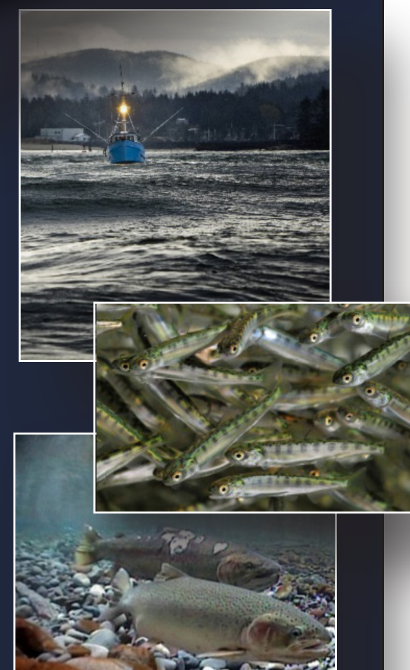
# Salmonids in the Lower Coos Watershed



*Summary:*

- *Wild Coho salmon returns have marginally increased in the Coos River over the past 20 years but have recently declined in streams associated with Haynes Inlet and South Slough.*
- *Fall Chinook runs in the Coos River basin have been strong over the past 30 years.*
- *Winter steelhead abundance has declined; hatchery fish may comprise an increasingly large share of the population in the mid-south coast monitoring area.*
- *Substantial numbers of hatchery-raised fish have been released in the Coos River. The long-term effectiveness of these programs is a matter of on-going debate.*

**Evaluation**

Status of fall Chinook and cutthroat trout appear strong. These populations should continue to be monitored.

**Evaluation**

Status of coho and steelhead is of concern. Some indictors appear strong, while others are deteriorating.

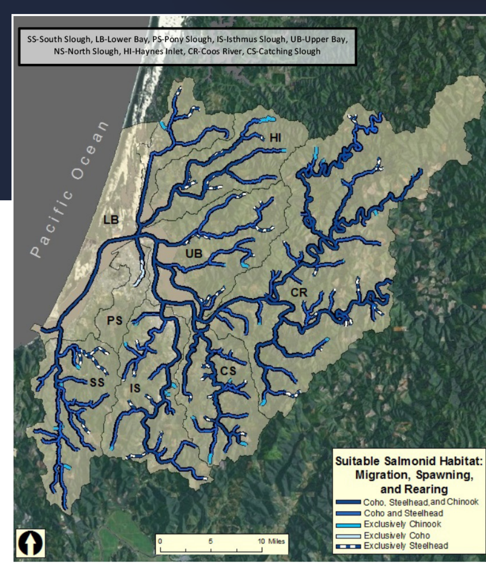



Figure 1. The spatial extent of habitat in the study area considered suitable for Coho and Chinook salmon, and for winter Steelhead migration, spawning, or rearing sometime during the past five reproductive cycles (ODFW 2013f).

**What's happening?**

Populations of salmonids in the lower Coos watershed primarily consist of Coho salmon (*Oncorhynchus kisutch*), winter steelhead (*Oncorhynchus mykiss irideus*), fall Chinook salmon (Oncorhynchus tshawytscha), and coastal cutthroat trout (*Oncorhynchus clarki clarki*). These fish use the waters of the Coos system for important life history functions such as migration, spawning, and rearing.

This document summarizes available information to describe the current abundance and distribution of juvenile and adult Coho, Chinook, steelhead, and other salmonids. It presents habitat maps and reports trends in abundance, as well as factors affecting their abundance such as hatchery production, predation, and the local effects of climate change.

Informationfor this summary was largely derived from activities supporting the Oregon Plan for Salmon and Watersheds (Oregon Plan). For example, adult Coho and winter steelhead abundance data are available through the Oregon Adult Salmonid Inventory and Sampling Project (OASIS), a component of the Oregon Plan (ODFW 2013d; ODFW 2013e; Suring and Lewis 2008; Suring et al. 2008; Brown and Lewis 2009 & 2010; Brown et al. 2011 & 2012; Jacobsen et al. 2013). Data for marine survival of Coho in the lower Coos watershed are published in the Life Cycle Monitoring Program (LCM) of the Oregon Plan (Suring et al. 2012). Spawning surveys for fall Chinook in the Coos River Basin contribute to the OASIS project and provided adult abundance data for this document (ODFW 2002, 2003b, 2004, 2005b, 2006, 2007, 2008, 2009, 2010, 2011, 2012b, & 2013g). Information from the Oregon Plan is supplemented by other reports and unpublished, raw data from the Coos Watershed Association (ODFW 2014a; ODFW 2005a; CoosWA 2013a).

Salmonid Species Distribution

This assessment, like all the assessments in the Inventory, divides the project area into nine subsystems: South Slough, Pony Slough, Lower Bay, Upper Bay, Isthmus Slough, Catching Slough, Haynes Inlet, North Slough, and Coos River (see Figure 1). Coho salmon spawning occurs primarily in the Coos River, Upper Bay, and Haynes Inlet subsystems. Spawning occurs to a lesser extent in the North Slough, Catching Slough, Isthmus Slough, and South Slough subsystems. There is Coho migration and rearing habitat in all

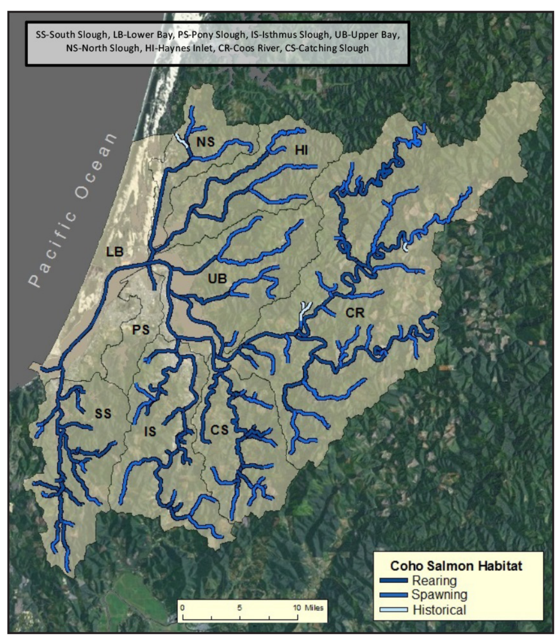


Figure 2. The spatial extent of coho salmon. Data: ODFW 2013b

nine subsystems (Figure 2). The spatial extent of winter steelhead closely corresponds with Coho salmon (Figure 3). Although fall Chinook salmon depend on habitats in all subsystems for some life cycle stages, their distribution is more limited than Coho and steelhead.

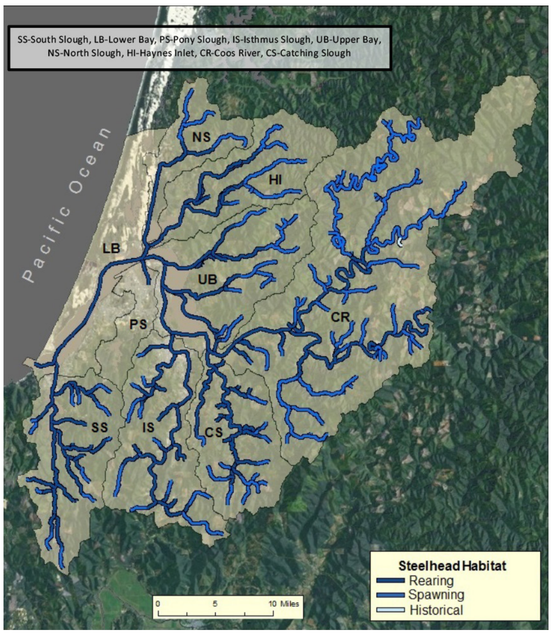



Figure 3. The spatial extent of winter steelhead.
Data: ODFW 2013b

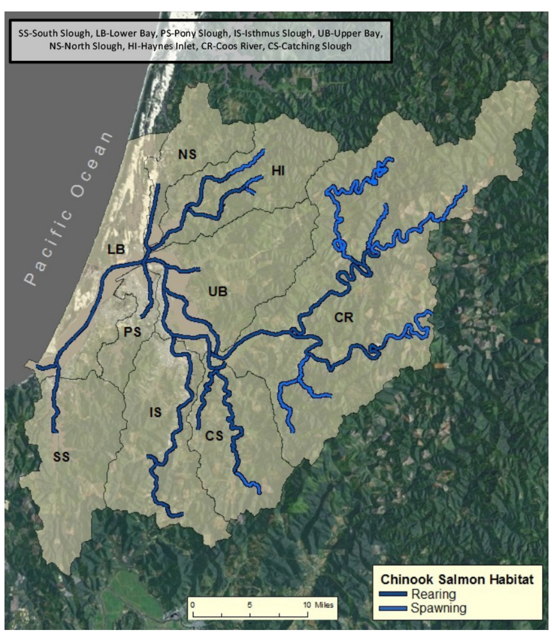



Figure 4. Spatial extent of Chinook salmon. Data: ODFW 2013b

Chinook spawning occurs primarily in the Coos River subsystem, with very limited spawning also in the Haynes Inlet, Catching Slough, Isthmus Slough, and South Slough subsystems (Figure 4).

