Science, Service, Stewardship

2016 5-Year Review: Summary & Evaluation of Southern Oregon/Northern California Coast Coho Salmon

National Marine Fisheries Service West Coast Region
Arcata, California

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5-Year Review: SONCC Coho Salmon

Species Reviewed	**Evolutionarily Significant Unit**
coho salmon (Oncorhynchus kisutch)	Southern Oregon/Northern California Coast (SONCC) coho salmon

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1. General Information

1.1 Introduction

Many West Coast salmon and steelhead (Oncorhynchus spp.) stocks have declined substantially from their historic numbers and now are at a fraction of their historical abundance. There are several factors that contribute to these declines, including overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices. These factors collectively led the National Marine Fisheries Service to list 28 salmon and steelhead stocks in California, Idaho, Oregon, and Washington under the Federal Endangered Species Act (ESA).

The ESA, under section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from threatened to endangered; or (3) have its status changed from endangered to threatened. Such reviews for the Southern Oregon/Northern California Coast (SONCC) coho salmon Evolutionarily Significant Unit (ESU) occurred in 2005 (Good et al. 2005) and 2011 (NMFS 2011). This document describes the results of the 2015 review of ESA-listed SONCC coho salmon.

Background on salmonid listing determinations

The ESA defines species to include subspecies and distinct population segments (DPS) of vertebrate species. A species may be listed as threatened or endangered. To identify distinct population segments of salmon species, we apply the Policy on Applying the Definition of Species under the ESA to Pacific Salmon (56 FR 58612). Under this policy, we identify population groups that are evolutionarily significant units (ESU) within their species. We consider a group of populations to be an ESU if it is substantially reproductively isolated from other populations, and represents an important component in the evolutionary legacy of the biological species. We consider an ESU as constituting a DPS and therefore a species under the ESA.

Artificial propagation programs (hatcheries) are common throughout the range of ESA-listed West Coast salmon and steelhead. Prior to 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed essential for conservation of a species. We revised that approach in response to a court decision (Alsea Valley Alliance v Evans 2001) and on June 28, 2005, announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204; hatchery listing policy). This policy establishes criteria for including hatchery stocks in ESUs and DPSs. In addition, it (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of an ESU or DPS be included in any listing of the ESU or DPS; (3) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (4) affirms our commitment to fulfilling trust and treaty obligations with regard to the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon

ESUs and steelhead DPSs.

To determine whether a hatchery program is part of an ESU or DPS, we consider the origins of the hatchery stock, where the hatchery fish are released, and the extent to which the hatchery stock has diverged genetically from the donor stock. We include within the ESU or DPS (and therefore within the listing) hatchery fish that are derived from the population in the area where they are released, and that are no more than moderately diverged from the local population.

Due to the Alsea Valley court decision, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37160) On November 4, 2011, we completed the five-year review for SONCC coho salmon (NMFS 2011).

1.2 Methodology used to complete the review

On February 6, 2015, we announced the initiation of five-year reviews for 17 ESUs of salmon and 11 DPSs of steelhead in Oregon, California, Idaho, and Washington (80 FR 6695). We requested the public submit new information on these species that has become available since our 2010-2011 five-year reviews. In response to our request, we received information from Federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals. We considered this information, as well as information routinely collected by our agency, to complete these five-year reviews.

To complete the reviews, we first asked scientists from our Northwest and Southwest Fisheries Science Centers to collect and analyze new information about ESU and DPS viability. To evaluate viability, our scientists used the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. Through the application of this concept, the science centers considered new information for a given ESU or DPS relative to the four salmon and steelhead population viability criteria. They also considered new information on ESU and DPS boundaries. At the end of this process, the science teams prepared reports detailing the results of their analyses (Ford et al. 2015).

To further inform the reviews, we also asked our Southwest Fisheries Science Center salmon management biologists familiar with hatchery programs to consider new information available since the previous listing determinations. Among other things, they considered hatchery programs that have ended, new hatchery programs that have started, changes in the operation of existing programs, and scientific data relevant to the degree of divergence of hatchery fish from naturally spawning fish in the same area. They produced a report (Jones 2015) describing their findings. Finally, we consulted our Northwest biologists and other salmon management specialists familiar with hatchery programs, habitat conditions, hydropower operations, and harvest management. In a series of structured meetings, by geographic area, these biologists identified relevant information and provided their insights on the degree to which circumstances have changed for each listed entity.

In preparing this report, we considered all relevant information received by December 1, 2015, including: the work of the Southwest Fisheries Science Center (Williams et al. 2015); the report of the regional biologists regarding hatchery programs (Williams et al. 2015); the SONCC coho salmon recovery plan (NMFS 2014); the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for SONCC coho salmon; information submitted by the public and other government agencies; and the information and views provided by the geographically-based domain team. The present report describes the agency's findings based on all of the information considered.

1.3 Background – Summary of Previous Reviews, Statutory and Regulatory Actions, and Recovery Planning

1.3.1 Federal Register Notice announcing initiation of this review

80 FR 6695; February 6, 2015

1.3.2 Listing history

NMFS listed SONCC coho salmon under the ESA and classified it as a threatened species in 1997 (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for the SONCC coho salmon ESU.

Salmonid Species	ESU Name	Original Listing	Revised Listing(s)
Coho salmon (*O. kisutch*)	SONCC coho salmon	**FR Notice:** 62 FR 24588 **Date:** 5/06/1997 **Classification:** Threatened	**FR Notice:** 70 FR 37160 **Date:** 6/28/2005 **Re-classification:** Threatened

1.3.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat, to the maximum extent prudent and determinable, for species it lists under the ESA. Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, on which are found those physical or biological features essential to the conservation of the species, and those features which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time of listing if the agency determines that the area itself is essential for conservation of the species. We designated critical habitat for SONCC coho salmon in 1999 (Table 2). Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take, but instead authorizes the agency to adopt regulations it deems necessary and advisable for species conservation including regulations that prohibit take (ESA section 4(d)). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibit take except in specific circumstances (Table 2). In 2005, we revised our 4(d) regulations for consistency between ESUs and DPSs, and, to take into account our hatchery listing policy (Table 2).

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for SONCC coho salmon.

Salmonid Species	ESU Name	4(d) Protective Regulations	Critical Habitat Designations
Coho salmon (*O. kisutch*)	SONCC coho salmon	FR notice: 65 FR 42421 Date: 7/10/2000 Revised: 6/28/2005 (70 FR 37160)	FR notice: 64 FR 24049 Date: 5/5/1999

1.3.4 Review history

Table 3 lists the numerous scientific assessments of the status of SONCC coho salmon DPS. These assessments include status reviews conducted by our Northwest Fisheries Science Center and technical reports prepared in support of recovery planning for this DPS.

Table 3. Summary of previous scientific assessments for SONCC coho salmon.

Salmonid Species	ESU Name	Document Citation
Coho salmon (*O. kisutch*)	SONCC coho salmon	NMFS 2011 Williams et al. 2008 Williams et al. 2006 Good et al. 2005 NMFS 2001 Weitkamp et al. 1995

1.3.5 Species' recovery priority number at start of 5-year review process

On June 15, 1990, NMFS issued guidelines (55 FR 24296) for assigning listing and recovery priorities. For recovery plan development, implementation, and resource allocation, we assess three criteria to determine a species' recovery priority number from 1 (high) to 12 (low): (1) magnitude of threat; (2) recovery potential; and (3) conflict with development projects or other economic activity. NMFS re-evaluated the recovery priority numbers for listed species as part of the FY2013-FY2014 ESA Biennial Report to Congress (NMFS 2015a). As a result of the re-evaluation, SONCC coho salmon changed from 1 to 5. Table 4 lists the current recovery priority numbers for the subject species, as reported in NMFS 2015aRegardless of a species' recovery priority number, NMFS remains committed to continued efforts to recovery all ESA-listed species under our authority.

1.3.6 Recovery plan or outline

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plans for the SONCC coho salmon ESU.

Salmonid Species	ESU Name	Recovery Priority Number	Recovery Plan
Coho salmon (*O. kisutch*)	SONCC coho salmon	5	Title: Southern Oregon/Northern California Coast (SONCC) Coho Salmon Recovery Plan Date: 9/30/2014 Type: Final FR Notice: 79 FR 58750

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2. Review Analysis

In this section, we review new information to determine whether the SONCC coho salmon ESU delineation remains appropriate.

2.1 Delineation of species under the Endangered Species Act

Is the species under review a vertebrate?

ESU Name	YES	NO
SONCC coho salmon	X	

Is the species under review listed as a DPS?

ESU Name	YES	NO
SONCC coho salmon	X	

Was the DPS listed prior to 1996?

ESU Name	YES	NO	Date Listed if Prior to 1996
SONCC coho salmon		X	n/a

Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 DPS policy standards?

In 1991, NMFS issued a policy on how the agency would delineate DPSs of Pacific salmon for listing consideration under the Endangered Species Act (ESA) (56 FR 58612). Under this policy, a group of Pacific salmon populations is considered an “evolutionarily significant unit” (ESU) if it is substantially reproductively isolated from other con-specific populations, and it represents an important component in the evolutionary legacy of the biological species. The 1996 joint NMFS-Fish and Wildlife Service (FWS) Distinct Population Segment (DPS) policy (61 FR 4722) affirmed that a stock (or stocks) of Pacific salmon is considered a DPS if it represents an ESU of a biological species. Accordingly, in listing the Middle Columbia River steelhead DPS under the DPS policy in 1999, we used the joint DPS policy to delineate the DPS under the ESA.

2.1.1 Summary of relevant new information regarding delineation of ESU

ESU/DPS boundaries

The SONCC coho salmon ESU currently includes populations spawning from Elk River (Oregon) in the north to Mattole River (California) in the south, inclusive. New genetic data are available from collections in 2003, including microsatellite genotypes for fish from most extant populations in California, and included samples from populations coast wide (Gilbert-Horvath et al. Submitted). These recent genetic data do not suggest the need for a re-examination of the boundaries between the Central California Coast coho salmon ESU and the SONCC coho salmon ESU. These data show clear separation between populations south and north of Punta Gorda, the current southern boundary of the ESU. The Biological Review Team for Oregon Coast coho salmon ESU reviewed genetic data and concluded that a reconsideration of the ESU boundary the between the SONCC and Oregon Coast coho salmon ESUs was not necessary (Stout et al. 2010). In 2015, a new sampling effort was conducted to resample all sites sampled in 2003 California-wide survey (Gilbert-Horvath et al. unpublished data) and included samples from populations located in the Oregon portion of the SONCC coho salmon ESU. These collections and analyses are still underway at the time of this report and therefore are not available for consideration.

Membership of hatchery programs

As part of its 2005 review and listing determination (70 FR 37160), NMFS determined that the artificially propagated coho salmon hatchery stocks from Cole Rivers Hatchery, Iron Gate Hatchery, and the Trinity River Hatchery are part of the SONCC coho salmon ESU. These artificially propagated stocks were considered no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (70 FR 37160). An updated review of these hatchery programs indicates that all three continue to be operational and that no substantial changes in their management have been implemented since the last status review that would increase their divergence from natural populations. Based on the updated information, all three programs continue to propagate fish that are considered part of the SONCC coho salmon ESU.

2.2 Recovery criteria

The ESA requires NMFS to develop recovery plans for each listed species. Recovery plans must contain, to the maximum extent practicable, objective measureable criteria for delisting the species, site-specific management actions necessary to recover the species, and time and cost estimates for implementing the recovery plan.

Does the species have a final, approved recovery plan containing objective, measurable criteria?

ESU Name	YES	NO
SONCC coho salmon	X	

2.2.1 Adequacy of recovery criteria

Based on new information considered during this review, are the recovery criteria still appropriate?

