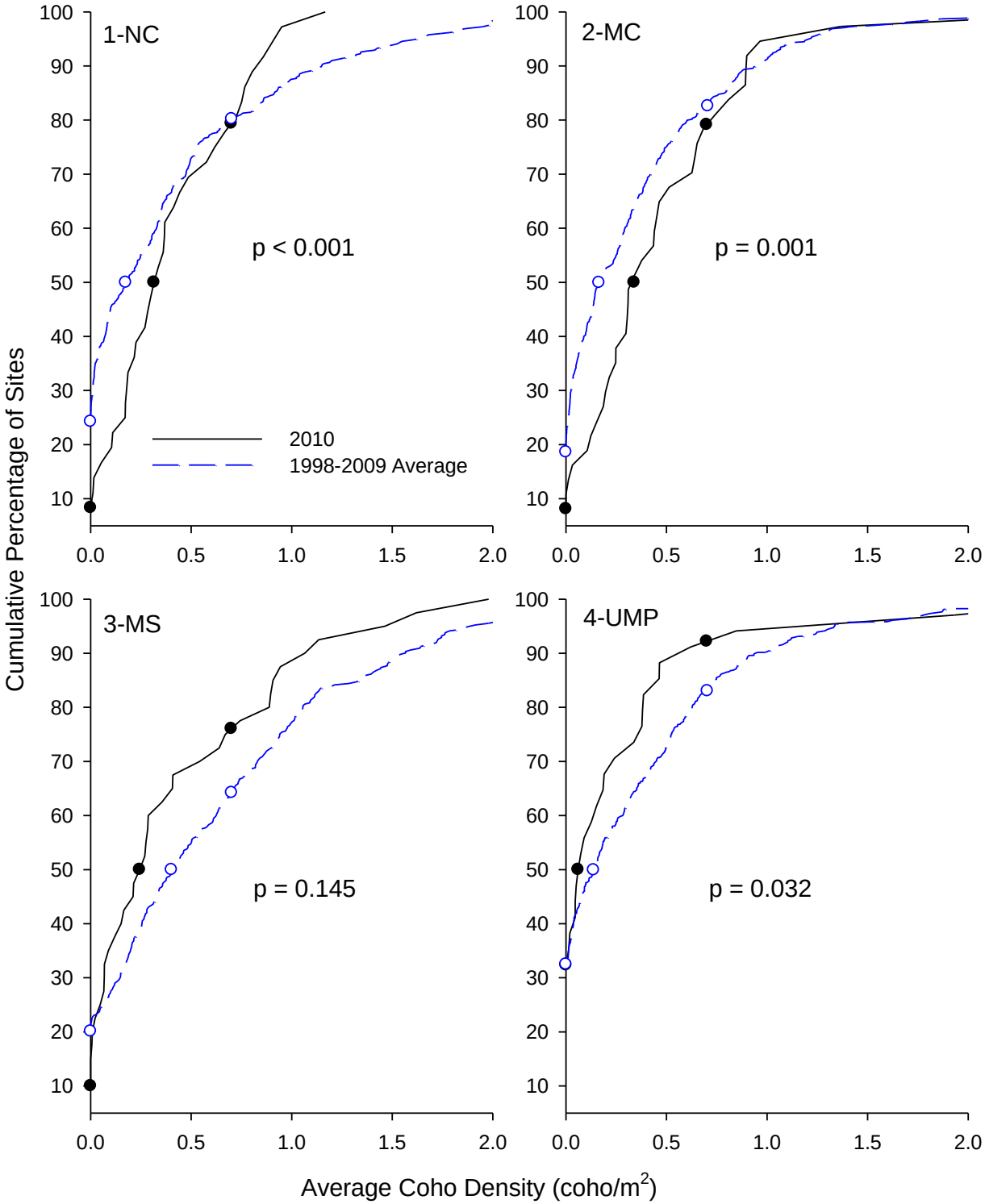


Figure 3. Average coho density CDFs from snorkeled tributary sites for the four monitoring areas of the Oregon Coast Coho ESU comparing 2010 with the average from 1998-2009. P values are for the comparison test of the two curves. The three points shown on the curves, from left to right, are the percentage of unoccupied sites, the median density, and the percentage of sites below 0.7 coho/m^2 (full seeding).