<u>Status and Trends: Adult Coho Salmon</u>

OASIS monitors 24 adult Coho salmon populations at over 500 sites on the Oregon coast. Generally, wild Coho abundance on the Oregon coast has increased since 1990 while hatchery Coho abundance has decreased (Figure 5).

For the entire coast, the greatest increases in wild Coho abundance occurred in the late 2000s (Figure 5). The wild Coho population decreased from 2003-2007 then recovered during 2007-2011. The Oregon Department of Fish and Wildlife estimates that 99,094 wild Coho spawned on the Oregon coast in 2012, which represents a 380% increase from 1990 but a 72% decrease from the peak in 2011 (ODFW 2013d and 2013e).

The abundance of hatchery Coho salmon has been declining since 1990 (Figure 5). There was a sharp decline in the late 1990s and another period of steady decline between the early 2000s to 2012 (ODFW 2013d and 2013e).

Approximately 9,414 adult wild Coho spawned in the Coos River in 2012, which represents a 320% increase from 1990 and a 72% decrease from the 2001 peak level (Figure 5)(ODFW 2013d and 2013e).

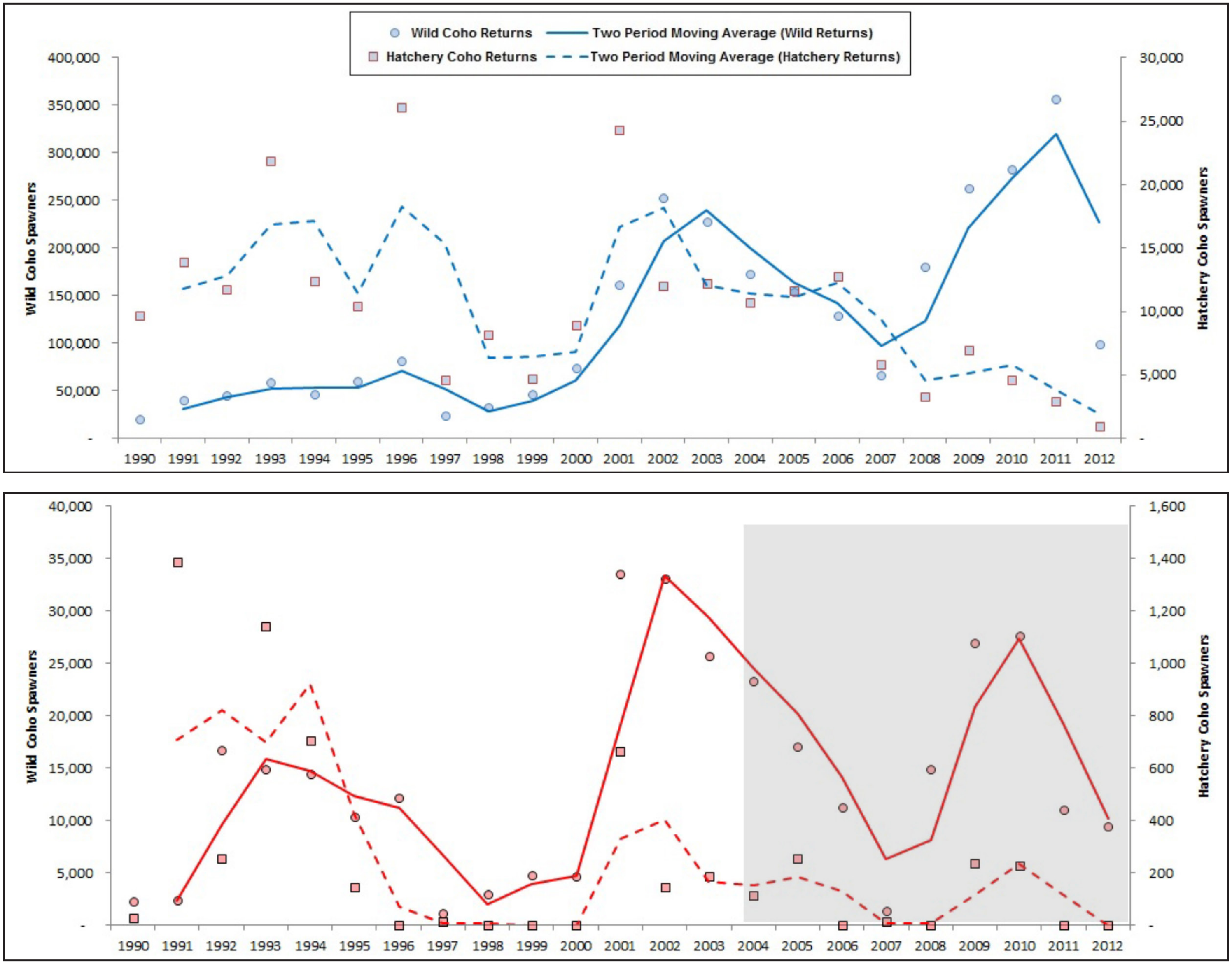



Figure 5. Adult Coho abundance estimates for the Oregon coast (blue) and the Coos River (red). Shaded area represents salmon returns to the Coos system after Coho hatchery programs were eliminated in 2004. Data: ODFW 2013d and 2013e

| OASIS Site | Returning Adults (2012) | Twenty-year Avg. (1990-2012) | Min | Max | Std error |
|---|---|---|---|---|---|
| **Coos River** | **9,414** | **14,011** | **1,112** | **33,595** | **2,129** |
| Umpqua River | 20,948 | 27,111 | 3,334 | 94,655 | 4,657 |
| Tillamook | 1,686 | 4,790 | 80 | 19,250 | 1,266 |
| Yaquina | 6,268 | 5,799 | 317 | 23,800 | 1,352 |
| Siuslaw | 11,946 | 12,393 | 501 | 55,445 | 2,795 |
| Coquille | 5,911 | 12,754 | 2,033 | 55,667 | 2,580 |
| All Oregon Coast Sites | 99,094 | 125,092 | 20,652 | 356,243 | 20,105 |

Table 1. Abundance of wild Coho salmon at OASIS sites. The Umpqua River data aggregate four OASIS sites including the Lower Umpqua, Middle Umpqua, North Umpqua, and South Umpqua. Data: ODFW 2013d and 2013e

The abundance of hatchery Coho in the Coos River has sharply declined since the 1990s (Figure 5). Hatchery Coho abundance in the Coos River peaked in the early 1990s, but since then, there have been several years with zero estimated hatchery fish on natural spawning grounds. The last hatchery Coho smolt release in the Coos basin was made in 2004 (G. Vonderohe, pers. comm., April 21, 2014). Summary statistics describing 20-year trends in the status of Coho salmon at several OASIS sites are presented in Table 1. Adult and juvenile Coho salmon populations in South Slough's Winchester Creek have also been tracked annually by the Oregon Plan's LCM since 1999 (Figure 6).

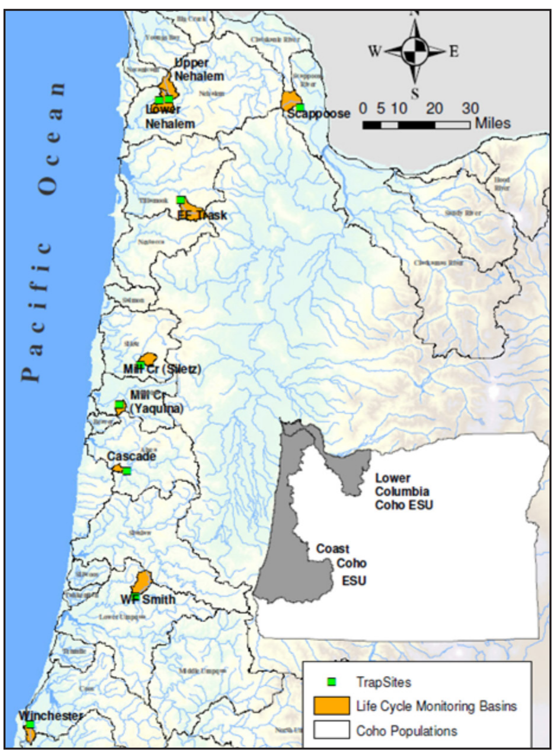



Figure 6. The locations of all eight life cycle monitoring basins. Graphic: Suring et al. 2012.

Although there are no clear trends in abundance for wild adults in LCM basins, the data do exhibit a weak pattern of cyclical returns in some basins (e.g., Siletz Mill Creek and Smith River in Figures 7b and 7c). In Winchester Creek, adult wild Coho returns are decreasing, and marine survival rates are low compared to other sites (Figure 7d).

Between 2000 and 2011, the marine survival rate for Coho salmon in Winchester Creek averaged approximately 4%, with the highest rate (approximately 10%) in 2001 and lowest (less than one percent) in 2008. The Winchester Creek site averaged 121 spawning Coho returning annually, with a lower bound of only five adults returning in 2000 and an upper bound of 374 adults in 2004 (Table 2).