ESU Name	YES	NO
SONCC coho salmon	X	

Are all of the listing factors that are relevant to the species addressed in the recovery criteria?

ESU Name	YES	NO
SONCC coho salmon	X	

2.2.2 List the demographic recovery criteria as they appear in the recovery plan

For the purposes of reproduction, salmon and steelhead typically exhibit a metapopulation structure (Schtickzelle and Quinn 2007, McElhany et al. 2000). Rather than interbreeding as one large aggregation, ESUs and DPSs function as a group of demographically independent populations separated by areas of unsuitable spawning habitat. For conservation and management purposes, it is important to identify the independent populations that make up an ESU or DPS. For recovery planning and development of recovery criteria, the SONCC Technical Recovery Team (TRT) identified independent and dependent populations within the SONCC coho salmon ESU. The TRT grouped these populations into diversity strata: Groups of populations that span the diversity and distribution that currently exists or historically existed within the ESU, where “diversity” refers to diversity of (potential) selective environments, diversity of phenotypes, including life history types, and diversity of genetic variation (Williams et al. 2006). The ESU is composed of seven diversity strata: Northern Coastal Basins, Central Coastal Basins, Southern Coastal Basins, Interior Rogue River, Interior Klamath River, Interior Trinity River, and Interior Eel River (Figure 1).

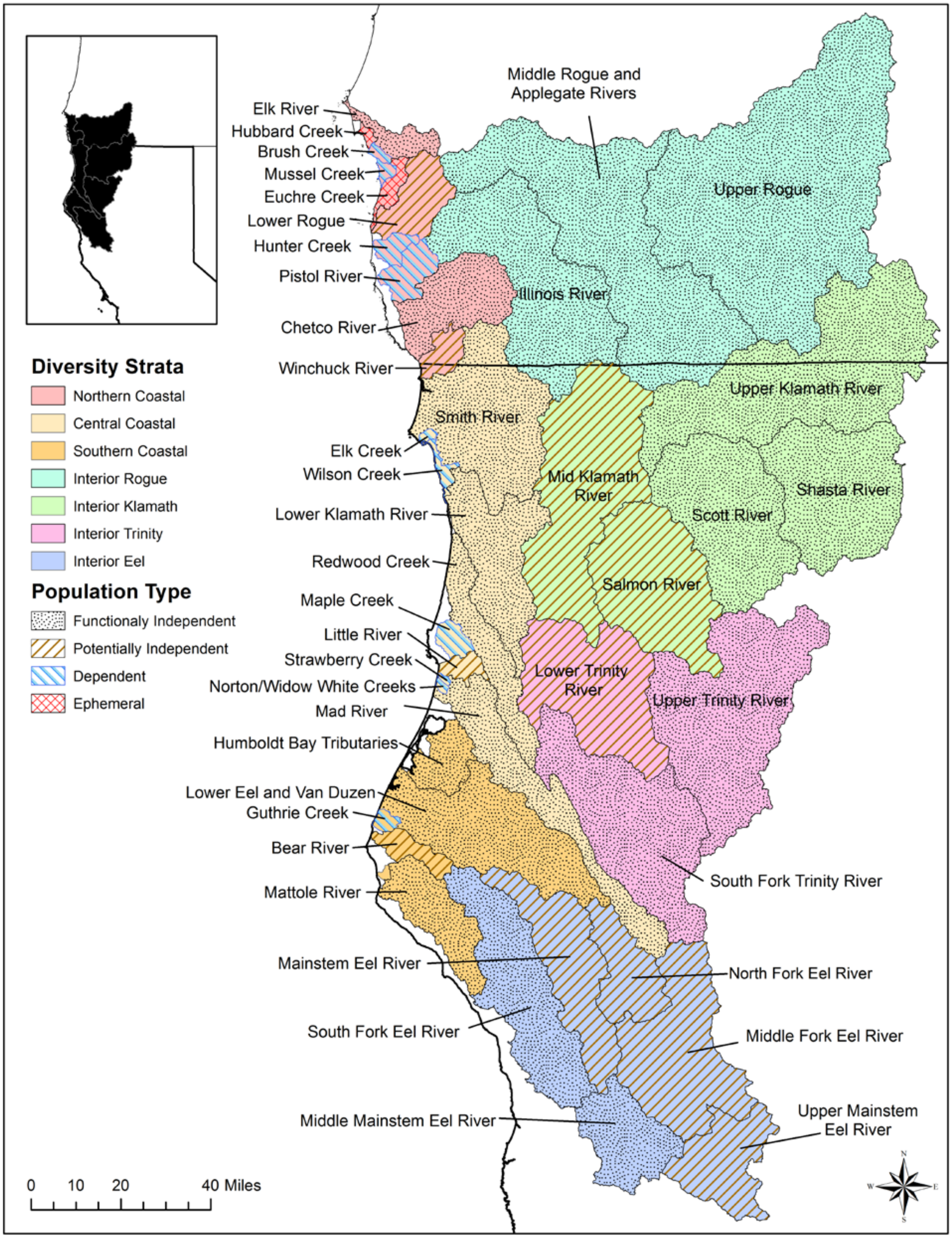

Figure 1. Historic population structure of the SONCC coho salmon ESU, including populations and diversity strata, as described in Williams et al. (2006). Source: NMFS 2014.

The recovery plan (NMFS 2014) and the TRT (Williams et al. 2008) described specific biological viability criteria based on the VSP concept (McElhany et al. 2000) at the population, diversity stratum and DPS levels. At the population level, the TRT (Williams et al. 2008) recommended specific biological criteria for two of the viability components of VSP – abundance and productivity. The recovery plan (NMFS 2014) adopts these criteria and presents criteria for the other two viability components of VSP – spatial structure and diversity. The population viability ratings are low extinction risk (viable), moderate extinction risk, and high extinction risk.

To achieve viability, the ESU must have sufficient representation, redundancy, connectivity, occupancy, and resiliency (Williams et al. 2008) which is accomplished by having populations meet demographic criteria that encompasses the viable salmonid population (VSP) parameters, (i.e., abundance, productivity, spatial structure, and diversity criteria; see Table 5). The ESU demographic recovery criteria highlight the need for a continuous set of functional populations across the ESU, which together form the basis for a viable ESU. Core populations will play a major role in recovering this ESU while the other populations will contribute to maintaining and increasing connectivity and diversity (Table 5).

The biological recovery criteria are as follows. In order for the ESU to be viable, all “core” populations should be at low risk of extinction, all Non-Core 1 populations should be at least at moderate risk of extinction, and all Non-Core 2 and dependent populations should have demonstrated juvenile occupancy (Table 5). Table 6 describes the number of spawners needed in each population in order for its respective diversity stratum to be at low risk of extinction. Population growth rates should be neutral or positive for all Core and Non-Core 1 populations (Table 5). Populations should be widely distributed, and there should be sufficient inter- and intra-stratum connectivity. Hatchery impacts on wild fish should be low or moderate, and life history diversity should be attained and retained (Table 5). The abundance criterion associated with each population is described in Table 6.

Table 5: Demographic recovery criteria for SONCC coho salmon ESU (NMFS 2014).

<table>
<tr><th>VSP Parameter</th><th>Population Role</th><th>Biological Recovery Objective</th><th>Biological Recovery Criteria[1]</th></tr>
<tr><td rowspan="2">Abundance</td><td>Core</td><td>Achieve a low risk of extinction</td><td>The geometric mean of wild adults over 12years meets or exceeds the “low risk threshold” of spawners for each core population[2,3,4]</td></tr>
<tr><td>Non-Core 1</td><td>Achieve a moderate or low risk of extinction[2]</td><td>The annual number of wild adults is greater than or equal to four spawners per IP-km for each non-core population[2]</td></tr>
<tr><td>Productivity</td><td>Core and Non-Core 1</td><td>Population growth rate is not negative</td><td>Slope of regression of the geometric mean of wild adults over the time series ≥ zero[4]</td></tr>
<tr><td rowspan="2">Spatial Structure</td><td>Core and Non-Core 1</td><td>Ensure populations are widely distributed</td><td>Annual within-population juvenile distribution ≥ 80%[4] of habitat[5,6] (outside of a temperature mask[7])</td></tr>
<tr><td>Non-Core 2 and Dependent</td><td>Achieve inter- and intra-stratum connectivity</td><td>≥ 80% of accessible habitat[4] is occupied in years[8] following spawning of cohorts that experienced high marine survival[9]</td></tr>
<tr><td rowspan="2">Diversity</td><td>Core and Non-Core 1</td><td>Achieve low or moderate hatchery impacts on wild fish</td><td>Proportion of hatchery-origin adults (pHOS)</td></tr>
<tr><td>Core and Non-Core 1</td><td>Achieve life-history diversity</td><td>Variation is present in migration timing, age structure, size, and behavior. The variation in these parameters[10] is retained.</td></tr>
</table>

[1] All applicable criteria must be met for each population in order for the ESU to be viable.

[2] See Table 6 for specific spawner abundance requirements needed to meet this objective.

[3] In the Shasta River, Upper Trinity River, and Upper Rogue River populations, IP above some anthropogenic dams was excluded from the spawner target, so the low-risk threshold for these populations is based on the IP downstream of those dams.

[4] Assess for at least 12 years, striving for a coefficient of variation (CV) of 15% or less at the population level (Crawford and Rumsey 2011).

[5] Based on available rearing habitat within the watershed (Wainwright et al. 2008). For purposes of these biological recovery criteria, “available” means accessible. 80% of habitat occupied relates to a truth-value of +1.0, (true: juveniles occupy a high proportion of the available rearing habitat within the watershed (p. 56, Wainwright et al. 2008).

[6] The average for each of the three year classes over the 12-year period used for delisting evaluation must each meet this criterion. Strive to detect a 15% change in distribution with 80% certainty (Crawford and Rumsey 2011).

[7] Williams et al. (2008) identified a threshold air temperature, above which juvenile coho salmon generally do not occur, and identified areas with air temperatures over this threshold. These areas are considered to be within the temperature mask.

[8] If young-of-year were sampled, sampling would occur the spring following spawning of the cohorts experiencing high marine survival. If 1+ juveniles were sampled, sampling would occur approximately 1.5 years after spawning of the cohorts experiencing high marine survival, but before outmigration to the estuary and ocean.

[9] High marine survival is defined as 10.2% for wild fish and 8% for hatchery fish (Sharr et al. 2000). If marine survival is not high, then this criterion does not apply.

[10] This variation is documented in the population profiles in Chapters 7 to 46 of NMFS (2014).

Table 6: Demographic recovery criteria for each population of SONCC coho salmon (NMFS 2014).