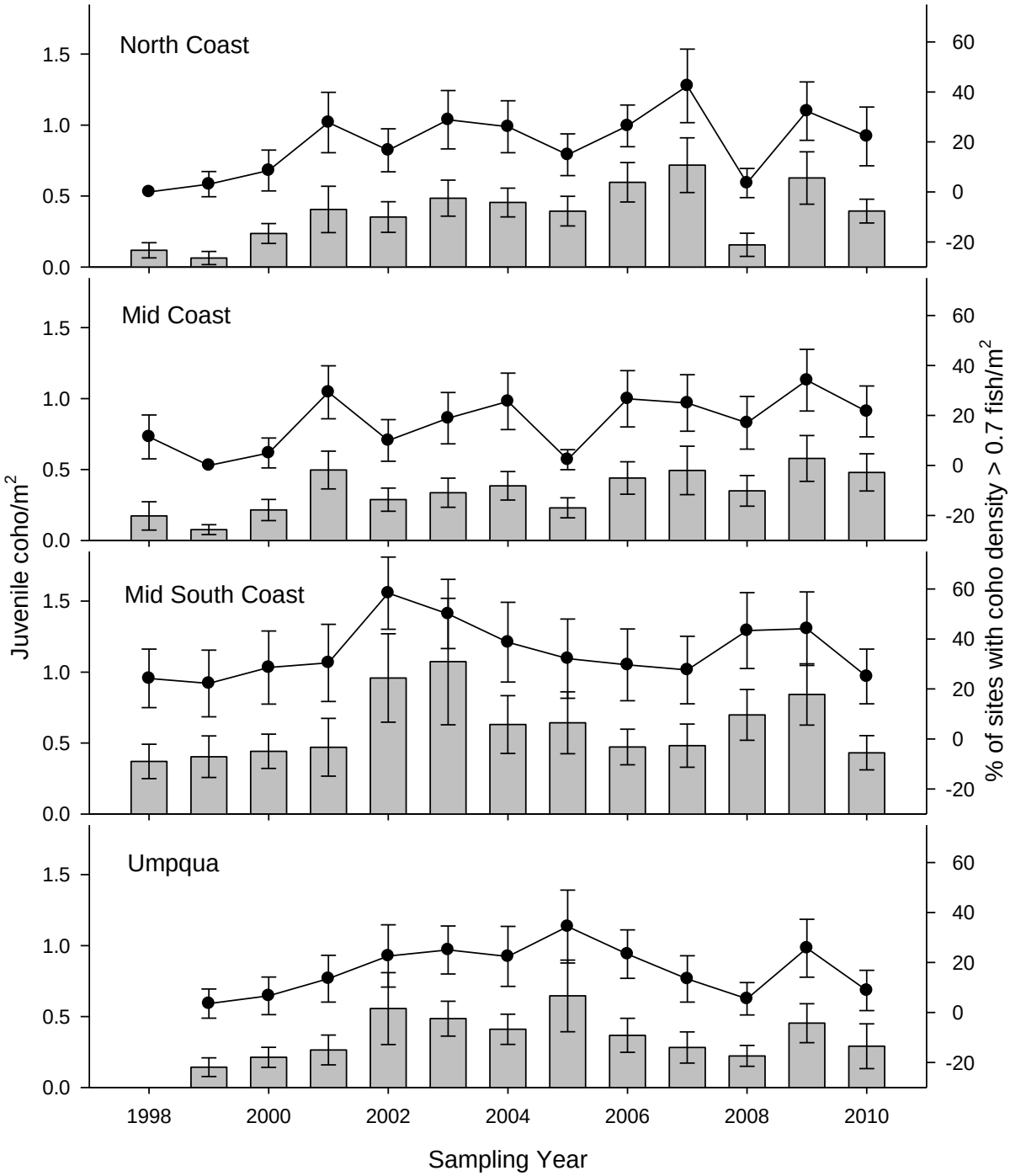


Figure 4. Annual trends in abundance and frequency metrics for juvenile coho salmon in the Monitoring Areas of the Oregon Coast Coho ESU, based on snorkel surveys in 1st-3rd order stream reaches. Panels are organized by monitoring strata. Gray bars are for mean average density (coho/meter^2) and black symbols are for % of sites with fish density >0.7 fish/meter^2.