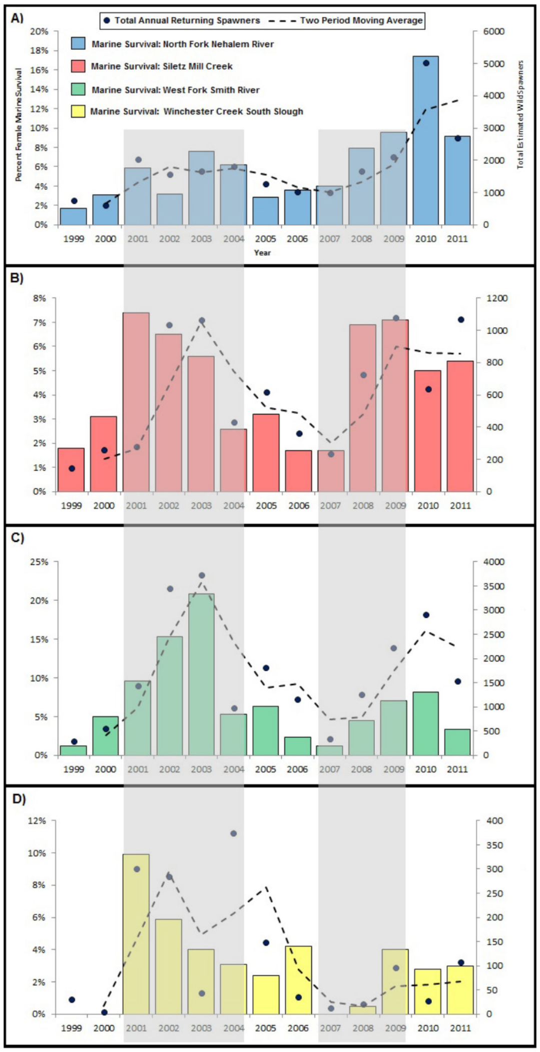



Figure 7. Trends in Coho salmon marine survival rates (bar graph) and returning wild spawning adult numbers (line graph) for four of the eight LCM basins. Generalized areas of high return rates (2001-2004) and low return rates (2007-2009) have been highlighted in grey. Data: Suring et al. 2012, ODFW 2012a.

The standard error measures the statistical variance from year to year, thus the small standard errors in the Winchester Creek data suggest that annual Coho runs are consistently small and marine survival is consistently low. This observation is supported by a general decline in adult wild Coho returning to Winchester Creek since the early 2000s (Figure 7).

**Summary Statistics: Marine Survival Rate in Four LCM Basins (2000-2011)**

| | Mean | Min | Max | Std Error |
|---|---|---|---|---|
| NF Nehalem River | 6.7% | 2.9% | 17.4% | 1.2% |
| Siletz Mill Creek | 4.7% | 1.7% | 7.4% | 0.6% |
| WF Smith River | 7.4% | 1.2% | 20.9% | 1.6% |
| Winchester Creek | 4.0% | 0.5% | 9.9% | 0.8% |

**Summary Statistics: Returning Adult Coho for Spawning in Four LCM Basins (2000-2011)**

| | Mean | Min | Max | Std Error |
|---|---|---|---|---|
| NF Nehalem River | 1,879 | 612 | 5,026 | 329 |
| Siletz Mill Creek | 652 | 237 | 1,104 | 100 |
| WF Smith River | 1,783 | 335 | 3,730 | 315 |
| Winchester Creek | 121 | 5 | 374 | 37 |

Table 2. The summary statistics for marine survival and number of returning adult Coho for spawning. Data: Suring et al. 2012, ODFW 2012a

To put the Winchester Creek LCM data in perspective, the second lowest marine survival rates were observed in Siletz Mill Creek (4.7% on average) between 2000 and 2011, with a peak of 7.4% in 2001 and a low of 1.7% in 2006 and 2007. Trends for LCM basin sites are summarized in Figure 7 and Table 2.

Time series analyses of population status are also performed for other subsystems where the data are sufficiently robust. The Coos Watershed Association (CoosWA) has conducted stream surveys in the salmon-bearing waterways of the Haynes Inlet subsystem since the early 2000s.

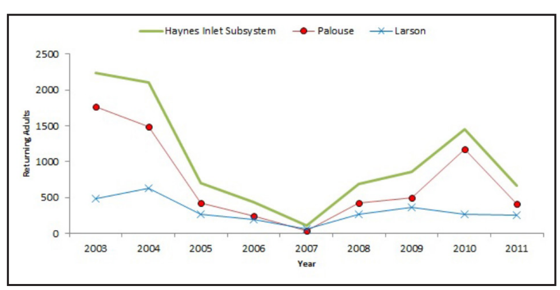



Figure 8. Trends in adult Coho returns to the Haynes Inlet subsystem. Data: CoosWA 2013a

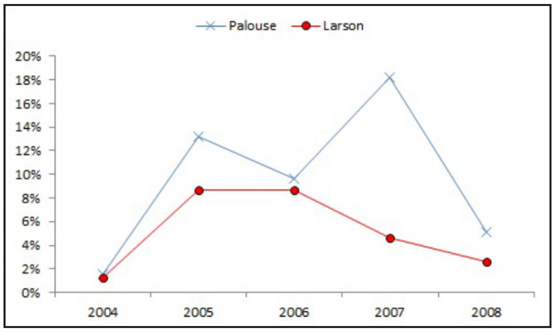



Figure 9. Marine survival is the proportion of Coho smolts that return to the Haynes Inlet Subsystem to spawn as adults. Data and caption: CoosWA 2013a

According to CoosWA (2013a), Coho returns to the Haynes Inlet subsystem trended downward in the early 2000s, but recovered from 2007-2010 (Figure 8). In 2011, CoosWA estimated 671 returns to the Haynes Inlet Subsystem, which was a decrease from 2010-levels and below the eight-year average (1,015 annual returns).

CoosWA (2013a) also estimated marine survival rates of adults returning to Palouse and Larson creeks in the Haynes Inlet subsystem for 2004-2008 (Figure 9). Survival rates in Palouse Creek were consistently higher than at Larson Creek. In general, marine survival rates increased from 2004-2006, except for a decrease in Palouse Creek returns in 2006. From 2006-2008, marine survival declined except for an increase at Palouse Creek in 2007.

<u>Status and Trends: Juvenile Coho Salmon</u>
Since 1998, ODFW has monitored juvenile Coho distribution and abundance as part of the Western Oregon Rearing Project (WORP) (Rodgers 2000, 2001, 2002; Jepsen and Rodgers 2004; Jepsen 2006; Jepsen and Leader 2007a, 2007b, 2008; Suring and Constable 2009, 2010; Constable and Suring 2010, 2012, 2013). WORP investigates juvenile distribution and reports pool occupancy rates (percent of pools with juveniles present) and abundance (fish per m2), which is measured by average density of juveniles in pools.

WORP is divided into regional "monitoring areas" that are grouped into larger "evolutionarily significant units" (ESU) and "distinct population segments" (DPS)(Figure 10). The Coos estuary is part of the mid-south coast monitoring area, which includes the Tenmile, Coos, Coquille, Floras, and Sixes River basins.

Juvenile abundance is a "coincident indicator" of adult abundance, meaning that current trends in juvenile abundance reflect current trends in the abundance of the adults that

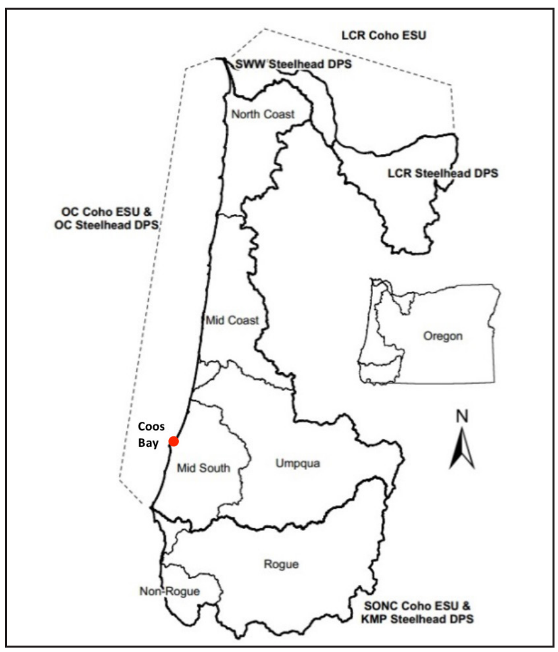



Figure 10. The spatial extent of Coho and steelhead monitoring areas, evolutionarily significant units (ESU), and distinct population segments (DPS) Graphic: Constable and Suring 2013; Codes: LCR- Lower Columbia River, SWW- Southwest Washington, OC- Oregon Coast, SONC- Southern Oregon Northern California, KMP- Klamath Mountain Province

statistically different from zero (i.e., neither increasing nor decreasing).

CoosWA (2013a) has also monitored juvenile Coho abundance in the Haynes Inlet Subsystem from 2006-2012 (Figure 13). The number of out-migrating smolts from the Haynes Inlet Subsystem increased from 2006 to 2011 but declined in 2012.