Diversity Stratum	Independent Population	Population Role	Minimum Number of Spawners[1]
Northern Coastal Basins	Elk River	Core	2,400
	Brush Creek	Dependent	None- Juv. Occupancy
	Mussel Creek	Dependent	None- Juv. Occupancy
	Lower Rogue River	Non-Core 1	320
	Hunter Creek	Dependent	None- Juv. Occupancy
	Pistol River	Dependent	None- Juv. Occupancy
	Chetco River	Core	4,500
	Winchuck River	Non-Core 1	230
Interior Rogue R.	Illinois River	Core	11,800
	Middle Rogue and Applegate	Non-Core 1	2,400
	Upper Rogue River	Core	13,800
Central Coastal Basins	Smith River	Core	6,800
	Elk Creek	Dependent	None- Juv. Occupancy
	Wilson Creek	Dependent	None- Juv. Occupancy
	Lower Klamath River	Core	5,900
	Redwood Creek	Core	4,900
	Maple Creek/Big Lagoon	Dependent	None- Juv. Occupancy
	Little River	Non-Core1	140
	Strawberry Creek	Dependent	None- Juv. Occupancy
	Norton/Widow White Creek	Dependent	None- Juv. Occupancy
	Mad River	Non-Core 1	550
Interior Klamath R.	Middle Klamath River	Non-Core 1	450
	Upper Klamath River	Core	8,500
	Salmon River	Non-Core 1	450
	Scott River	Core	6,500
	Shasta River	Core	4,700
Interior Trinity R.	Lower Trinity River	Core	3,600
	Upper Trinity River	Core	5,800
	South Fork Trinity River	Non-Core 1	970
Southern Coastal Basins	Humboldt Bay tributaries	Core	5,700
	Lower Eel and Van Duzen	Core	7,900
	Guthrie Creek	Dependent	None- Juv. Occupancy
	Bear River	Non-Core 2	None- Juv. Occupancy
	Mattole River	Non-Core 1	1,000
Interior Eel R.	South Fork Eel River	Core	9,300
	Mainstem Eel River	Core	2,600
	Middle Fork Eel River	Non-Core 2	None- Juv. Occupancy
	North Fork Eel River	Non-Core 2	None – Juv. Occupancy
	Middle Mainstem Eel River	Core	6,300
	Upper Mainstem Eel River	Non-Core 2	None- Juv. Occupancy

[1]See Table 5 for demographic recovery criteria. Abundance estimates should strive for a coefficient of variation of 15 percent or less at the population level (Crawford and Rumsey 2011).

2.3 Updated information and current species' status

2.3.1 Analysis of VSP criteria

Quantitative population-level estimates of adult spawner abundance spanning more than 9-12 years are scarce for independent or dependent populations of coho salmon in the SONCC ESU, although monitoring in California has improved considerably since the 2011 viability assessment as a result of the implementation of the Coastal Monitoring Plan (CMP) across the California portion of the ESU. The CMP framework provides population abundance estimates at the appropriate spatial scale (i.e., population unit) based on redd counts from surveys of stream reaches selected according to a Generalized Randomized Tessellation Survey (GRTS) design. Redd counts are then expanded to adult estimates based on spawner: redd ratios determined at a network of life-cycle monitoring stations (LCMs). Although only estimates of redds are presented in this assessment of SONCC coho salmon ESU, these estimates still provide a better basis for assessing status compared with previous reviews and will increase greatly in value as these time series become longer and we gain a better understanding of the relationship between spawner: redd ratios among populations and among years within a population from life-cycle monitoring stations. Although only one population has enough years of abundance data collected to meet the requisite four generations called for by the TRT for application of viability criteria, the abundance data collected in other populations with shorter time series provide a substantially better basis for assessing status compared with previous reviews. The value of these abundance data will increase as these time series become longer. In addition, ongoing weir-based estimates are available for population units in the Klamath Basin (Scott and Shasta rivers), our longest time series sets for this ESU.

Unfortunately, the few estimates available at the population unit spatial scale from the Oregon portion of the ESU for the 2011 assessment are no longer collected. The estimate of Rogue River coho salmon that is a composite of several population units (Huntley Park seine counts) continues to be collected and is extremely valuable.

In California, seven independent populations are currently monitored at the "population unit" scale. Most of this monitoring produces estimates of adult escapement based on random subsampling within the population area. In contrast, the counts from the Shasta River are not based on an estimate. In this location, the actual numbers of fish passing a video weir are counted. Only the video weir count from the Shasta River meets the minimum duration to assess under the viability criteria (12 years) (Table 7, Figure 2). Of great concern is the extremely low numbers of fish passing the weir in 2014 (46 coho salmon), which is less than the depensation threshold of 144 fish (NMFS 2014), and that only four of those fish were considered to be 3-year olds (Chesney and Knechtle 2015) The Shasta River count is now 14 years in duration (4+ generations) and from this time series a slight decline is apparent, although the slope of the decline is not significantly different from zero (Figure 3).

Table 7. Viability metrics for independent populations of coho salmon in the SONCC coho salmon ESU.

Stratum/population	Years	$\overline{N}_{a(arith)}$	$\overline{N}_{a(geom)}$	$\overline{N}_{g(harm)}$	$\hat{C}$	$\hat{T}$ *(95% CI)*
Northern Coastal Basins						
Elk River	-	-	-	-	-	-
Lower Rogue River	-	-	-	-	-	-
Checto River	-	-	-	-	-	-
Winchuck River	-	-	-	-	-	-
Central Coastal Basins						
Smith River[a,b] (*redd estimate*)	2	355	331	NA	NA	-
Lower Klamath River	-	-	-	-	-	-
Redwood Creek[b,c] *(redd estimate)*	4	529	516	NA	NA	-
Maple Creek/Big Lagoon[d]						
Little River	-	-	-	-	-	-
Mad River	-	-	-	-	-	-
Southern Coastal Basins						
Humboldt Bay tributaries[b,e] *(redd estimate)*	4	1038	919	NA	NA	-
Low. Eel/Van Duzen rivers	-	-	-	-	-	-
Bear River[a]	-	-	-	-	-	
Mattole River[b,f] *(redd estimate)*	2	47	46	NA	NA	-
Interior – Rogue						
Illinois River	-	-	-	-	-	-
Mid. Rogue/Applegate rivers	-	-	-	-	-	-
Upper Rogue River	-	-	-	-	-	-
Interior – Klamath						
Middle Klamath River	-	-	-	-	-	-
Upper Klamath River	-	-	-	-	-	-
Salmon River	-	-	-	-	-	-
Scott River[g] (*video weir – adults*)	8	810	404	1713	NA	0.145 (-0.389, 0.678)
Shasta River[h] (*video weir – adults*)	14	127	84	252	0.87	-0.094 (-0.231, 0.044)
Interior - Trinity						
South Fork Trinity River	-	-	-	-	-	-
Lower Trinity River	-	-	-	-	-	-
Upper Trinity River	-	-	-	-	-	-
Interior - Eel						
South Fork Eel River[b,i] *(redd estimate)*	4	1347	1310	NA	NA	-
Mainstem Eel River	-	-	-	-	-	-
North Fork Eel River[d]						
Middle Fork Eel River[d]						
Middle Mainstem Eel River	-	-	-	-	-	-
Upper Mainstem Eel River[d]						

NA indicates not available or applicable; dash (-) indicates no estimate of appropriate spatial scale or sampling design for viability analysis. Trends are shown only for populations where time series is at least 6 years; bold indicates significant trend.
a – Data from Garwood and Larson (2014). Data available for 2011 and 2012, data for 2013 and 2014 not available at time of analysis.
b – Redd counts (estimates), not adult escapement.
c – Data from Ricker et al. (2014a, 2014b, 2014c, and 2014d); data from 2010 to 2013.
d – Population unit designated by Williams et al. (2006 and 2008), not included in NMFS (2014).
e – Data from Ricker et al. (2015a, 2015b, 2015c, and 2015d); data from 2010 to 2013.
f – Data from Ricker and Lindke 2014 and Ricker et al. 2014e; data for 2011 and 2012.
g – Data from Morgan Knechtle, California Department of Fish and Wildlife; data from 2007 to 2014.
h – Data from Morgan Knechtle, California Department of Fish and Wildlife; data from 2001 to 2014.
i – Data from Ricker et al. (2015e, 2015f, 2015g, and 2015h); data from 2010 to 2013.

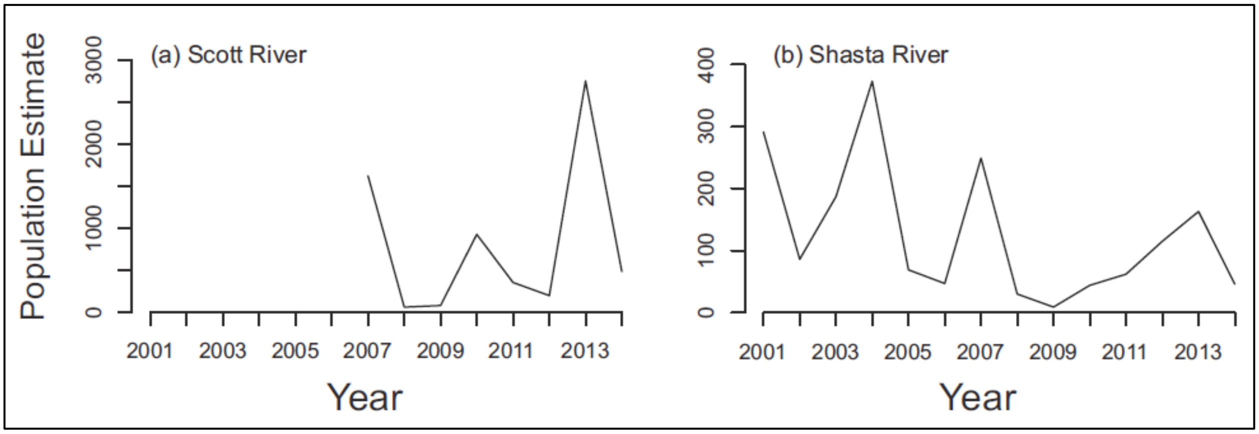

Figure 2. Population abundance for independent populations of SONCC coho salmon.

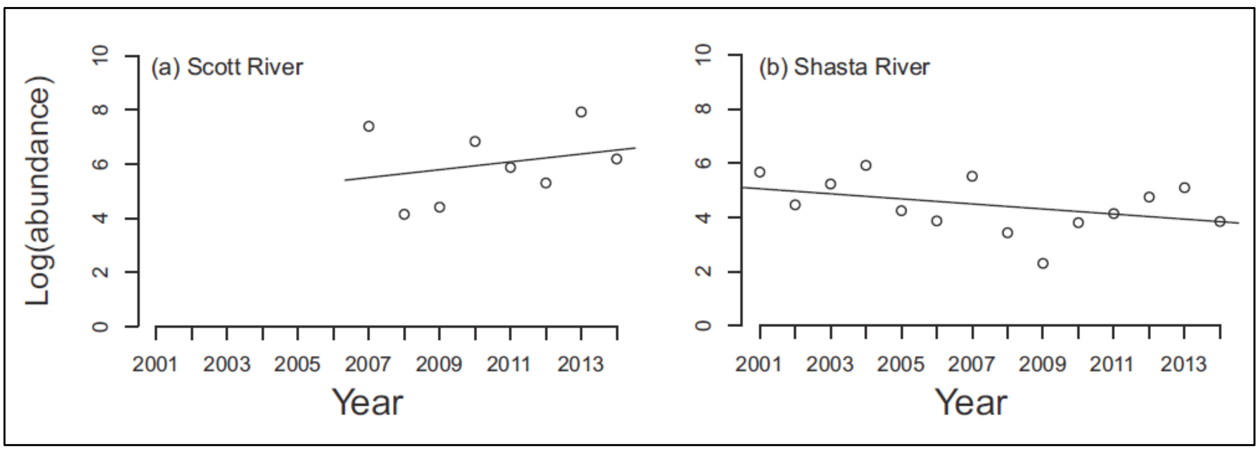

Figure 3. Population trends (log abundance) for independent populations of SONCC coho salmon.

The Shasta River and Scott River adult counts represent the longest-term population-unit spatial scale monitoring currently underway in the SONCC coho salmon ESU. With implementation of the CMP, monitoring activities have been established at five population units; these monitoring activities provide appropriate data to assess population viability (Table 7). There are now four years of data (estimated number of redds) for Smith River, Redwood Creek, Humboldt Bay, and the South Fork Eel River, although only the first two years of data were available for the Smith

River at the time of this assessment. The Mattole River population has a time series of two years and has the lowest estimated number of redds (47) of any of the five new time series.

Trends in abundance were only calculated for those populations where at least six years of data were available (Table 7). The slope of the trend line for both the Shasta River and Scott River did not differ from zero. If monitoring continues, at the time of the next assessment in 2020 the Scott River will have more than 12 years of data. In addition, the time series information for Smith River, Redwood Creek, Humboldt Bay, South Fork Eel River, and the Mattole River will all be at least two generations in length (six years) if all of the described monitoring continues.