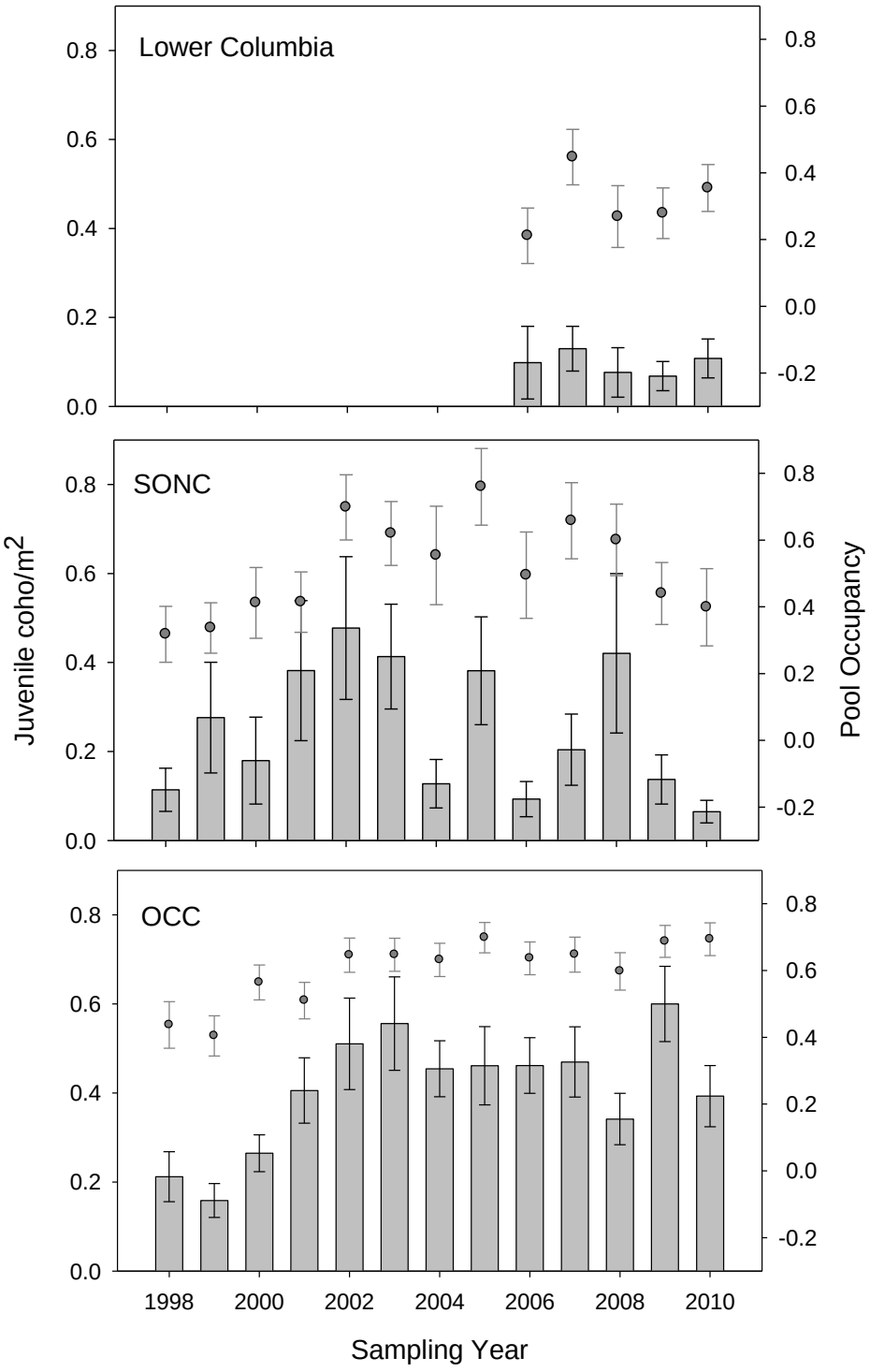


Figure 5. Annual trends in abundance and frequency metrics for juvenile coho salmon in three Oregon ESUs, based on surveys in 1st-3rd order stream reaches. Gray bars are for mean density (coho/meter^2) and gray dots are for mean percent pool occupancy.

Oregon Coast Steelhead

In 2010 juvenile steelhead occurred in 79% of 1st-3rd order sites and density was 0.034 fish/m^2 (Table 3). Pool occupancy and density have been traditionally lower in the Umpqua but in 2010 both metrics were lower in the Mid South (Figure 6). 4th-6th order mainstem streams were not surveyed in the Oregon Coast DPS. For the ESU densities and pool occupancies were similar to past years (Figure 7).

Klamath Mountain Province Steelhead

In 2010 steelhead occurred in 95% of 1st-3rd order sites and 100% of 4th-6th sites of the Oregon portion of the Klamath Mountain Province steelhead DPS. Density averaged 0.066 fish/m^2 in tributary reaches and 0.017 fish/m^2 in mainstem reaches. The Rogue had higher tributary densities than the South Coast MA. Densities and pool occupancies were similar to past years.

Lower Columbia River/Southwest Washington Steelhead

The Oregon portion of the two steelhead DPSs had similar density metrics (Table 3) but the Southwest Washington DPS had higher site occupancies and mean pool occupancies than the Lower Columbia DPS. No 4th-6th order streams were surveyed in the Southwest Washington DPS. Very few steelhead were observed in the Lower Columbia River mainstem sites, most of these were on the main channel of the Clackamas River. Densities showed a slight increase from 2008-2009 and pool occupancies were similar (Figure 7).