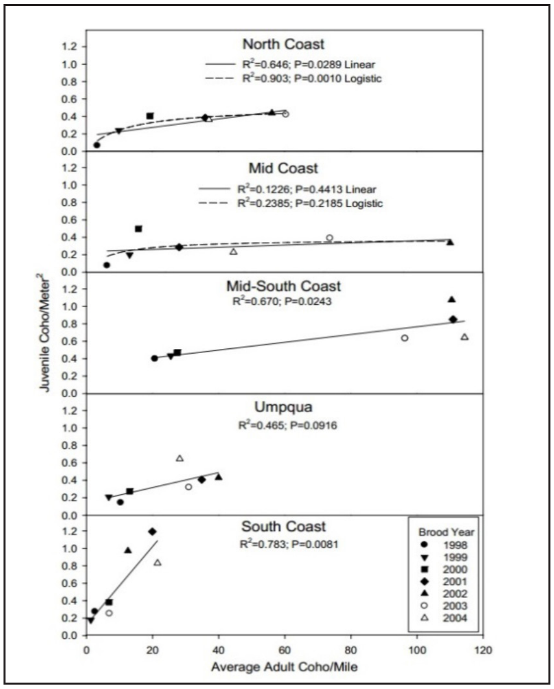



Figure 11. The relationship between juvenile abundance (fish/m2) and the average density (fish/mile) of the adults that produced them. $R^2$ is the percent of variation in adult abundance explained by juvenile abundance. Graphic: Jepsen and Leader 2007a

produced them. Jepsen and Leader (2007a) estimate with a high degree of confidence ($p<0.05$) that 67% of the variation in adult abundance is explained by variation in juvenile abundance in the mid-south coast ($R2=0.67$)(Figure 11).

Juvenile pool occupancy in the mid-south coast monitoring area has increased since 1998 (Figure 12). In 2011, juveniles were present in 79% of the area's pools (an 18% increase from 1998 levels). However, juvenile density was more variable: 12-year low (0.17 fish/m2) in 1998 and maximum density (1.07 fish/m2) in 2003. Overall, pool occupancy has shown a statistically significant ($p < 0.01$) annual increase since 1998, while the annual change in pool density ($p > 0.05$) is not

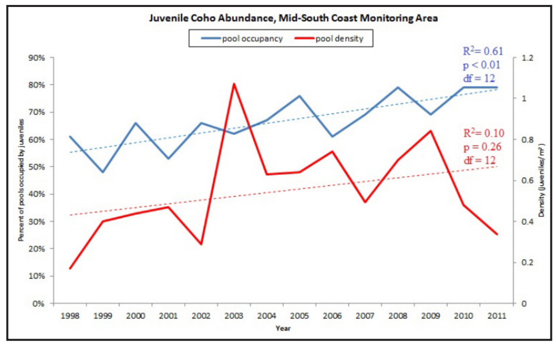



Figure 12. Juvenile Coho abundance in first through third order ("wadeable") streams in the mid-south coast monitoring area. Data: Rodgers 2000, 2001, 2002; Jepsen and Rodgers 2004; Jepsen 2006; Jepsen and Leader 2007a, 2007b, 2008; Suring and Constable 2009, 2010; Constable and Suring 2010, 2012, 2013

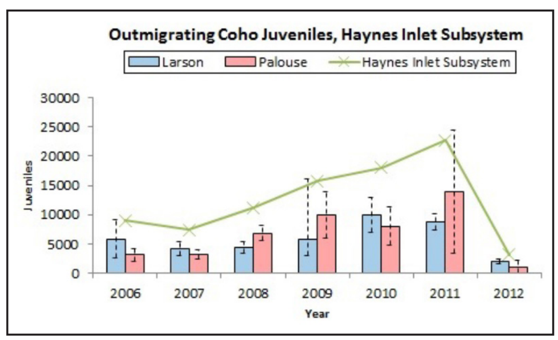



Figure 13. Juvenile Coho abundance in Larson and Palouse Creeks. Large confidence intervals are a reflection of low trap efficiency. Mean abundance in the Haynes Inlet Subsystem (green line) is represented by the sum of the annual means for Larson and Palouse Creeks Data: CoosWA 2013a

Status and Trends: Chinook Salmon

The Oregon Native Fish Status Report (ONSFR) provided historic data for Chinook salmon stocks in the Coos River basin (ODFW 2005a). To evaluate the status of Chinook salmon populations, the ONFSR uses six criteria

**Six Native Fish Conservation Policy Evaluation Criteria for the ONFSR**

**Existence:** "No more than 20% of the historical populations within the species management unit (SMU) have become extinct and no natural population within the SMU ...shall be lost in the future..."

**Distribution:** "Naturally produced members of a population must occupy at least 50% of a population's historic habitat."

**Abundance:** "The number of naturally produced spawners must be greater than 25% of the average abundance of naturally produced spawners over the most recent 30 year time period."

**Productivity:** "In years when total spawner abundance is less than the average abundance of naturally produced spawners over the past 30 years, then the rate of population increase shall be at least 1.2 adult offspring per parent..."

**Reproductive Independence:** "At least 90% of the spawners within a population must be naturally produced and not hatchery produced fish..."

**Hybridization:** "The occurrence of individuals that are the product of deleterious hybridization with species that are non-native to the basin in which they are found must be rare or nonexistent."

Table 3. Excerpts of ONFSR evaluation criteria.
Source: ODFW 2003a

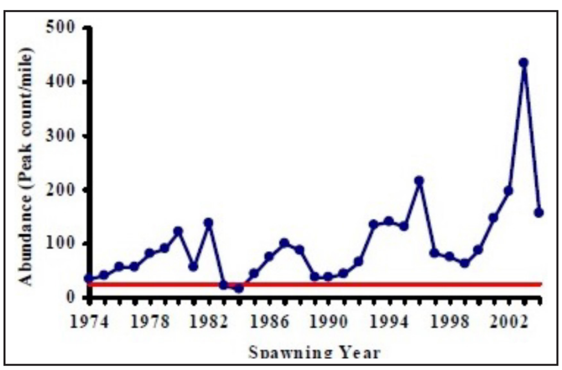



Figure 14. Historic abundance of adult fall Chinook salmon in the Coos River in number of observed fish (both live and dead) per mile at peak count. Benchmark necessary to pass ONFSR abundance criteria is highlighted in red. Graph: ODFW 2005a

established by the Native Fish Conservation Policy in 2003. These guidelines are referred to as "interim criteria" because they provide temporary guidance prior to the completion of conservation plans (ODFW 2005a; ODFW 2003a)(Table 3).

The Coos River fall Chinook population met five of the six ONFSR criteria, meaning that the near-term sustainability (5 -10 years) of native Coos River fall Chinook at levels that provide "ecological, economic, recreational, and aesthetic benefits to present and future generations" may potentially be at risk (ODFW 2005a). It should be noted that Chinook salmon hatchery production between 1995 and 2005 greatly affected ODFW's ability to determine the status of wild Coos River Chinook salmon populations.

The data (ODFW 2005a) suggest that while the fall Chinook abundance in the Coos River varied considerably, it generally increased between 1974 and 2004, reaching a peak in 2003 (Figure 14).

The abundance of Fall Chinook in the Coos River has remained relatively large compared to most Oregon coast sites. ODFW's estimated 30-year average density for Coos River fall Chinook (101 fish per mile) is only exceeded by Chinook abundance in five of the remaining fifteen sampled estuaries on the Oregon coast (Table 4).

More recent Chinook abundance data were provided by ODFW spawning survey summaries (ODFW 2002, 2003b, 2004, 2005b, 2006,

| Species Mgmt. Unit | 30 Year Average | Abundance by Return Year (peak count per mile) 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|
| **Coos** | **101** | **--** | **87** | **148** | **195** | **434** | **155** |
| Necanicum | 7 | 2 | 4 | 10 | 11 | 21 | -- |
| Nehalem | 67 | -- | 53 | 89 | 156 | 86 | 78 |
| Tillamook | 63 | -- | 17 | 65 | 74 | 61 | 66 |
| Nestucca | 181 | -- | 80 | 132 | 310 | 68 | 190 |
| Salmon | 1748 | 1208 | 1245 | 1273 | 1196 | 3302 | -- |
| Siletz | 52 | -- | 54 | 103 | 145 | 101 | 34 |
| Yaquina | 34 | -- | 1 | 26 | 28 | 31 | 26 |
| Alsea | 69 | -- | 80 | 203 | 188 | 193 | 160 |
| Yachats | 90 | 135 | 128 | 109 | 149 | 197 | -- |
| Siuslaw | 186 | -- | 138 | 349 | 423 | 604 | 476 |
| North Umpqua | 166 | -- | 202 | 247 | 154 | 581 | 267 |
| Upper Umpqua | 4344 | 1979 | 2591 | 5402 | 7621 | 10158 | -- |
| Lower Umpqua | *Insufficient Data* | 20 | 57.1 | 60.5 | 156 | 241 | -- |
| Coquille | 78 | -- | 73 | 93 | 137 | 187 | 142 |
| Floras | 71 | -- | 42 | 128 | 173 | 170 | 62 |
| Sixes | 60 | -- | 2 | 67 | 57 | 51 | 153 |