Besides the population-unit spatial scale estimate that are required to assess population viability, there are two other data sets that provide insight into the condition of coho salmon in the ESU although at spatial scales that do not allow for assessing population viability.
An estimate of spawners from 2002-03 to 2013-14 in Freshwater Creek, a Humboldt Bay tributary, shows a trend that is not significantly different than zero ($p > 0.07$) over the 13-year period (Figures 4 and 5; Table 8). The Freshwater Creek monitoring site supports a Life Cycle Monitoring station operated as outlined in the CMP (Ricker and Anderson 2014). This LCM provides data to understand the relationships between redd counts and estimated adult escapement. This is a critical relationship to understand, as CMP efforts currently focus on redd counts for many practical reasons. In addition, this and other LCMs will provide estimates of marine survival that will provide context when evaluating trends in abundance and effectiveness of restoration activities (Figure 6).

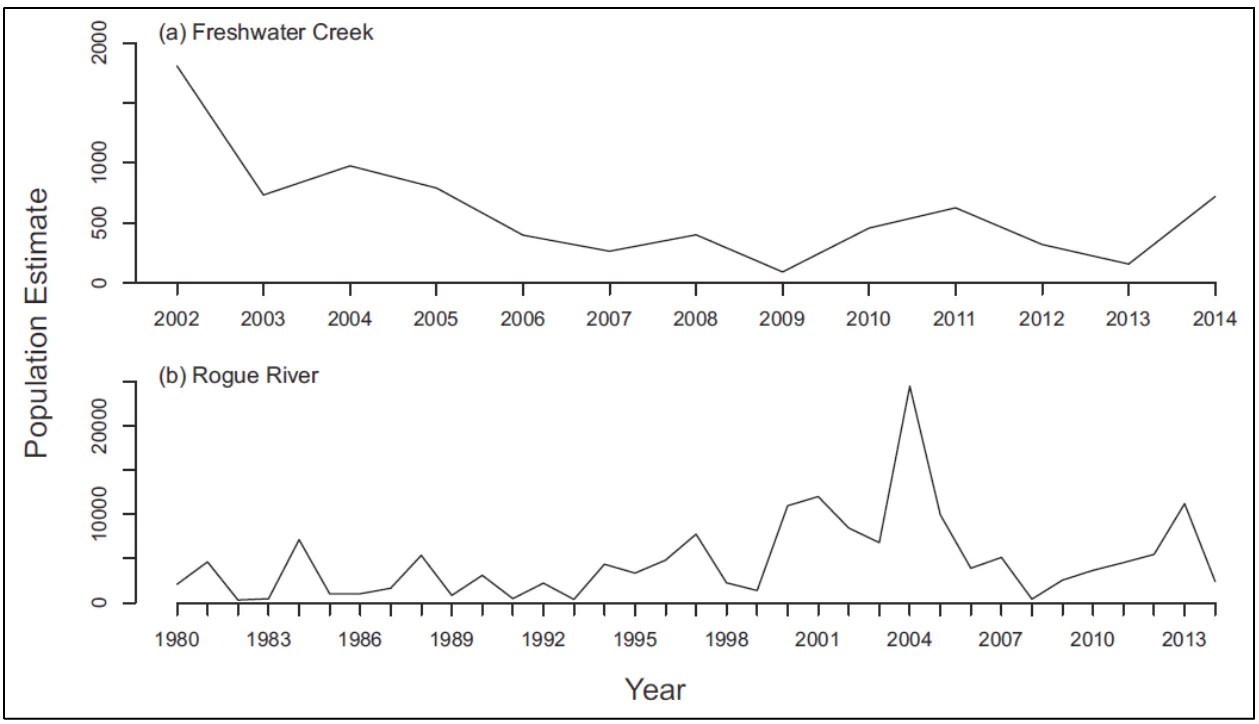

Figure 4. Population estimate for two locations at the sub-population unit scale.

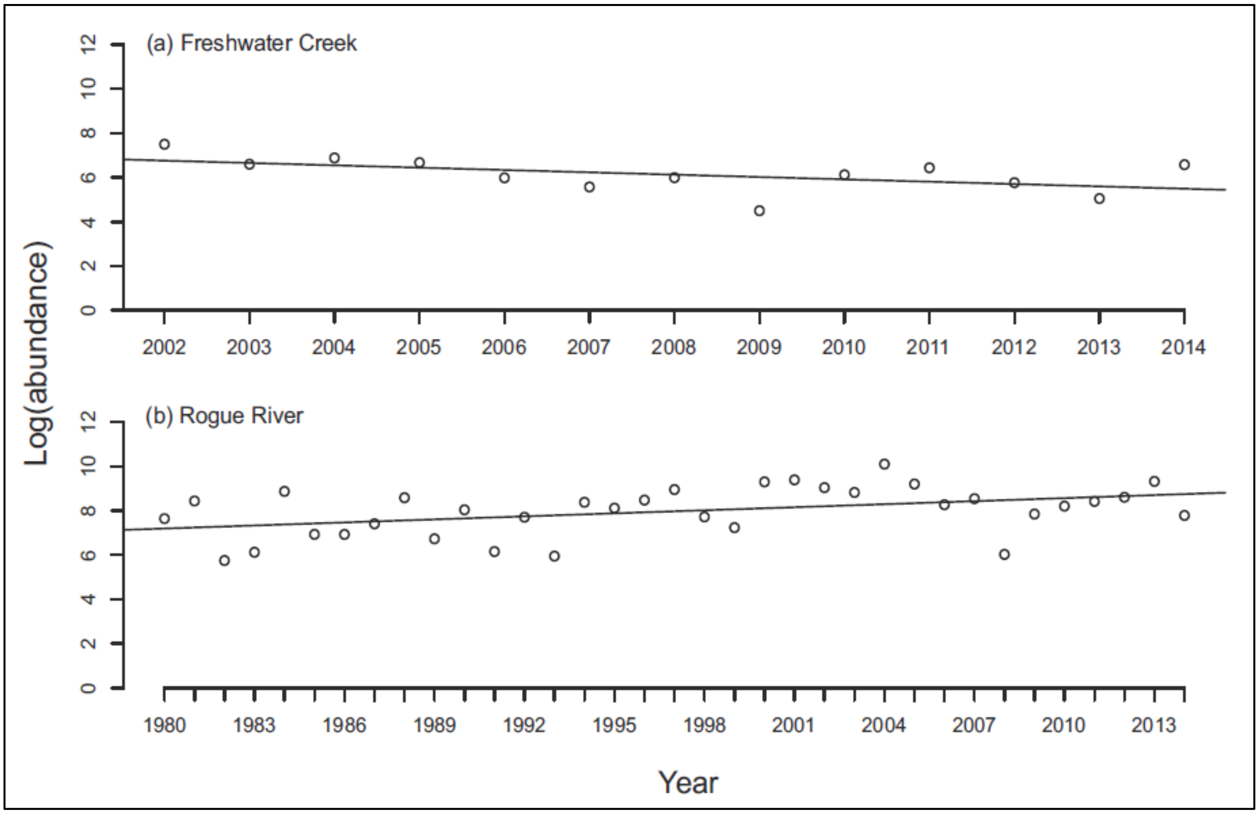

Figure 5. Population trends (log abundance) for two sub-population unit scale locations.

Table 8. Short- and long-term trends in SONCC coho salmon abundance (wild fish) based on partial or composite population estimates and population indices. Trends in bold are significantly different from 0 (α = 0.05).

Spawning tributary (Population)	Years	Data type	Average (range)	$\hat{T}$ (95% CI)	Data sources
Rogue Basin[a]	12	Composite, mark-recapture	6717 (414 - 24509)	-0.074 (-0.262, 0.150)	ODFW – Todd Confer
	35		4764 (314 - 24509)	0.046 (0.011, 0.081)	
Freshwater Creek (Humboldt Bay)	12	Partial pop., weir-carcass mark-	493 (89 - 974)	-0.070 (-0.200, 0.060)	Ricker et al. (2014g)
	13	recapture	594 (89 – 1807)	-0.105 (-0.222, 0.013)	S. Ricker, pers. com.,

a – These estimates are derived from mark-recapture estimates based on returns to Cole River Hatchery expanded by the mark rate observed at Huntley Park. The Oregon Department of Fish and Wildlife staff advises that these data provide a more precise estimate of coho salmon escapement in the Rogue Basin compared to the Huntley expansion method used previously (and in 2010 status review)Data provided by Todd Confer (District Biologist, Oregon Department of Fish and Wildlife, Gold Beach, Oregon).

b - Maximum live/dead counts do not distinguish between natural and hatchery-origin spawners. Counts may include both, particularly in the early part of the time series.

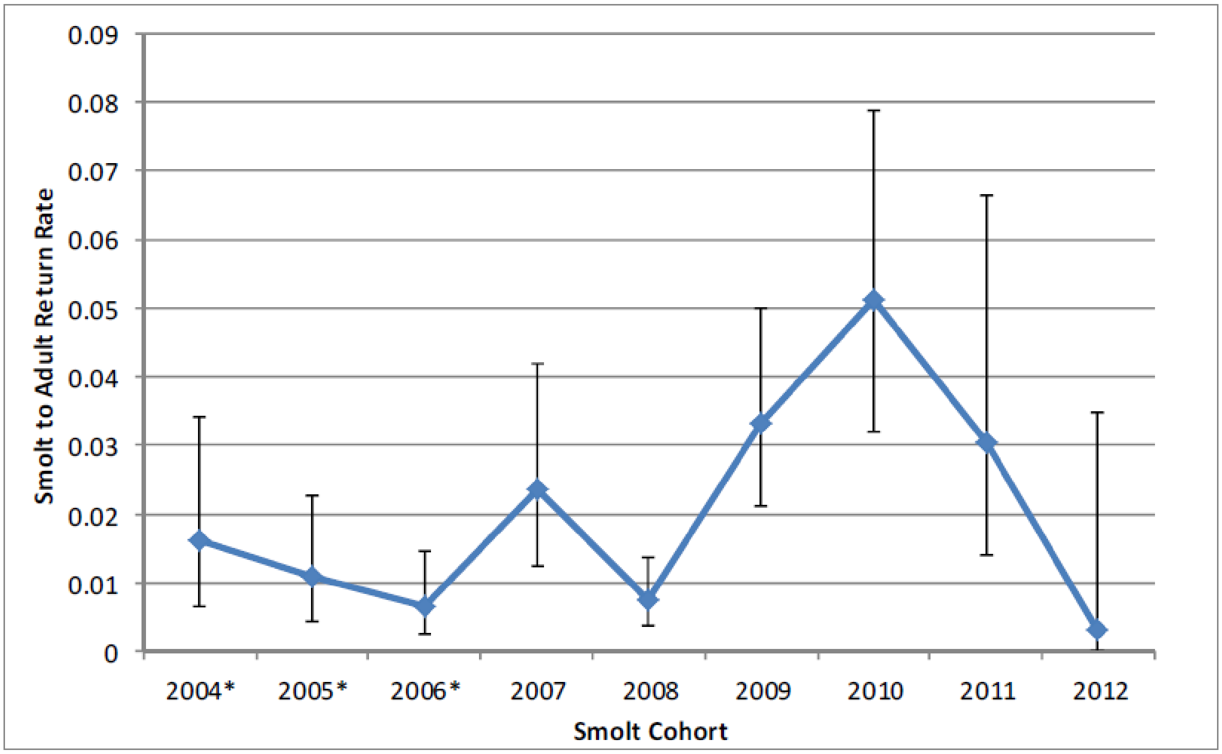

Figure 6. Smolt to Adult Return (SAR) rates and 95% confidence intervals for Freshwater Creek coho salmon smolt cohorts 2004-2012. SAR for smolt cohorts 2004-2006 were estimated using smolts trapped at the Lower Main Stem (LMS) trap site. SAR for smolt cohorts 2007-2012 were estimated using smolts trapped at the Freshwater Weir (HFAC) trap site.