ESU/DPS Comparisons

Coho

The Oregon Coast coho ESU had the highest coho distribution and 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 SONC in density but estimates were much lower for all other metrics (Figure 5).

Steelhead

The Klamath Mountain Province steelhead DPS had the highest steelhead distribution and density estimates (Figure 7). The Oregon Coast and Southwest Washington DPSs had similar average pool occupancy and density estimates for steelhead. Pool and Site Occupancies were very similar between the North Coast MA and the Southwest Washington DPS. The Lower Columbia River had lower occupancy estimates than Southwest Washington and the Oregon Coast, but similar density estimates.

Table 3. Distribution and density estimates for juvenile steelhead in western Oregon streams summer 2010. 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/m^2)	95% CI
1-3 Order Streams					
North Coast	86%	51%	± 9%	0.046	± 0.012
Mid Coast	81%	37%	± 7%	0.037	± 0.009
Mid South	78%	29%	± 7%	0.016	± 0.006
Umpqua	69%	38%	± 9%	0.035	± 0.019
KMP Rogue	90%	57%	± 11%	0.075	± 0.028
KMP South Coast	100%	72%	± 6%	0.056	± 0.014
Lower Columbia	66%	27%	± 6%	0.034	± 0.011
Southwest WA	79%	45%	± 11%	0.036	± 0.012
4-6 Order Streams					
KMP Rogue	100%	74%	± 16%	0.020	± 0.018
KMP South Coast	100%	81%	± 12%	0.014	± 0.009
Lower Columbia	67%	48%	± 24%	0.013	± 0.015