Table 4. Fall Chinook abundance data for 16 Oregon coast species management units. Table: ODFW 2005a

| Survey Area | 2013 Abundance | Eleven Yr. Avg. (2002-2013) | Min | Max | Std. error |
|---|---|---|---|---|---|
| S. Fk. Coos | 143 | 233 | 50 | 532 | 37 |
| E Fk. Millicoma | 224 | 219 | 36 | 650 | 55 |
| W. Fk. Millicoma | 312 | 110 | 14 | 418 | 34 |
| Williams | 53 | 78 | 23 | 167 | 13 |

Table 5. Fall Chinook abundance data (fish per mile) for four Coos River species management units. Table: ODFW 2002, 2003b, 2004, 2005b, 2006, 2007, 2008, 2009, 2010, 2011, 2012b, & 2013g

2007, 2008, 2009, 2010, 2011, 2012b, & 2013g). These data indicate that fall Chinook abundance in the Coos watershed decreased in the mid-2000s but recovered with peak abundances in 2010 for the Coos River and in 2011 for the Millicoma River (Figure 15). Although abundance declined after the highs of 2010/2011, adult Chinook peak counts are again increasing , with both the Coos and Millicoma Rivers exceeding the 30-year average in 2013 (Table 5). Currently, ODFW considers Coos fall Chinook a viable population with a low probability of extinction (ODFW 2014a).

<u>Status and Trends: Adult Winter Steelhead</u>

In 2003, OASIS initiated monitoring efforts to assess trends in the abundance of winter steelhead populations in coastal areas (Jacobsen et al. 2013). The Tenmile, Coos, Coquille, Floras, and Sixes River basins represent the mid-south coast monitoring area (Figure 16).

The OASIS project estimates Steelhead abundance by surveying "redds" (gravel "nests" in

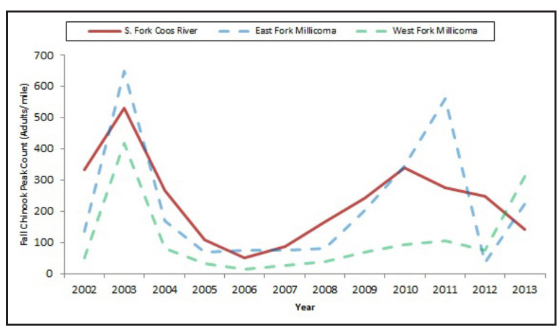



Figure 15. Abundance for fall Chinook in three local rivers. Millicoma peak count data (dashed) are subject to more variability than South Fork Coos data (solid), because Millicoma survey results are more dependent on river flow conditions (G. Vonderohe, pers. comm., April 21, 2014). Data: ODFW 2002, 2003b, 2004, 2005b, 2006, 2007, 2008, 2009, 2010, 2011, 2012b, and 2013g

stream bottoms where fish lay their eggs- see Background). Redd abundance in the Oregon Coast Distinct Population Segment (DPS) declined from 2003 to 2009, with a period of marginal increase in 2007. It again increased from 2009 to 2013, except for a decline in 2011, and reached a ten-year high in 2013 (Figure 17). ODFW notes that ideal survey conditions, including low flow and high water clarity in 2013 may have caused the unusually high rate of redd observation (Jacobsen et al. 2013).

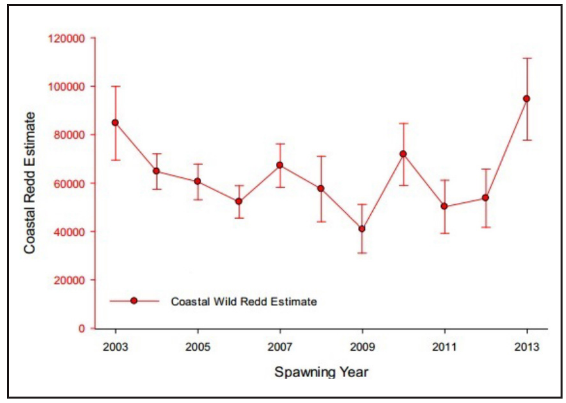


Figure 17. Redd abundance in the Oregon Coast DPS Data: Jacobsen et al. 2013

For the mid-south coast monitoring area (MSCMA), which includes mainly the Coos and Coquille watersheds, the number of redds observed in 2013 were 25% fewer compared with peak levels in 2007 (Table 6). Redd abundance declined from 2007-2012, but has recovered in2013 (Figure 18).

Figure 16. OASIS map of monitoring areas for winter steelhead. Monitoring areas are divided between two Oregon Coast Distinct Population Segments (DPS). The Oregon Coast DPS is shaded above in yellow, and the Klamath Mountain Province DPS is in pink. Graphic: Jacobsen et al. 2013

Hatchery steelhead accounted for approximately 21% of all spawning steelhead in the MSCMA. The proportion of hatchery origin spawners (pHOS) in 2013 was larger in the MSCMA than any other monitoring area on the Oregon coast (Jacobsen et al. 2013). However, data for the Coos and Millicoma Rivers indicate that local pHOS may be substantially lower than 21% (ODFW 2014b). In addition, pHOS in the MSCMA generally increased slightly over the past seven years but leveled off recently (Figure 19), although ODFW (2014b) data indicate that Coos and Millicoma River populations may not exhibit the same trend. Due to a high pHOS, the winter steelhead population in the Coos River basin failed to meet ODFW's reproductive independence criterion (Table 3)(ODFW 2005a).

| Monitoring Area | 2013 Redd Abundance | Seven-Year Avg. (2007-2013) | Min | Max | Std. error |
|---|---|---|---|---|---|
| **Mid-south coast** | **19,476** | **17,612** | **8,403** | **26,048** | **2,547** |
| North coast | 30,144 | 19,279 | 9,961 | 30,144 | 2,792 |
| Mid coast | 31,030 | 22,575 | 13,987 | 31,030 | 2,023 |
| Umpqua | 22,807 | 15,243 | 9,282 | 22,807 | 1,899 |
| South coast | 8,961 | 6,937 | 1,808 | 14,268 | 1,719 |

Table 6. Winter steelhead abundance data in terms of redd abundance from 2007 to 2013. Data: Suring and Lewis 2008; Suring et al. 2008; Brown and Lewis 2009 and 2010; Brown et al. 2011 and 2012; Jacobsen et al. 2013

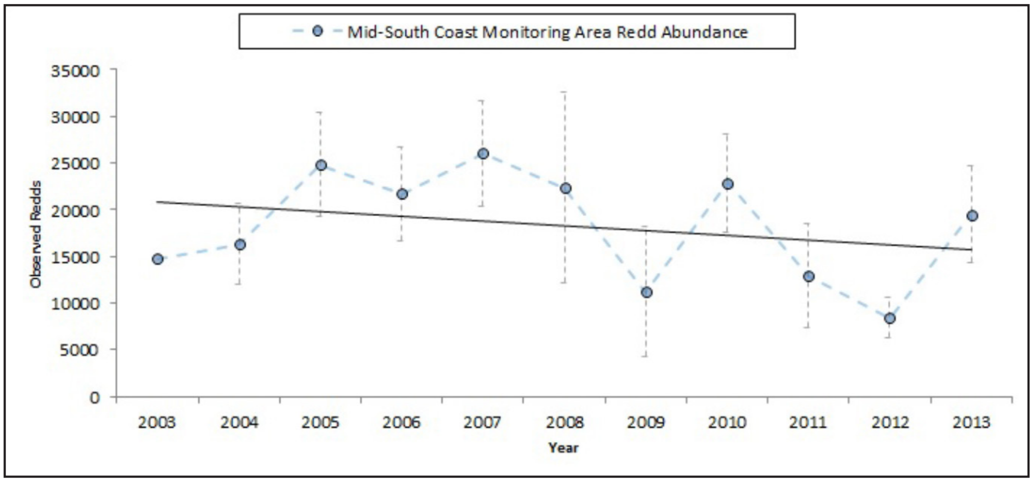



Figure 18. Trends in winter steelhead abundance in terms of number of redd observations over time (blue). Linear regression model (black) suggests a marginal decrease over time ($R^2$=0.08). However, this decrease is not statistically different from zero (p = 0.39). Data: Jacobsen et al. 2013