The only estimate available to assess the status of coho salmon in the Oregon portion of the SONCC ESU is from the Rogue River. These estimates are derived from mark-recapture estimates based on returns to Cole River Hatchery, expanded by the mark rate observed at Huntley Park. The Huntley Park seine estimates provide the best overall assessment available of coho salmon spawner abundance in the basin (Good et al. 2005). Four independent populations contribute to this count (Lower Rogue River, Illinois River, Middle Rogue and Applegate rivers, and Upper Rogue River), which has had a significant positive trend ($p = 0.01$) over the past 35 years and a non-significant negative trend ($p > 0.05$) over the past 12 years or four generations (Table 8; Figures 4 and 5).

No extensive and systematic survey of presence of coho salmon has been conducted in the SONCC in the past 10 years. Garwood (2012) developed a list of historical and recent occurrence of coho salmon in the California portion of the SONCC ESU. Garwood (2012) evaluated brood years almost exclusively from 1979 to 2004 and therefore did not include field observations for the most recent three generations. No comparable survey data are available for the period from 2005 to 2014.

In the recovery plan, NMFS also assessed the current extinction risk of each population within the ESU (NMFS 2014). Each population was rated against the abundance biological criteria identified in the recovery plan and assigned an extinction risk (Table 9). Though population-level estimates of abundance for most independent populations are lacking, the best available data indicate that none of the seven diversity strata appears to support a single viable population as defined by the SONCC coho salmon technical recovery team's viability criteria (low extinction risk; Williams et al. 2008). Further, 24 out of 31 independent populations are at high risk of extinction and six are at moderate risk of extinction (Table 9). Since the recovery criteria require that all seven diversity strata be rated as viable, more progress must be made before the SONCC coho salmon ESU can be considered recovered.

Table 9. SONCC coho salmon ESU core and non-core 1 populations and their predicted current risk of extinction based on available information.

Stratum	Population	Estimated Extinction Risk	Depensation Threshold*	Extinction Risk Criteria Used[1]
Northern Coastal Basin	Elk River	High	63	Spawner density
	Lower Rogue River	High	81	Population decline
	Chetco River	High	135	Spawner density
	Winchuck River	High	57	Spawner density
Interior Rogue River	Illinois River	High	590	Population decline
	Middle Rogue/Applegate	High	603	Population decline
	Upper Rogue River	Moderate	689	Spawner density
Central Coastal Basin	Smith River	High	325	Spawner density
	Lower Klamath River	High	205	Spawner density
	Redwood Creek	High	151	Spawner density
	Little River	Moderate	34	Spawner density
	Mad River	High	136	Spawner density
Interior Klamath	Middle Klamath River	Moderate	113	Spawner density
	Upper Klamath River	High	425	Spawner density
	Shasta River	High	144	Spawner density
	Scott River	Moderate	250	Spawner density
	Salmon River	High	114	Spawner density
Interior Trinity	Lower Trinity River	High	112	Spawner density
	South Fork Trinity River	High	242	Spawner density
	Upper Trinity River	Moderate	365	Spawner density
South Coastal Basin	Humboldt Bay tributaries	Moderate	191	Spawner density
	Lower Eel/Van Duzen	High	394	Spawner density
	Mattole River	High	250	Spawner density
Interior Eel	Mainstem Eel River	High	68	Spawner density
	Middle Mainstem Eel River	High	232	Spawner density
	South Fork Eel River	Moderate	464	Spawner density

*Calculated by multiplying the number of IP-km by 1 (Williams et al. 2008 for methodology).

Although long-term data on coho abundance in the SONCC coho salmon ESU are scarce, all evidence from trends since the 2011 assessment (Williams et al. 2011) indicates little change. The two population-unit scale time series for the ESU both have a trend slope not different from zero. The composite estimate for the Rogue Basin populations showed a non-significant negative trend over the past 12 years and a significantly positive trend over the 35 years of the data set (p = 0.01). The continued lack of long-term data (more than 12 years) remains a concern, although the implementation of CMP for California populations thus far is an extremely positive step in the correct direction in terms of providing the information needed to assess and evaluate population and ESU viability. The lack of population spatial scale monitoring sites in Oregon is of great concern and increases the uncertainty when assessing viability. Additionally, many independent populations are likely well below low-risk abundance targets based on the limited data available, and several are likely below the high-risk depensation thresholds specified by the TRT and the Recovery Plan (NMFS 2014). Though population-level estimates of abundance for most independent populations are lacking, it does not appear that any of the seven diversity strata currently supports a single viable population as defined by the TRT's viability criteria, although all diversity strata are occupied.

In addition to the implementation of population monitoring in California through the CMP, the implementation of life cycle monitoring stations is also an extremely positive development that will allow estimation of freshwater and marine survival, calibration of various sampling methods, and provide a platform for support of research needed to refine appropriate conservation and recovery efforts.

2.3.1.1 Summary of previous BRT conclusions

Status reviews by Weitkamp et al. (1995) and Good et al. (2005) concluded that the SONCC coho salmon ESU was likely to become endangered. Risk factors identified in these early status reviews included severe declines from historical run sizes, the apparent frequency of local extinctions, long-term trends that were clearly downward, and degraded freshwater habitat and associated reduction in carrying capacity.

In the most recent viability assessment, Williams et al. (2011) reported that although long-term data on coho salmon abundances in the SONCC-coho salmon ESU were scarce, all evidence from shorter-term research and monitoring efforts indicated that conditions had worsened for populations in this ESU since the review by Good et al. (2005). Williams et al. (2011) concluded that the SONCC-coho salmon ESU was likely to become endangered. The apparent negative trends across the ESU were of great concern, as was the lack of information to determine if there had been improvement in freshwater habitat and survival. However, the negative trends were considered in the context of the apparent low marine survival during the period that likely contributed to the observed declines.

2.3.1.2 Review of TRT documents and findings

The geographic setting of the SONCC coho salmon ESU includes coastal watersheds from Elk River (Oregon) in the north to Mattole River (California) in the south. The ESU is characterized by three large basins and numerous smaller basins across a diverse landscape. The Rogue River and Klamath River extend beyond the Coast Range and include the Cascade Mountains. The Eel River basin also extends well inland, including inland portions at relatively high elevation and portions that experience dryer and warmer summer temperature. The numerous moderate and smaller coastal basins in the ESU experience relatively wet, cool, and temperate conditions that contrast interior sub-basins of the Rogue, Klamath, and Eel basins, which exhibit a range of conditions including snowmelt-driven hydrographs, hot dry summers, and cold winters. The lower portions of these large basins are more similar to the smaller coastal basins in terms of environmental conditions than they are to their interior sub-basins.

The Technical Recovery Team (TRT) for the SONCC coho salmon ESU prepared two documents intended to guide recovery-planning efforts for the ESA-listed coho salmon. The first of these reports described the historical population structure of the ESU (Williams et al. 2006) In general, the historical population structure of coho salmon in the SONCC ESU was characterized by small-to-moderate-sized coastal basins where high quality habitat is in the lower portions of the basin and by three large basins where high quality habitat was located in the lower portions, middle portions of the basins provided little habitat, and the largest amount of habitat was located in the upper portions of the sub-basins. The SONCC TRT categorized populations into one of four distinct types based on its posited historical functional role in the ESU: functionally independent populations, potentially independent populations, dependent populations, and ephemeral populations.

In addition to categorizing individual populations, the population structure report also placed populations into diversity strata, which are groups of populations that likely exhibit genotypic and phenotypic similarity due to exposure to similar environmental conditions or common evolutionary history (Williams et al. 2006). This effort was a prerequisite for development of viability criteria that consider processes and risks operating at spatial scales larger than those of individual populations.

The second TRT report proposes a framework for assessing viability of coho populations in the SONCC coho salmon ESU (Williams et al. 2008)This report established biological viability criteria, from which delisting criteria were developed by a federal recovery planning team (NMFS 2014)These criteria consist of both population-level viability criteria and ESU-level criteria. Application of these criteria requires time series of adult spawner abundance spanning a minimum of four generations for independent populations.

The population viability criteria represent an extension of an approach developed by Allendorf et al. (1997) and include criteria related to population abundance (effective population size), population decline, catastrophic decline, spawner density, and hatchery influence (Table 10). In general, the spawner density low-risk criterion, which seeks to ensure a population’s viability in terms its ability to fulfill its historical functional role within the ESU, is the most conservative. The ESU-level criteria are intended to ensure representation of the diversity within an ESU across much of its historical range, to buffer the ESU against potential catastrophic risks, and to provide sufficient connectivity among populations to maintain long-term demographic and genetic processes. These criteria are summarized in Williams 2015.

Since the TRT developed viability criteria for the SONCC coho salmon ESU, a NMFS recovery planning team has completed the federal recovery plan for SONCC coho salmon (NMFS 2014). This plan includes establishment of population-level and ESU-level recovery criteria for independent populations of SONCC coho salmon. These recovery criteria generally follow the viability criteria developed by the TRT, but may deviate slightly for certain populations based on additional analysis.

Application of recovery and viability criteria requires population-level estimates of adult spawner abundance spanning a minimum of four generations for independent populations (Williams et al. 2008)In reality, for most of the coho salmon populations in this ESU, estimates meeting these criteria are lacking. However, since the mid-2000s, implementation of the Coastal Monitoring Plan (CMP) has greatly expanded, and shorter time series of adult spawner abundance are now available for many populations. In a few other areas, composite estimates of several populations, or estimates representing only a portion of a population, constitute the best available data. These shorter time series, composite estimates, or partial population estimates are presented in those cases where the data collection for these estimates has occurred consistently. However, these data should be viewed with the understanding that they may reflect short-term natural variation in environmental conditions in both the freshwater and marine environments. Year-to-year perturbations in abundance data resulting from short-term changes in the environment are averaged out and put into context when viewing longer data sets.

2.3.2 Five-factor analysis

Section 4(a)(1)(b) of the ESA directs us to determine whether a species is threatened or endangered because of any of the following factors: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or human-made factors affecting its continued existence. Section 4(b)(1)(A) requires us to make listing determinations after conducting a review of the status of the species and taking into account efforts to protect such species. Below we discuss new information relating to each of the five factors as well as efforts being made to protect the species.

2.3.2.1 Listing Factor A: Present or threatened destruction, modification or curtailment of its habitat or range

Significant habitat restoration and protection actions at the Federal, state, tribal, and local levels have been implemented to improve degraded habitat conditions and restore fish passage. While these efforts have been substantial and are expected to benefit the survival and productivity of the targeted populations, we do not have evidence demonstrating that improvements in habitat conditions have led to improvements in population viability. The effectiveness of habitat restoration actions and progress toward meeting the viability criteria should be monitored and evaluated with the aid of newly implemented monitoring and evaluation programs. Generally, it takes one to five decades to demonstrate increases in viability.

Below, we summarize information on the **status and trends in habitat** conditions since our last 2010-2011 status review. We specifically address: (1) the **key emergent or ongoing habitat concerns** (threats or stresses) focusing on the top concerns that potentially have the biggest impact on viability and (2) **key protective measures and major restoration actions** that substantially address an ongoing threat, or that represent a noteworthy conservation strategy.

Key Emergent or Ongoing Habitat Concerns

Insufficient instream flow

The lack of water for summer rearing juveniles has worsened since the previous status review and is a primary factor inhibiting recovery of the ESU. While every life stage of coho salmon requires adequate stream flow, summer rearing juveniles are most vulnerable because stream flows within the ESU naturally reach annual lows during the late summer or early fall due to lack of precipitation. To make matters worse, groundwater and surface water withdrawals to irrigate agricultural crops and serve residences are highest during this period of lowest stream flow, resulting in the potential for significant flow reductions and insufficient flow to support rearing coho salmon.