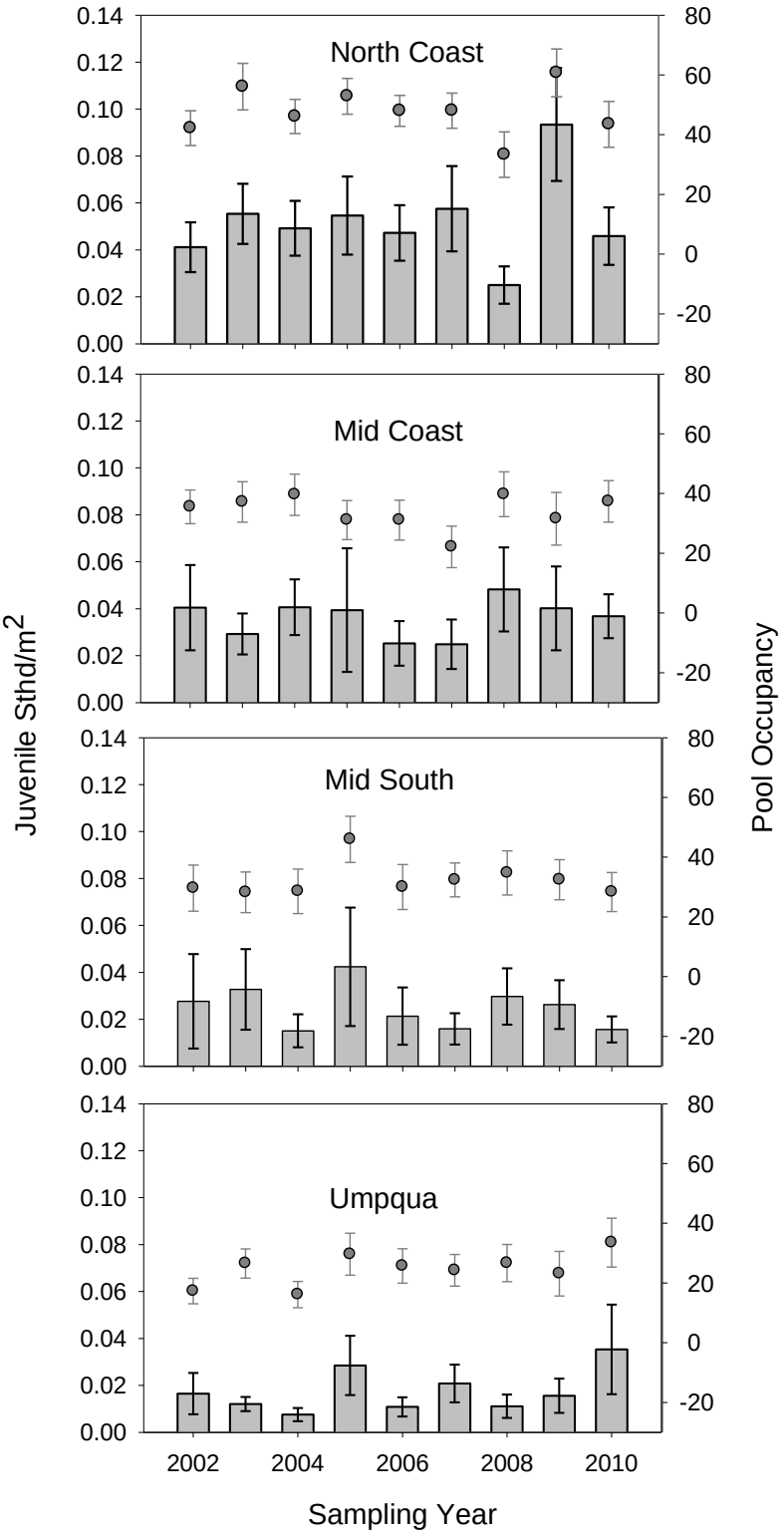


Figure 6. Annual trend in abundance and frequency metrics for juvenile steelhead in the four Monitoring Areas of the Oregon Coast Coho ESU, based on snorkel surveys in 1st-3rd order stream reaches. Panels are organized by monitoring strata. Gray bars are for mean density (sthd/meter^2) and dots are for mean percent pool occupancy.