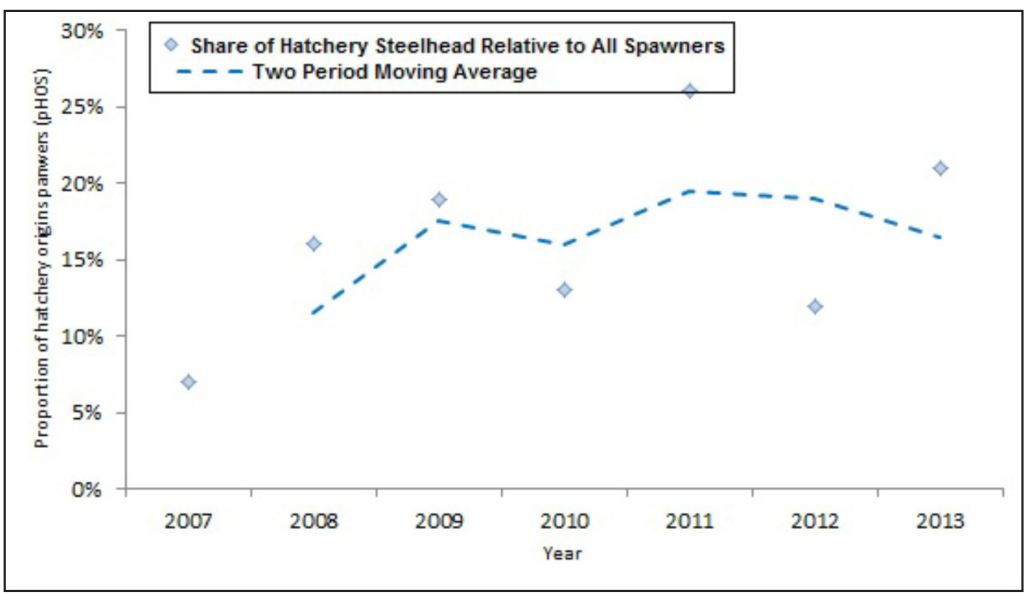



Figure 19. Proportion of hatchery origin spawners (pHOS) for the 2007 to the 2013 spawning seasons in the MSCMA. Data: Suring and Lewis 2008; Suring et al. 2008; Brown and Lewis 2009 and 2010; Brown et al. 2011 and 2012; Jacobsen et al. 2013

Overall, however, steelhead trout are classified as a viable population with a low probability of extinction in the MSCMA (ODFW 2014a).

Status and Trends: Juvenile Winter Steelhead

As part of the Western Oregon Rearing Project (WORP), ODFW has monitored juvenile steelhead distribution and abundance since 2002 (Jepsen and Rodgers 2004; Jepsen 2006; Jepsen and Leader 2007a, 2007b, 2008; Suring and Constable 2009, 2010; Constable and Suring 2010, 2012, 2013). The project studies juvenile distribution by recording pool occupancy rates (percent of pools with juveniles present) and abundance (fish per m2) as measured by average density of juveniles in pools. See "Status and Trends: Juvenile Coho Salmon" for an explanation of WORP structure and the importance of juvenile abundance.

Juvenile steelhead pool occupancy was variable between 2002 and 2007 (Figure 20). However, occupancy increased steadily from 2007-2011, reaching a 9-year high (44%) in 2011 (the most recent data available). The density data do not indicate a clear trend. In the early 2000s, density first decreased, then reached its 9-year high in 2005 (0.05 fish/m2) and then rose and fell after 2005. In 2011, density was 0.026 fish/m2 (a 13% decrease from 2002 and 48% lower than the 2005 peak).

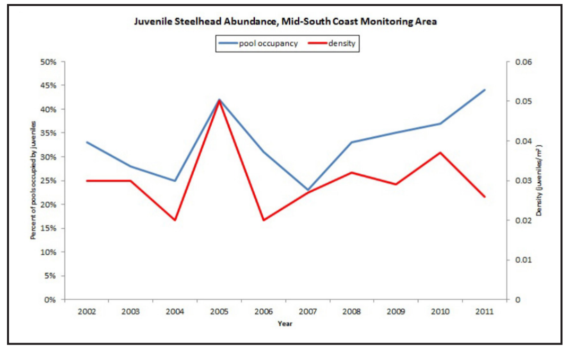



Figure 20. Juvenile steelhead abundance in first through third order ("wadeable") streams in the mid-south coast monitoring area. Data: Jepsen and Rodgers 2004; Jepsen 2006; Jepsen and Leader 2007a, 2007b, 2008; Suring and Constable 2009, 2010; Constable and Suring 2010, 2012

Status and Trends: Other Salmonid Species

**Coastal cutthroat trout** (*Oncorhynchus clarki clarki*) occupy almost all available stream habitats along the Oregon coast (at least seasonally), with the exception of streams with barriers to fish passage near the ocean (ODFW 2005a). Between 1998 and 2003, ODFW surveys found coastal cutthroat trout in the headwaters of most perennial streams and many seasonal streams. Their densities in Oregon coast waters are high and stable, therefore all stocking of cutthroat trout ended in 1996 with many programs being discontinued prior to that. Coastal cutthroat trout are able to respond quickly to changes in habitat quality and quantity; they can also persist in isolated populations or when interacting with other salmonid and non-salmonid species. Furthermore, this species is at low risk for failing the reproductive independence criterion established by the Native Fish Conservation Policy because hatchery releases were discontinued (ODFW 2005a).

Data describing local cutthroat trends are available for the Haynes Inlet subsystem. CoosWA has reported cutthroat captures as part of their juvenile fish trap (rotary screw trap) monitoring program on Larson and Palouse Creeks since 2005 (CoosWA 2013b).

Cutthroat trout captures in the Haynes Inlet subsystem generally rose from 2005-2011, with the greatest increase occurring in Larson Creek between 2009 and 2011 (Figure 21). However, captures in 2012 were well below 2011 levels due to a sharp decline in Larson Creek captures and the continued decline in Palouse captures from 2009 to 2012.

**Chum salmon** (*Oncorhynchus keta*) are at the very southern end of their range along the Oregon coast. Historic abundance and distribution information is limited. However, ODFW identified the Coos River basin as one of thirteen statewide historic chum salmon populations based on records for commercial landings. Although ODFW-sponsored surveys periodically report chum sightings in the Coos watershed, their frequency and number suggest that the population is effectively extinct in local waters (ODFW 2005a).

Commercial landing records were also used to help identify historic populations of **spring Chinook salmon.** However, since commercial landings were concurrent with hatchery releases, quantifying historic spring Chinook populations is difficult. The Coos River population of spring Chinook is classified by ODFW as extinct (ODFW 2005a).

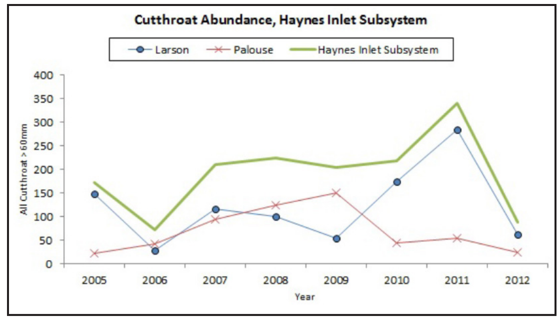



Figure 21. Cutthroat abundance in the Haynes Inlet Subsystem. These data have not been adjusted for trap efficiency. Data: CoosWA 2013b

**Why is it happening?**

Many environmental and human-related factors influence migration timing and the distribution and abundance of salmonid species in the Coos watershed. Among those factors are: 1) the condition and availability of spawning and rearing habitat, 2) commercial and recreational fish harvests, and 3) the effect of hatchery fish in wild fish populations. Salmon with limited spawning habitat availability (e.g., South Slough Coho) may be particularly vulnerable to these factors (P. Burns, pers. comm., April 23, 2014).

Oceanographic and climatic conditions may partially explain variations in salmon migration behavior and population levels. For example, the Pacific Decadal Oscillation (PDO) and El Niño Southern Oscillation (ENSO) are large-scale climate patterns that affect both marine and terrestrial biological communities throughout the western hemisphere. The PDO is a cyclical change in ocean conditions that generally shift every few decades from cold (negative) phases to warm (positive) phases. During a cold phase, the western part of the Pacific warms while the eastern part cools, with the opposite happening in a warm phase (Figure 22). In Oregon, a PDO cold phase is characterized by anomalously cool and oxygen-saturated waters; a warm phase is associated with usually warm and less oxygenated waters (O'Higgins and Rumrill 2007). The PDO phase was negative (cold) throughout 2013 and is expected to transition to near-neutral conditions in early 2014 (NOAA Northwest Fisheries Science Center 2014).

Mysak (1986) describes ENSO as a climatic event that tends to occur every two to seven years and is characterized by an unusual warming of tropical Pacific waters. In Oregon, the ENSO generally produces warmer, drier climatic conditions, and is frequently associated with lower precipitation and streamflow. However, ENSO events are sometimes unpredictable and can result in a higher frequency of winter storms and flooding. The presence or absence of ENSO conditions has been tracked using the Oceanic Niño Index, or ONI, since 1955 (Figure 23).

The PDO and ENSO are not completely independent, because ENSO events generally occur more frequently during the warm phase of the PDO (Hare et al. 1999).

These climatic oscillations are likely to have direct and important effects on salmon populations in both marine and freshwater environments (Naiman et al. 2002). Mantua et al. (1997) explains that PDO conditions first affect primary producers and consumers which in turn affect the higher level consumers such as salmon. Hare et al. (1999) suggest that these events are likely to affect salmon abundance through marine survival rates. Their research indicates that a 20-year warm PDO from the late 1970s to the late 1990s in the Pacific Northwest was marked by low primary productivity due to increased stratification in the California Current and poor foraging conditions for Pacific salmon.