An increasing contributor to low-flow conditions is the emergence of marijuana cultivation in many important watersheds of the SONCC coho salmon recovery domain. The SONCC domain is dominated by sparsely populated forestland, which along with the area's ideal dry summer growing conditions, have contributed to parts of the California portion becoming the nation's epicenter for outdoor marijuana cultivation. Although the number of plants grown each year in California is unknown, water diversions required to support these plants is placing a high demand on a limited supply of water (Bauer et al. 2015). Most diversions for marijuana cultivation occur at headwater springs and streams, thereby removing the coldest, cleanest water at the most stressful time of the year for coho salmon (Bauer, S., pers. comm. 2013b). Based on an estimate from the medical marijuana industry, each marijuana plant may consume 900 gallons of water per growing season (Humboldt Growers Association [HGA] 2010). Bauer et al. (2015) evaluated four watersheds within the California portion of the SONCC ESU known to support prolific marijuana cultivation and concluded that water demand for marijuana cultivation exceeded streamflow during low-flow periods in three of the watersheds (Figure 7). Water demand data are from a remote sensing exercise using aerial imagery from 2011–2012 and are compared with each year's annual seven-day low flow value for the period of record in each study watershed. Data from water years 1977, 1981, 1987–1989, and 1991–1994 were excluded from Outlet Creek watershed due to seven-day low flow values of zero at the gage. Water demand as a percentage of seven-day low flow would be >100% in these years, but the authors could not determine by how much more.

Measure 91 was approved in November 2014, legalizing recreational cultivation and uses of marijuana in Oregon starting July 1, 2015. Marijuana sales to recreational users from dispensaries started October 1, 2015. As of July 1, 2015, Oregon Health Authority data show 282 grow sites across Oregon serving 11 or more medical marijuana patients – a 129 percent increase since 2012. This was due, in part, to anticipation of recreational marijuana legalization. Similar high rates of marijuana grow expansion are expected in the near future. This expansion will put similar stress on low water levels and high temperatures as seen in California.

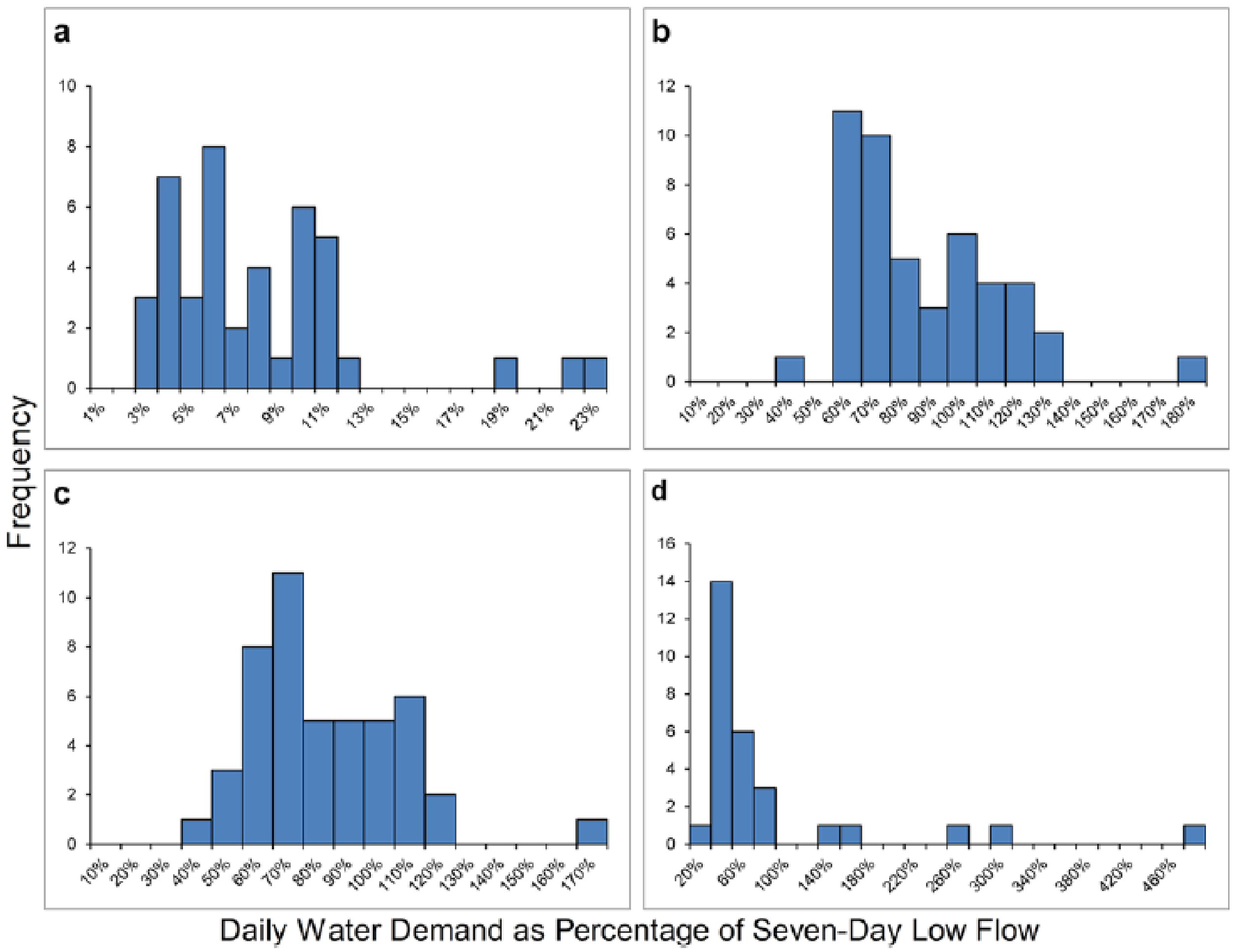

Figure 7. Frequency distribution of the water demand for marijuana cultivation as a percentage of seven-day low flow by year in each study watershed. Source: Bauer et al. 2015. (a) Upper Redwood Creek watershed (USGS gage near Blue Lake, CA, coverage from water year (WY) 1954–1958 and 1973–2014), (b) Salmon Creek watershed (data modeled using USGS gage on Elder Creek, CA, coverage from WY 1968– 2014), (c) Redwood Creek South (data modeled using USGS gage on Elder Creek, CA, coverage from WY 1968–2014), and (d) Outlet Creek (USGS gage near Longvale, CA, coverage from WY 1957–1994).

Reduced flow results in shallower, smaller, and less complex pools where coho salmon juveniles over-summer (May and Lee 2004). Another potential result of low summer flow is loss of hydraulic connectivity in riffles (Magoulick and Kobza 2003), reducing food availability for juvenile salmonids and hence reducing growth rates (Stillwater Sciences and Dietrich 2002, McBain and Trush 2012), increasing likelihood of starvation. With loss of connectivity, fish movement is restricted to single habitat units where they must expend energy to roam for food and become more vulnerable to predation (Magoulick and Kobza 2003).

California and Southern Oregon are in the fourth year of an ongoing and unprecedented drought, which has resulted in record low flows in many watersheds within the ESU. When the amount of available water decreases, such as during a drought, water withdrawals, even if restricted, likely extract a greater percentage of the baseflow compared to non-drought conditions. This increased impact causes an increased stress on coho salmon and other wildlife. The drought is discussed in greater detail under Listing Factor E.

Unsuitable water temperature

Unsuitable water temperature is one of the most widespread and significant stresses in the SONCC coho salmon ESU, and because of the ongoing drought, summer water temperatures likely increased since the last status review. Coho salmon rely on cool thermal refugia to survive hot summers in the predominantly warm and dry summer climate that characterizes much of the ESU. Water temperature tends to increase as discharge drops synchronously with warming air temperatures, reducing the availability of cool thermal refugia. Coho salmon can survive at high daily maximum temperatures if (1) high quality food is abundant, (2) thermal refugia are available, and (3) competitors or predators are few (NRC 2004).

Water temperature influences coho salmon growth and feeding rates (partly through increased metabolism) and development of embryos and alevins (McCullough 1999), as well as timing of life-history events such as freshwater rearing, seaward migration (Holtby and Scrivener 1989), upstream migration and spawning (Spence et al. 1996). Increased water temperature can be detrimental to the survival of most life stages of coho salmon, but in the SONCC coho salmon ESU summer-rearing juveniles are the most likely to be affected by elevated water temperatures. Elevated water temperature can result in increased levels of stress hormones in coho salmon, often resulting in mortality (Ligon et al. 1999). Increased water temperature, even at sub-lethal levels can inhibit migration, reduce growth, stress fish, reduce reproductive success, inhibit smoltification, contribute to outbreaks of disease, and alter competitive dominance (Elliott 1981). Increases in water temperature may result from changes in the quantity and quality of riparian vegetation, the presence of dams, water diversions, other anthropogenic activities, and have also been correlated to large-scale (or localized) climate change and precipitation. Additionally, threats including timber harvest, urbanization, roads, and other land use activities affect water temperatures within the SONCC coho ESU.

Based on a review of available data, NMFS concluded that impaired water quality is either a high or a very high stress in 27 out of 40 populations in the SONCC coho salmon ESU. The U.S. Environmental Protection Agency (EPA) has recognized 21 watersheds in the ESU as impaired for temperature. Total Maximum Daily Loads have been established or are in progress for these watersheds.

Insufficient winter- and summer-rearing habitat

The paucity of both instream and off-channel habitat in freshwater and the stream-estuary ecotone is an ongoing concern. Rearing coho salmon require pools of cool water to survive the warm summer months, and low-velocity off-channel areas during the winter to avoid being swept downstream during high flows. The lack of both summer- and winter-rearing habitat was identified as one of the key stresses to this species (NMFS 2014).

Many streams within the SONCC ESU remain straightened, diked, and leveed, which results in unsuitable rearing habitat for coho salmon. Channel simplification causes indirect changes in the timing of peak flows, increases in the frequency of scour events, and changes in the movement of sediment through the system (IMST 2002). During winter, juvenile coho salmon select habitats with low water velocity such as alcoves, side channels, backwaters, beaver ponds, riverine ponds, and deep rootwad-formed pools. These habitats provide cover from predators and protection from high discharge, factors that may cause emigration and mortality of overwintering salmonids (Bell et al. 2001).

A significant contributor to lack of floodplain and channel structure in the SONCC coho salmon ESU is a paucity of instream large wood. Coho salmon juveniles favor pools that contain shelter provided by large wood (Reeves et al. 1989). Past and current timber harvest practices have degraded riparian forests across the SONCC coho salmon ESU, decreasing the number of large conifers in riparian zones, and reducing the potential for recruitment of long-lasting large wood (Sedell et al. 1988, Benda and Bigelow 2014). Hardwood trees like alder and willow are now the most abundant species in many riparian zones (Roni et al. 2002). These hardwood species do not provide long lasting large wood for channel forming processes (Cederholm et al. 1997) and their maximum potential size, and therefore stability, is much smaller than conifers. Early accounts of Pacific Northwest streams described prolific accumulations of wood in rivers and streams that settlers then cleared to facilitate movement of boats and logs during the late 1800s and early 1900s (Collins and Montgomery 2002). Then, during the 1950s, 1960s, and into the 1970s, fishery managers and biologists further removed large wood from streams, fearing it restricted fish passage and led to log jams and bank erosion (Sedell et al. 1988, Gallagher et al. 2012). As a result, the amount of large wood in streams is currently far lower than historical levels, resulting in a reduced capacity of stream habitats to support coho salmon.