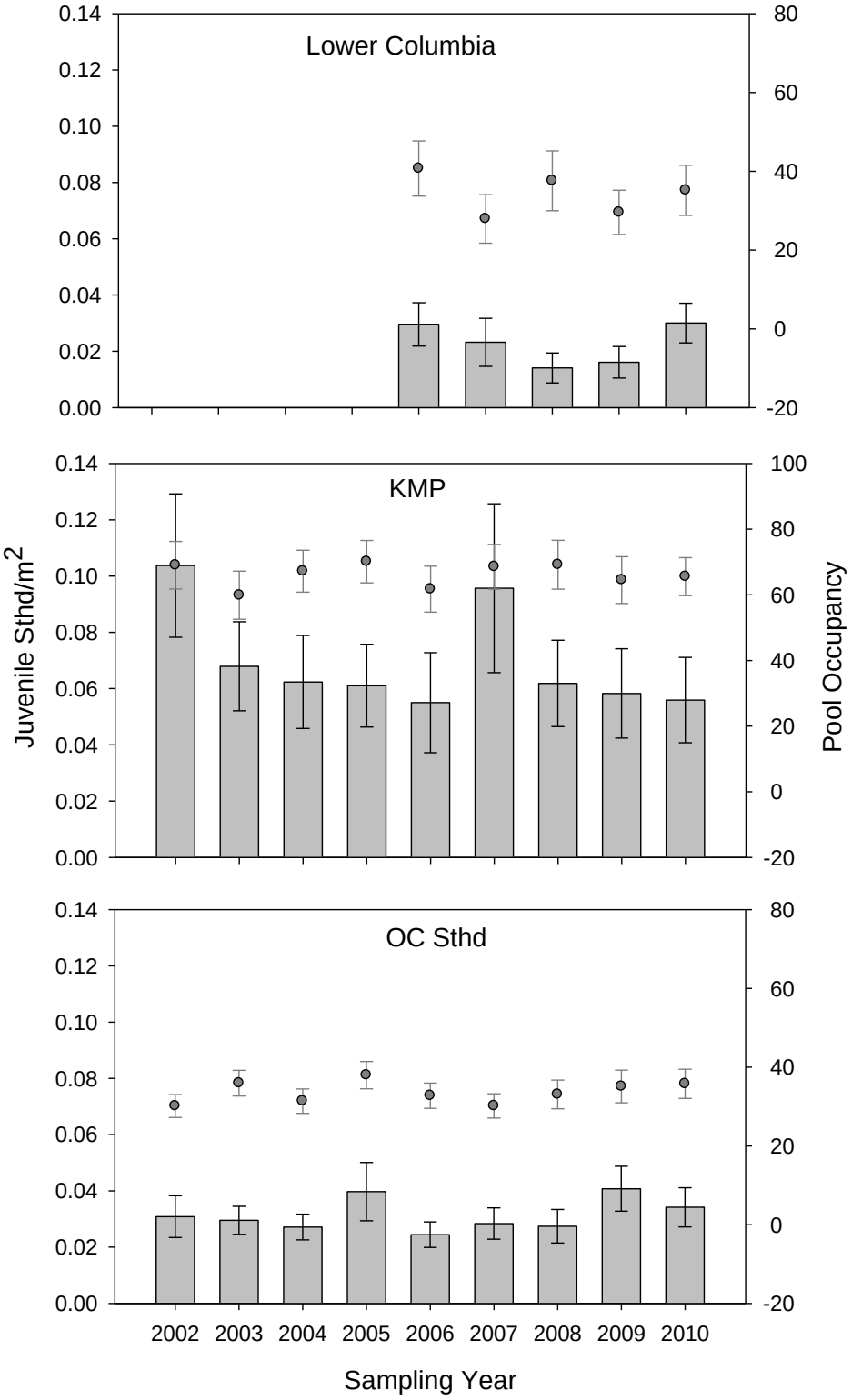


Figure 7. Annual trend in abundance and frequency metrics for juvenile steelhead in three Oregon steelhead DPS, based on snorkel surveys. Gray bars are for mean density (sthd/meter^2) and dots are for mean percent pool occupancy.