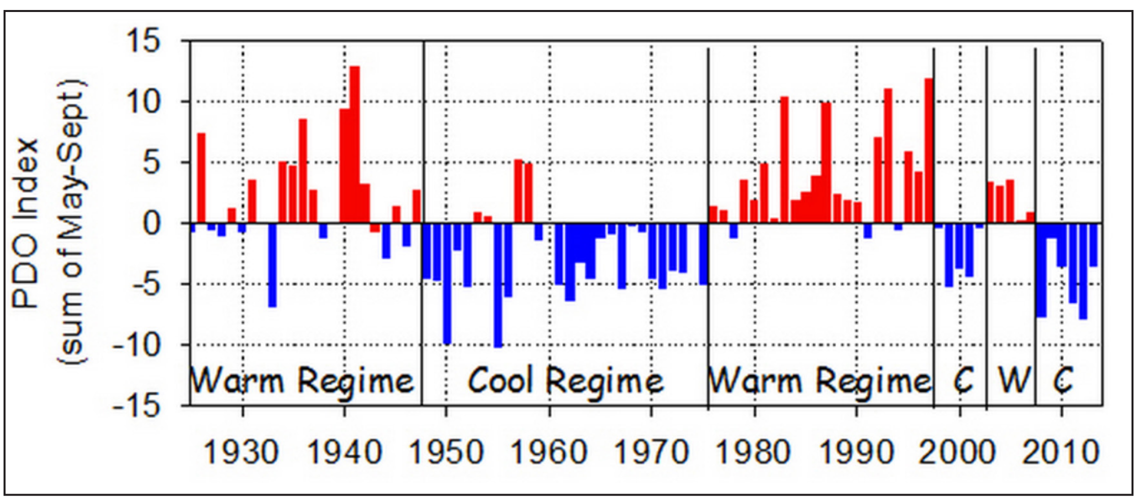



Figure 22. Time series of shifts in signs of the Pacific Decadal Oscillation (PDO), 1925 to present. Values are averaged over the months of May through September. Red bars indicate positive (warm) years; blue bars negative (cool) years. Graphic and caption: NOAA Northwest Fisheries Science Center 2014

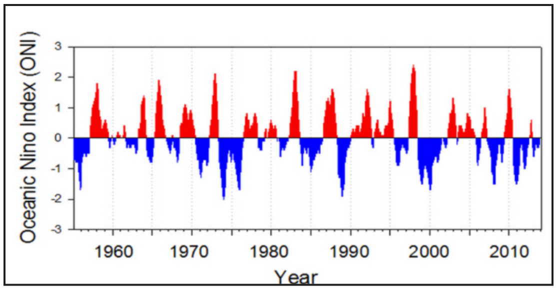


Figure 23. Values of the ONI, 1955 - present. Red bars indicate warm conditions in the equatorial Pacific, blue bars indicate cool conditions in equatorial waters. Large and prolonged El Niño events are indicated by large, positive values of the index. Graphic and caption: NOAA Northwest Fisheries Science Center 2014

Climatic events may also influence salmon abundance through abiotic factors. For example, changes in precipitation regimes may limit access to spawning grounds and stream temperatures may reach uninhabitable levels in locations near the southern end of salmon distribution ranges (Naiman et al. 2002). It's important to note that discrete climatic effects on salmon populations may be masked or overwhelmed by human-related influences such as hatchery production (Mantua et al. 1997).

**Background**

Salmonids are fish belonging to the family Salmonidae which includes Coho, Chinook, and chum salmon, steelhead and cutthroat trout and others. In many cases, these fish are anadromous, meaning they migrate from the sea to inland rivers and streams to spawn. The life cycle of anadromous fish begins with egg deposition and fertilization in the gravel of freshwater streams (Figure 24). Juvenile salmon emerge two to four months after fertilization and spend the next year or more in stream and upper estuarine habitats. Upon sufficient development they undergo smoltification, a physiological process that allows the young fish to migrate to the ocean and live in salt water.

Salmonids grow rapidly while in the ocean because food supplies are abundant. After living in the ocean for as long as five years, adult salmonids return to their home streams to spawn, relying on the fat reserves they've accumulated at sea to complete the migration. When a mature female is ready to spawn, she digs a nest (called a redd) in stream-bottom gravel, and deposits her eggs for fertilization by the male. Many salmonid species are "semelparous", which means they die after spawning. However, some species like steelhead and anadromous cutthroat trout have the ability to spawn repeatedly (Bowers et al. 1999, Cederholm et al. 1999).

Salmonid species provide crucial ecosystem services in the Coos watershed. Because most species of Pacific salmon (Oncorhynchus spp.) are semelparous, a sizeable spawning run will produce numerous salmon carcasses, which are an important food source for terrestrial animals and a critical means of transporting marine-derived nutrients back to land (Cederholm et al. 1999). Nutrients provided by salmon carcasses sustain the productivity of riparian ecosystems, a process that is sometimes referred to as stream "fertilization". Salmon have been identified as keystone species due to their ecological importance (Wilson and Halupka 1995).

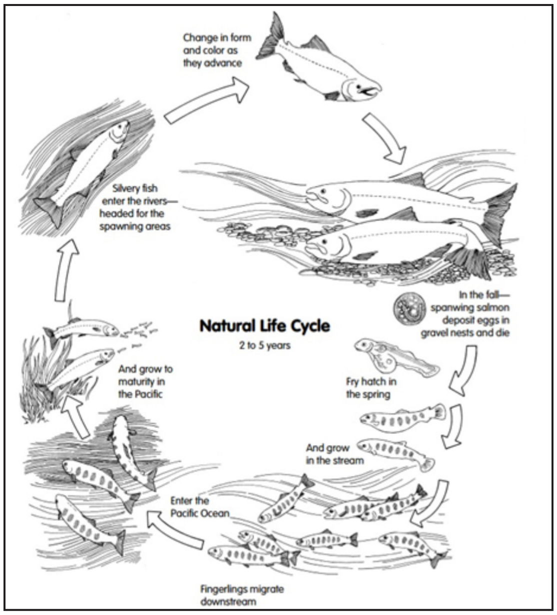



Figure 24. The life cycle of anadromous salmonids.
Graphic: Bowers et al. 1999

**Fish Hatcheries**

In an effort to supplement wild stocks of fish in Oregon waters, ODFW manages several fish hatchery and rearing programs along the coast. The Coos basin has ODFW hatchery programs on the Isthmus Slough and the Coos and Millicoma Rivers, with additional acclimation sites for both fall Chinook (two sites) and Winter Steelhead (four sites). Hatchery programs are coordinated by the Salmon and Trout Enhancement Program (STEP)(Figure 25). The goals of these local programs include: a) producing fish that are ecologically and genetically similar to wild populations, and b) educating students and the public through STEP (ODFW 2013a). In addition to live fish production, hatchery programs are a substantial source of salmon carcasses for stream fertilization (see Background).

The long-term effectiveness of hatchery programs is controversial due to genetic and ecological concerns. Research suggests that declines in wild populations, coupled with increases in hatchery production, may accelerate genetic changes in Pacific salmon species (*Oncorhynchus spp*.). These changes could compromise the long-term fitness of some species by reducing genetic variability and essentially eliminating locally adaptive gene complexes (Waples and Teel 1990; Christie et al. 2012). Furthermore, when hatchery and wild fish interbreed over several generations, the genetic effect of captive breeding practices may have a cumulative, negative influence on the reproductive fitness of wild stocks. As a result, it can take many years for wild stocks to recover after hatchery practices are terminated (Araki et al. 2009).

The production and release of fish bred in captivity may also be associated with ecological impairment. For example, competition is often cited as a harmful ecological interaction

Figure 25. A STEP volunteer helps to monitor fall Chinook populations at the Dellwood static trap, an ODFW installation on the South Coos River.

between hatchery and wild fish (Weber and Fausch 2003).

The long-term competitive abilities of fish may be affected by their genetic traits as well as behavioral, morphological, and physiological characteristics developed under different environmental conditions. Captive breeding is often associated with high densities, low current velocities, low selective pressures, and confined feeding. (Weber and Fausch 2003).

Some of these differences may result in higher competitive abilities for hatchery fish while some will result in lower competitive abilities. For example, several studies have found that hatchery fish are usually larger and grow faster than their wild counterparts (Fleming et al. 2002; Rhodes and Quinn 1999; Fleming and Einum 1997) which would presumably help them compete in the wild. Research also suggests that captive bred fish are generally less fit to avoid predation than wild fish (Johnsson et al. 1996; Berejikian 1995; Johnsson and Abrahams 1991). It's difficult to determine the full ecological consequence of these differences, because many of them have yet to be quantified (Weber and Fausch 2003).

Although the local risk of competition between hatchery and wild fish is thought to be minimized by the relatively large size of Coos Bay and surrounding estuaries, some concern still exists (ODFW 2014a). ODFW has outlined a set of best management practices for Coos watershed hatchery operations in a series of Hatchery and Genetic Management Plans (ODFW 2013c).