The historical decline in beaver (Castor canadensis) populations has also contributed to lack of floodplain and channel structure. Although still much reduced from pre-trapping levels, beaver populations have rebounded somewhat since the end of the era of intensive trapping. Recent studies in the Lower Klamath, Middle Klamath, and Shasta sub-basins confirm that beaver ponds provide high quality summer and winter rearing habitat for coho salmon (Chesney et al. 2009, Silloway 2010). In addition to creating off channel habitat for juvenile coho salmon, beaver ponds can raise the water table, store spring runoff for late season release into streams (Parker 1986) and cool the water downstream of the beaver dams (Pollock et al. 2003). Beaver ponds have been shown to expand riparian forests (Pollock et al. 2007) and decrease erosive perturbation (Parker 1986). Beaver ponds slow high velocity stream flows and trap sediment behind their dams, which speeds up the recovery rate of down-cut stream channels and reduces turbidity downstream (Naiman et al 1988).

Key Protective Measures and Major Restoration Actions

PacifiCorp HCP

In February 2012, NMFS issued an Incidental Take Permit (NMFS 2012a) for PacifiCorp's implementation of a Habitat Conservation Plan (HCP) to minimize and mitigate for the interim operations of PacifiCorp's Klamath Hydroelectric Project on the mainstem Klamath River. The HCP's Coho Salmon Conservation Strategy was designed to enhance the viability of the Upper

Klamath coho salmon population; enhance coho salmon spawning habitat and instream flow conditions, and water quality downstream of Iron Gate Dam; reduce disease incidence and mortality in juvenile coho salmon downstream of Iron Gate Dam; enhance migratory and rearing habitat for coho salmon in the Klamath River mainstem corridor; and enhance and expand rearing habitat for coho salmon in key tributaries. All coho salmon populations in the Klamath basin will benefit from this strategy.

California's Forest Practices Act Road Rules

New rules for managing timber harvest on certain private lands were adopted in 2012. These rules have resulted in expanded stream-buffer widths, less damaging road and harvesting techniques, and limits on riparian harvesting that will collectively improve instream and riparian habitat and function over the long-term.

California's Groundwater Sustainability Management Act

The Groundwater Sustainability Management Act (GSMA) was signed into law in October 2014. This law, for the first time in California history, regulates and manages the state's groundwater resources to ensure sustainability of the resource. Environmental beneficial uses, including cold-water fisheries, are to be considered when balancing competing uses for an aquifer's safe yield, which suggests that minimizing groundwater pumping impacts on streamflow will be an integral part of future groundwater management. Unfortunately, the GSMA slowly phases in the new regulatory scheme (e.g., over drafted groundwater basins have 40 years to achieve a sustainable state), suggesting that meaningful streamflow improvement resulting from the act may be decades in the future.

Oregon's Integrated Water Resource Strategy

Initiated in 2012 (OWRD 2012), Oregon's integrated water resource strategy is intended to provide answers to the following questions posed by the Oregon Legislature: What is the current state of Oregon's water supply relative to its needs, and what must Oregon do to ensure that sustainable supplies of clean and abundant water are available to meet future instream and out-of-stream needs? Through this new program, the state of Oregon will gain a better understanding of instream flows and flow needs, which may lead to enhanced water management.

Dam removals on the Rogue River

Two dams were removed on Evans Creek, a tributary to the Rogue River, during summer 2015 (NMFS 2015b). Wimer and Fielder Dams were abandoned irrigation diversion dams that significantly hindered fish passage for migrating salmon attempting to reach high quality habitat upstream. The dams' fish ladders did not accommodate juvenile salmonid movement or adult upstream passage under low flow conditions. The removal significantly improved passage to 60 miles of coho salmon habitat. This habitat will support spawning and rearing and contains off-channel refugia.

Restoration projects

Between 2004 and 2012, the state of California's Fisheries Restoration Grants Program (FRGP), which is primarily funded through the Pacific Coast Salmon Recovery Fund (PCSRF), expended approximately $100 million on coho salmon recovery projects in California in the range of both SONCC coho salmon and Central California Coast coho salmon. Four hundred and thirty three projects were funded (CDFW 2015). The main types of projects funded, and the metrics for the results of those projects, are described in Table 10. Sixty seven percent of these projects occurred in the SONCC coho salmon domain. These projects were carried out by a number of entities, which included the State of California's Department of Fish and Wildlife (especially for monitoring projects), other state agencies, Federal agencies including the U.S. Forest Service and NOAA Fisheries, tribes, non-governmental organizations, non-profit groups, private landowners, and private timber companies.

Table 10. Types of habitat restoration projects funded through the FRGP program from 2004 through 2012, with metrics. Source: CDFW 2015.

Project Type	Metric	Quantity
Fish Passage Improvement	Number blockages removed	118
Fish Passage Improvement	Miles of stream opened	209
Fish Screening Projects	Number fish screens installed/replaced	92
Instream Habitat Improvement	Total miles of stream treated	223
Riparian Habitat Improvement	Miles of riparian bank treated	149
Riparian Habitat Improvement	Acres of riparian area treated	1,467
Upland Habitat Improvement	Miles of road treated	462
Monitoring	Miles of stream monitored	1,578
Organizational Support	Number watershed assessment plans/assessments completed	196

Between 2011 and 2013, the total funding for watershed restoration projects in Oregon exceeded $154 million. Between 2013 and 2014, the state of Oregon's Watershed Enhancement Board (OWEB) invested more than 77 million dollars and leveraged over 52 million in matching funds to support activities related to restoration of watersheds in Oregon. From 2013 to 2015, the total funding for watershed restoration projects in Oregon totaled to $129 million. These totals include grant funds awarded through OWEB and other contributions from partner organizations. Partners include landowners, non-profit organization, local businesses, individuals, and all levels of government. Watershed metrics for completed projects during the periods 2011-2011 and 2012-2013 are presented in Table 11. Many of these projects benefited SONCC coho salmon, but the metrics specifically for the SONCC range are unknown.

Table 11. Watershed metrics from completed projects reported to the Oregon Watershed Restoration Inventory (OWRI) in 2010-2011 and 2012-2013. Sources: OWEB 2012 and 2014.

		Quantity	
Project Type	**Metric**	**2010-2011 (Total)**	**2012-2013 (Total)**
Riparian Habitat Improvement	Riparian stream miles treated	811	436
Riparian Habitat Improvement	Miles of instream habitat treated	202	178
Riparian Habitat Improvement	Wetlands acres treated/created	4,374	3,440
Upland Habitat restoration	Miles of road closed and decommissioned	31	35
Upland Habitat Restoration	Miles of roads improved	64	110
Upland Habitat Improvement	Upland acres treated	173,999	124,588
Fish Passage Improvement	Number of stream crossings improved	152	216
Fish Passage Improvement	Miles made accessible to fish due to stream crossing improvements	356	237
Fish Passage Improvement	Number of push-up dams retired	31	8
Fish Screening Projects	Number of fish screens installed on diversions	124	127
Monitoring	Miles of stream monitored	7,161	N/A
Organizational Support	Number of volunteer hours	70,577	42,146

Listing Factor A Conclusion

Water diversions in coho salmon tributaries during the most stressful season of the year have likely increased significantly since the last status review, and there is no indication that the threat will diminish in the foreseeable future. Because sufficient, cool flow is paramount to coho salmon survival, we conclude that the risk to the species' persistence resulting from habitat destruction and modification has increased since the last status review. Habitat concerns remain throughout the range of this ESU particularly in regards to water quality, water quantity, and rearing habitat. Restoration actions and regulatory changes since the last status review indicate some improvements have been made to freshwater and estuary habitat conditions in the ESU; but there is a great need for additional habitat restoration or protection. Based on the status of the populations and habitat throughout the ESU, numerous significant habitat protection and restoration actions will be necessary to bring this ESU to viable status.

2.3.2.2 Listing Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

Commercial and recreational harvest

Southern Oregon/Northern California Coast (SONCC) coho are primarily distributed off the coast of California and southern Oregon. Because coho-directed fisheries and coho retention have been prohibited off the coast of California since 1996, the SONCC coho ocean exploitation rate is generally low and attributable to non-retention impacts in California and Oregon Chinook-directed fisheries, impacts in Oregon mark-selective coho fisheries (primarily non-retention), and impacts in Oregon non-mark selective fisheries.

Natural-origin Rogue/Klamath coho salmon ocean exploitation rates have been estimated for years 1986-2014 using backward runs of the Fishery Regulation Assessment Model (FRAM) (L. LaVoy and R. Kope, NMFS, personal communication, March 30, 2015)These estimates are the best available measure of the ocean exploitation rate for SONCC coho salmon. This rate has been low and relatively stable since the mid-1990s (average of 5.3% for years 1994-2014), which contrasts sharply with the much higher rates estimated for the 1980s and early 1990s (average of 50.8% between 1986 and 1993) (Figure 8).

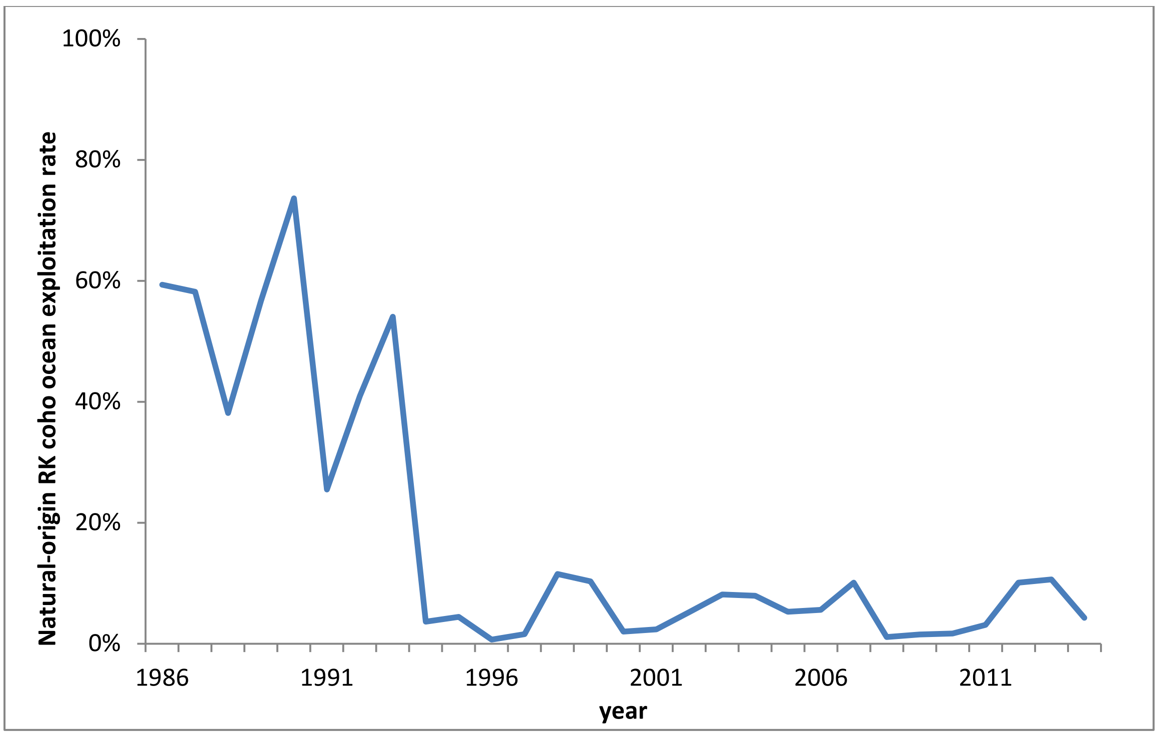

Figure 8. Natural-origin Rogue/Klamath (RK) coho salmon ocean exploitation rate estimates for years 1986-2014 (L. LaVoy and R. Kope, personal communication).