RESULTS WITH CHANGES TO POOL DEPTH CRITERIA

Introduction

Results from the Smith River Steelhead and Coho Monitoring Verification Study (Constable and Suring, in prep.) indicate that a large portion of the summer coho rearing population is found in habitats that do not meet the pool criteria of ≥40 cm in maximum depth. In the seven year study an average of 48% of the juvenile coho and 69% of the juvenile steelhead were found by electrofishing removal estimates (Armour, 1983) in pools that met this criteria, with a range of 32% to 61% for coho and 49% to 91% for steelhead. Densities from snorkeling and electrofishing in pools that met this criteria did not correlate well with total population estimates from electrofishing (for coho $R^2 = 0.258$, $p= 0.301$; for steelhead $R^2 = 0.012$, $p= 0.834$).

A much larger and more consistent portion of the coho and steelhead rearing population was detected by electrofishing in all pools regardless of size. Lowering the maximum depth threshold of the snorkel pool criteria produces a stronger correlation between the population estimate in snorkel pools and the total population estimate. Based on electrofishing data, by lowering the maximum depth threshold to 20 cm an average of 74 % of the coho population and 79% of the steelhead population would be sampled with a range of 65 – 81% and 54 - 91%, respectively. The population estimate of coho ($R^2 = 0.971$, $p< 0.001$) and steelhead in pools ($R^2 = 0.932$, $p< 0.001$) generated by including these smaller pools has a strong relationship with total population estimates.

In 2010 we lowered maximum depth criteria for snorkel pools to ≥20 cm. This change will be monitored for survey effort, accuracy and repeatability, and influences on occupancies, densities and population estimates.

Summary

The differences between data that included pools meeting the ≥40 cm criteria and data that included pool meeting the ≥20 cm criteria were slight. Survey counts in pools under the 40 cm criteria may be less consistent with resurvey counts, especially for steelhead. Including smaller pools produced a slight increase in coho site occupancies in the Mid Coast and a slight decrease in the Umpqua. Steelhead site occupancies were practically unchanged. Pool occupancies decreased in all areas for coho and steelhead. Fish/m^2 and pool population estimates did not show any significant change although there was a small reduction in the proportional size of the 95% confidence interval when including pools below the 40 cm criteria. We will continue to make these comparisons over time and monitor for differences in all metrics when pools below the ≥40 cm criteria are included in the data.

Survey Effort and Resurveys

Lowering the maximum depth criteria for pools ≥20 cm resulted in an additional 1,983 pools snorkeled in 1^{st}-3^{rd} order reaches and 18 pools in 4^{th}-6^{th} order reaches. An additional 64 pools were electrofished in 1^{st}-3^{rd} order reaches.

Two sites in the Mid Coast and one in the Umpqua contained pools that were ≥20 cm but <40 cm. Under the previous criteria these sites are considered non-target as not containing rearing habitat. With the new criteria the status of these sites target response adding three successfully completed sites (Table 1).

271 additional pools were resurveyed under the new depth protocol. In pools that were ≥40cm in maximum depth resurveyors observed a higher percentage of the fish counted in the original survey than in pools that were below 40 cm (Table 4). For pools that were ≥20 cm but <40 cm there was a strong relationship between original and resurvey counts for coho (R^2=0.949) but steelhead showed a much weaker relationship (R^2=0.474). When these pools are included into survey-resurvey comparisons the relationship is slightly weaker (R^2=0.95 for coho and R^2=0.80 for steelhead) than when only including pools that met the previous criteria.