**Predation**

Pacific salmon species are vulnerable to predation by seals and sea lions (pinnipeds) and by sea birds.

Particularly in areas with struggling salmon populations, seal and sea lion population growth has caused heightened concern about the pinnipeds' salmonid consumption (Orr et al. 2004).

Pacific harbor seal (*Phoca vitulina richardsi*) populations have grown in response to increased protection under the Marine Mammal Protection Act of 1972 (Wright et al. 2007; Brown et al. 2005; Orr et al. 2004). According to Orr et al. (2004), Oregon harbor seal populations increased by an average of 6-7% annually from 1978-1988, but their numbers have since leveled off to about 8,000 individuals. This estimate is corroborated by Brown et al. (2005), who suggest that Oregon harbor seal populations have experienced rapid growth over the past few decades and are currently at or near carrying capacity (Figure 26).

Research suggests that salmonids compose anywhere from 1-30% of the harbor seal diet, depending on the area, season, and sampling methods (Orr et al. 2004; National Marine Fisheries Service 1997). Wright et al. (2007) studied seal predation in the Alsea River estuary by observing feeding rates, analyzing scat content, and tracking seal movement to infer foraging behavior. They estimate that pinnipeds consumed 1,161 adult salmonids over the course of three months in fall 2002.

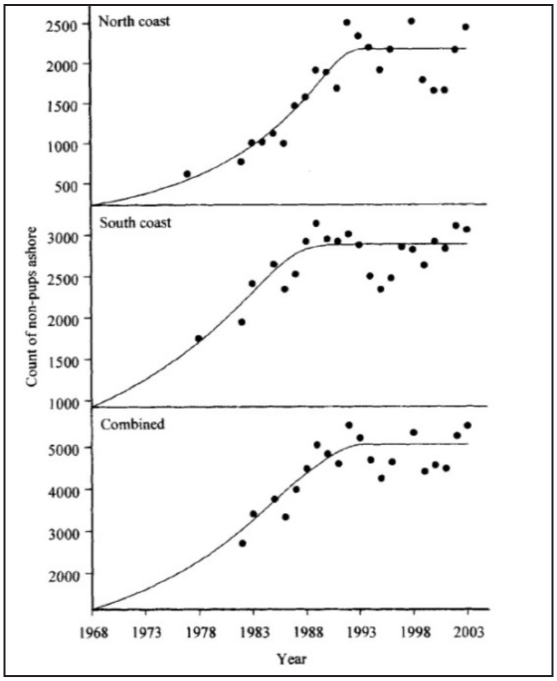



Figure 26. Average (black dots) and predicted (line) counts of non-pup harbor seals ashore in two survey regions in Oregon. The combined total represents the sum of the regional average and predicted values. Graphic and Caption: Brown et al. 2005

Scat content analyses indicate that salmonids comprise a relatively small share of the pinniped diet (Table 7). Coho was the most commonly salmonid consumed, and harbor seal predation accounted for approximately 21% of the total Alsea Coho run in 2002. Tracking suggest that only a small proportion of seals (12.5%) exhibit foraging behavior that is consistent with specialization in salmonid predation.

In addition to pinniped predation, juvenile salmonids are also vulnerable to predation by sea birds. Public concern is often voiced about juvenile salmonid predation by the double-crested cormorant (*Phalacrocorax auritus*, DCCO), a species that is known to prey on more than 250 species of freshwater and marine fishes (Adkins and Roby, 2010).

| Common Name | Taxon | Percentage of samples |
|---|---|---|
| **Salmonid spp. (adult)** | ***Oncorhynchus* spp.** | **9.4%** |
| **Salmonid spp. (juvenile)** | ***Oncorhynchus* spp.** | **0.8%** |
| Pacific herring | *Culpea pallasii* | 41.9% |
| English sole | *Parophrys vetulus* | 36.8% |
| Rex sole | *Glyptocephalus zachirus* | 19.7% |
| Dover sole | *Microstomus pacificus* | 15.4% |
| Pacific sand lance | *Ammodytes hexapterus* | 14.5% |
| Pacific tomcod | *Microgadus proximus* | 12.8% |
| Flatfish | Pleuronectidae | 11.1% |
| Sanddab spp. | *Citharichthys* spp. | 11.1% |
| Smelt spp. | Osmeridae | 11.1% |
| Butter sole | *Isopsetta isolepis* | 10.3% |
| Sculpin spp. | Cottidae | 9.4% |
| Pacific hake | *Merluccius productus* | 8.5% |
| Flatfish order | Pleuronectiformes | 7.7% |
| Northern anchovy | *Engraulis mordax* | 6.8% |
| Herring/shad | Clupeidae | 5.1% |
| Rockfish spp. | Sebastidae | 4.3% |
| Shiner perch | *Cymatogaster aggregate* | 4.3% |
| Unidentified fish | ----- | 4.1% |
| Octopus spp. | Octopodidae | 3.4 |
| Pacific staghorn sculpin | *Leptocottus armatus* | 3.4% |
| Surfperch spp. | Embiotocidae | 3.4% |
| Slender sole | *Lyopestta exillis* | 2.6% |
| Lingcod of greenling | Psettichthys melanostictus | 1.7% |
| Skate spp. | Hexagrammidae | 1.7% |
| Lamprey spp. | Rajidae | 1.7% |
| Codfishes | *Lampetra* spp. | 1.7% |
| Lingcod | Gadidae | 0.8% |
| Pacific sandfish | *Ophiodon elongatus* | 0.8% |
| Irish lord spp. | *Trichodon trichodon* | 0.8% |
| Pacific sardine | *Hemilepido tus* spp. | 0.8% |
| Cephalopod | Cephalopoda | 0.8% |
| Eelpout spp. | Zoarcidae | 0.8% |
| Poacher spp. | Agonidae | 0.8% |
| Gunnel spp. | Pholidae | 0.8% |

Table 7. Scat content analysis of the harbor seal. Source: Wright et al. 2007

In April and May 2012, ODFW conducted a diet study to assess DCCO predation on juvenile salmonids in Tillamook Bay (Adrean 2013). ODFW estimates that DCCOs consumed approximately 8,000 juvenile Coho (about 4% of all outmigrating Coho smolts) over two months (Adrean 2013).Their data indicate that the salmonid component of their diet was significantly higher in April than in May (Figure 27). Steelhead (47%) and Coho (21%) comprised the largest proportion of

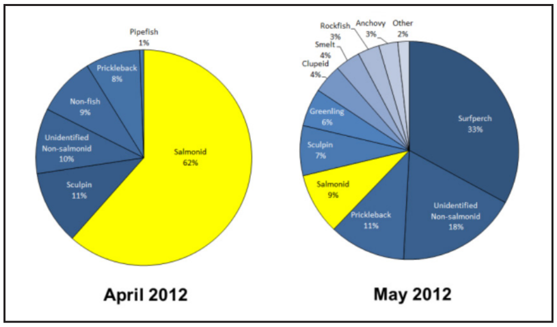



Figure 27. The composition of the double-crested cormorant diet during a two-month study period at Tillamook Bay in spring 2012. Data: Adrean 2013

| Salmonid Species | Proportion of All Salmonids Consumed |
|---|---|
| Steelhead | 47% |
| Coho | 21% |
| Cutthroat | 16% |
| Chum | 11% |
| Unidentified | 5% |

Table 8. Salmonid component of the double-crested cormorant diet in Tillamook Data: Adrean 2013

salmonids consumed (Table 8).

In 2013, the ODFW expanded the DCCO predation study to include two additional estuaries. Their preliminary results indicate that salmonids comprise about 6, 11, and 7% of the DCCO diet in the Tillamook, Umpqua, and Rogue systems, respectively. Almost all salmonids detected in the 2013 DCCO predation study were juvenile Coho salmon (J. Lawonn, pers. comm., April 21, 2014).

This analysis corroborates the research that was done by Oregon State University and the United States Geological survey on the Columbia River (Bird Research Northwest 2009). Their findings suggest that juvenile salmonids comprise approximately 10% of the DCCO diet on average, with data ranging from 2-25% of diet composition. They also support previous studies indicating that sand lance (*Ammodytes hexapterus*), clupeids (herrings and sardines), cottids (sculpins), embiotocids (surf perches), engraulids (anchovies), pholids (gunnels), and stichaeids (pricklebacks) are important prey items for DCCO populations in western North America (Adkins and Roby 2010).

In 2012, there were an estimated 1,260 breeding DCCO pairs on the Oregon coast (Adrean 2013). Statewide, DCCO populations have decreased from 2009 levels, which had about 2,384 breeding pairs (Adkins and Roby 2010). The DCCO breeding populations in the Coos estuary (at Coos Head and Cape Arago) may have decreased throughout the mid-2000s, but have since recovered (USFWS 2014). The U.S. Fish and Wildife Service estimates that there were 326 DCCO breeding pairs in the Coos Bay area in 2013 (down 15% from 2003).

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