Table 4**.** 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			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	19,015	17,660	92.9	15,610	14898	95.4	3,405	2,762	81.1
Sthd	1,867	1,905	100.2	1,757	1815	100.3	110	90	81.8

Salmonid Distribution and Density

Coho

Density and pool occupancy metrics that included pools that met the ≥20 cm maximum depth criteria had overlapping 95% CI with the same metrics from pools that were ≥ 40 cm. Although there is no statistical difference, density decreased by >1% in the North Coast and in the South Coast, 2.4% in the Mid-Coast, 4.1% in the Umpqua, and by 1.7% in 4th to 6th order streams in the Lower Columbia. Density increased by 2.5% in the Mid South and by 0.8% in 1st to 3rd order stream in the Lower Columbia. Mean Pool Occupancy decreased in all Monitoring areas by under 3%, except for 4th to 6th order streams in the Lower Columbia, which decreased by 3.6%. Site Occupancies were unchanged except for in the Mid Coast where they increased by 0.4% and the Umpqua where they decreased by 1.5%.

Steelhead

Similar to coho, including pools that met the new depth criteria produced small changes in steelhead density and pool occupancy metrics that had overlapping 95%CI with pools that were ≥ 40 cm.. Although not statistically different, densities decreased in all Monitoring Areas by less than 0.7%, except in the Umpqua where they decreased by 1.5%. Pool Occupancies decreased by less than 5% in all areas except the Mid-Coast, Umpqua, and larger order streams in the KMP on the South Coast where they

decreased by 7%, 5%, and 9% respectively and lower order stream in the Lower Columbia, where they increased by 0.3%. Site Occupancies were unchanged except in the Mid Coast where they increased by 4% and in the Umpqua where they decreased by 2%. Site Occupancies decreased slightly (>0.1%) in the Mid Coast and the Umpqua.

Pool Population Estimates

Results from the Smith River (Constable and Suring, in prep.) suggest that the most pronounced difference between depth protocols would be in pool population estimates. These estimates had the strongest relationship to total population estimates. Pool population estimates were calculated by multiplying the fish/km at each site by the site weight. In 2010 there was no statistical difference for coho (Table 5) or steelhead (Table 6) among the Monitoring Areas pool population estimates from the two maximum depth protocols. These estimates represent the number of fish in pools only from un-calibrated visual counts and should not be interpreted as total population estimates.

Although there was no statistical difference, in 2010 estimates that included pools that met the 20 cm threshold produced larger pool population estimates with proportionally smaller 95%CI. These increases were most pronounced in the Mid Coast and Mid South Coast.

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

Monitoring Area	2010 Coho Estimates					
	Pools ≥20 cm Max Depth			Pools ≥40 cm Max Depth		
	Estimate	95CI	CI Percent	Estimate	95CI	CI Percent
North Coast	843,535	206,891	25%	755,234	188,722	25%
Mid Coast	1,133,824	242,246	21%	861,871	206,003	24%
Mid South	1,404,939	291,548	21%	1,138,976	222,098	20%
Umpqua	892,752	318,892	36%	749,687	297,391	40%
SONC	233,725	83,059	36%	225,477	81,559	36%
Lower Columbia	209,512	83,625	40%	193,334	77,563	40%

Table 6. Comparison of total estimates of steelhead in snorkel pools using a maximum depth of ≥20 cm size criteria and those using a ≥40 cm size criteria.

Monitoring Area	2010 Steelhead Estimates					
	Pools ≥20 cm Max Depth			Pools ≥40 cm Max Depth		
	Estimate	95CI	CI Percent	Estimate	95CI	CI Percent
North Coast	76,158	24,036	32%	72,465	22,935	32%
Mid Coast	79,276	27,839	35%	67,515	26,193	39%
Mid South	53,116	22,403	42%	50,234	22,316	44%
Umpqua	102,046	39,391	39%	99,610	39,583	40%
KMP Rogue	69,731	25,312	36%	67,263	25,336	38%
KMP South Coast	60,149	12,303	20%	59,374	12,395	21%
Lower Columbia	34,685	15,791	46%	33,251	15,867	48%
Southwest WA	21,736	7,891	36%	20,996	7,922	38%

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