Freshwater recreational fishery impacts on SONCC coho are likely relatively low given California's statewide prohibition of coho retention, and normally only mark-selective coho retention in the Oregon portion of this ESU. Klamath basin tribes (Yurok, Hoopa, and Karuk) currently harvest a relatively small number of coho salmon for subsistence and ceremonial purposes (CDFG 2002)The Yurok fishery estimated harvest rate averaged 3.4% for the 1994–2014 period, and 2.3% for the 2011–2014 period (Yurok Tribal Fisheries 2015)The harvest rates reported in Yurok Tribal Fisheries (2015) are likely biased high because little escapement and harvest monitoring occur in the Klamath Basin, precluding a complete estimate of run size. Harvest rate estimates for the other two tribal fisheries are not available.

In summary, the available information indicates that the level of SONCC coho fishery impacts has not changed appreciably since the 2010 salmon and steelhead status review update (NMFS 2011).

Research and monitoring

The quantity of take of SONCC coho salmon authorized under ESA sections 10(a)(1)(A) and 4(d) for scientific research and monitoring remains low. The reported percent mortality for SONCC for the 2009-2014 California research programs was 0% , and 0.73% for natural juveniles. The percent mortality being authorized for the present five-year period is 0.03% for adults, and 0.11% for juveniles. We expect actual report mortality levels to be lower than authorized (NMFS 2015 – CA 4(d) Biop WCR-2015-3876).

Listing Factor B Conclusion

New information available since the last ESA status review indicates harvest impacts have remained relatively similar to those observed in the previous five years. We therefore conclude that the risk to the species' persistence because of overutilization remains essentially unchanged since the last status review.

2.3.2.1 Listing Factor C: Disease or predation

Disease

Ceratomyxosis, which is caused by C. shasta, has been identified as one of the most significant diseases for juvenile salmon due to its prevalence and impacts in the Klamath Basin (Nichols et al. 2003). Severe infection of juvenile coho salmon by C. shasta may contribute to declining adult coho salmon returns in the Klamath basin (Foott et al. 2010). Foott et al. (1999) found that when water temperatures are under 17 °C, Klamath River salmonids appear to be more resistant to ceratomyxosis. The risk of mortality from ceratomyxosis was lowest as water temperatures increased from 13 to 15 °C, and was greatest as temperatures increased from 18 to 21 °C (Ray et al. 2012). Given the drought conditions that have persisted for the last four years and associated high water temperatures (Section 2.3.2.3), the risk from ceratomyxosis has likely been higher in the last five years than in the previous five years.

Non-native species

The non-native Sacramento pikeminnow is observed throughout the Eel River basin and is a predator that impedes coho salmon recovery (Yoshiyama and Moyle 2010). No significant eradication efforts have been undertaken since the last status review. Pikeminnow were documented in Humboldt Bay in 2008 and 2011 (M. Wallace, CDFG, personal communication 2011). The Umpqua pikeminnow, a non-native species that preys upon coho salmon, is widespread in Rogue basin streams with warm water temperature and low gradient. High water temperatures associated with the drought (Section 2.3.2.3) likely created conditions that were more favorable for both Sacramento and Umpqua pikeminnow during the last four years.

Listing Factor C Conclusion

In summary, the impacts of C. shasta infection and of Sacramento and Umpqua pikeminnow have likely increased in the last four years due to drought effects on water temperature and fish distribution.

2.3.2.2 Listing Factor D: Inadequacy of existing regulatory mechanisms

State forest practices

A review of Oregon's Forest Practice Rules (IMST 1999) showed the regulations in place may be ineffective at protecting water quality and promoting riparian function and structure and the strategies are insufficient for recovering habitat of listed salmonids. The Oregon Rules represent the least conservative forest practice regulations administered by the state governments within the range of SONCC coho salmon. In a 2010 status review of Oregon Coast (OC) coho salmon, NMFS concluded that the Oregon Forest Practices Act does not adequately protect OC coho in all circumstances. In particular, disagreements persist regarding (1) whether the widths of riparian management areas (RMAs) are sufficient to fully protect riparian functions and stream habitats; (2) whether operations allowed within RMAs will degrade stream habitats; (3) operations on high-risk landslide sites; and (4) watershed-scale effects.

In 2015, NOAA and the Environmental Protection Agency determined that the state of Oregon had not submitted a fully approvable Coastal Nonpoint Control Program as required by section 6217(a) of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA), 16 U.S.C. 1455b. This finding was made because the state has not adopted additional forestry management measures needed to achieve and maintain applicable water quality standards and protect designated uses under Clean Water Act section 303. Management measures are needed to protect riparian areas for medium-size and small fish-bearing and non-fish-bearing streams, address the impacts of forest roads (particularly legacy roads), protect high-risk landslide areas, and ensure adequate stream buffers for the application of herbicides. Based on this information, the regulatory mechanisms associated with state-regulated forestry in Oregon are currently inadequate for maintaining suitable water quality.

Forest practice rules (FPRs) (CDFFP 2013) regulate management of non-Federal timberlands in California, and the governor-appointed Board of Forestry (BOF) promulgates these rules. Because of the abundance of private timberland and timber harvest activity in the SONCC coho salmon ESU domain, the FPRs are critically important for the species conservation. NMFS staff have actively engaged and participated in BOF meetings and expressed concern to the BOF that the current rules, while resulting in some improvements to riparian protections, will not adequately protect anadromous salmonids until several inadequacies in the FPRs are addressed. Specifically, NMFS believes that take of listed salmonids associated with timber harvest operations in California could be minimized (but not entirely avoided) if the following additional protections were added to the existing ASP rules: (1) provide Class II-S (standard) streams with the same protections afforded Class II-L (large) streams, (2) include provisions to ensure hydrologic disconnection between logging roads and streams, and (3) include provisions to avoid hauling logs on hydrologically connected streams during winter periods. In addition, NMFS believes the use of scientific guidance will provide additional limitations in the rate of timber harvest in watersheds to avoid cumulative impacts of multiple harvests, and provide greater protections to ensure the integrity of high gradient slopes and unstable areas. This may include limiting the areal extent of harvest in such areas. NMFS is working collaboratively with the BOF to limit the effects of forestry operations on threatened and endangered salmonid populations. At this time, however, the effects of past and present timber harvest activities in California continue to be an ongoing threat to the SONCC coho salmon ESU.

State agricultural regulations

The Oregon Department of Agriculture completed guidance for development of agricultural water quality management plans (AWQMPs) (as enacted by State Senate Bill 1010) at the time of federal listing. Plans that were consistent with this guidance were assumed to achieve the water quality standards of the state. However, despite completion of numerous AWQMPs, the state's water quality standards are still unmet. For example, monitoring in the Rogue River Basin has revealed unsuitable levels of E. coli, turbidity, and dissolved oxygen in recent years (ODA 2009). Accordingly, it appears that AWQMPs are not likely to be improving habitat conditions for coho salmon. The Oregon Department of Environmental Quality reported that the AWQMPs are not effective due to a lack of awareness that the plans exist, and resistance from municipalities to take the plans and rules seriously when developing land use laws (ODEQ 2009). The ability of AWQMPs to improve water quality will depend on public outreach efforts and the manner in which the plans are implemented.

In 2013, NOAA and EPA expressed concerns with the approvability of the state of Oregon's agricultural management measures and invited public comment (NOAA and EPA 2013). The agencies are concerned that water quality impairments from agricultural activities are widespread, and that the state may not be effectively implementing and enforcing its agricultural water quality management area plans (AWQMAPs) program. These concerns are supported by recent studies such as NMFS recent listings for Oregon Coast coho salmon and draft recovery plans for coho salmon that find insufficient riparian buffers around agricultural activities are one of the contributors to coho salmon decline. Due to these reasons, NMFS believes the regulatory mechanisms associated with state-regulated agriculture are currently inadequate. No determination has been made on the approval of the state of Oregon's agricultural management measures.

The State of California does not have regulations that directly manage agricultural practices, but relies on TMDLs developed under the CWA to improve water quality from all sources and parties. Numerous streams throughout the range of this ESU that are currently impacted by agricultural practices do not have TMDLs (NCRWQCB 2010) and many are not scheduled for completion until 2019. In the long term, we expect that TMDLs will be able to protect SONCC coho salmon and their habitat in California. Ultimately, their effectiveness in protecting coho salmon will depend on how well the protective measures are implemented, monitored, and enforced.

Overall, the effects of inadequate agricultural regulations remain a threat to the SONCC coho salmon ESU.

Water quality programs

At the time of the 1997 listing, NMFS identified limitations regarding the development of TMDLs for many 303(d) listed water bodies (62 FR 24588). The State water quality agencies and the EPA administers the CWA and are required to develop TMDLs for water bodies that are identified as impaired on the 303(d) list. Twenty-four TMDLs have been completed in the range of the SONCC ESU. Although TMDLs are expected to be effective long term, they are difficult to implement quickly and their efficacy in protecting coho salmon habitat will be unknown for years to come.

At the time of the original listing in 1997 (62 FR 24588), agricultural practices were identified as a threat to the SONCC coho salmon ESU. Since the listing, a number of agricultural water quality management plans (AWQMPs) have been completed in southern Oregon. NMFS hoped that implementation of AWQMPs would achieve state water quality standards. However, despite completion of numerous AWQMPs, the state’s water quality standards are still unmet. In California, Regional Water Quality Control Boards regulate water quality through their Total Maximum Daily Load (TMDL) program and permit waiver programs for agricultural runoff. TMDLs have been completed for many northern California watersheds, but the water quality impairments remain on the Clean Water Act’s (CWA) 303d list.

The regulatory mechanisms for addressing water quality remain a threat because most TMDLs have no implementation plan, hindering efforts to improve the water quality conditions.

Beavers

Regulations are currently inadequate for retaining beavers on landscapes where they can provide critical rearing habitat for SONCC coho salmon by backing up water to form slow water habitat and off-channel rearing areas. In Oregon, beavers on private lands are classified as a predatory species under current statutes, which allow private landowners to destroy beavers and their habitat without notification to state agencies. On public lands, beavers are classified as protected furbearers, a designation that requires purchase of a license prior to taking an unlimited amount. In California, CDFW issues depredation permits to private landowners to destroy problematic beavers, and allows recreational trapping of beavers (no bag or possession limit) in Del Norte, Humboldt, Siskiyou, and Trinity counties.

Regulatory improvements

Aquatic life criteria for contaminants

Because of a 2012 biological opinion, EPA has coordinated with NMFS to derive new recommended aquatic life criteria for copper, ammonia, cadmium, and aluminum that avoid jeopardizing the existence of the numerous salmon and steelhead ESUs and DPSs, including the SONCC coho salmon ESU. DEQ has revised Oregon Administrative Rules (Table 30 under OAR 340-041-8033) to match the EPA recommendations for the contaminants except copper. The copper criteria require running the EPA's biotic ligand model, which requires information not currently available. Because new NPDES permits include the current aquatic life criteria, the amounts of these toxics in the aquatic environment are likely slowly decreasing.

Contaminants from impervious surfaces

Contaminants from proposed actions that include impervious surfaces (roads, parking lots, and buildings) have been minimized by individual biological opinions and the SLOPES Stormwater, Transportation, and Utility programmatic opinion. These consultations result in project design requirements for efficiency of treatment systems and their maintenance and monitoring. As these actions are implemented, concentrations of contaminants in the aquatic systems will decrease.

Coho HELP Act

The Coho Habitat Enhancement Leading to Preservation Act, or Coho HELP Act, was adopted by CDFW in 2013. This Act applies to projects designed to remediate barriers to fish passage, bank stabilization, bank development, and live wood complexity, and creating or enhancing fish habitat, increasing stream complexity, or both (CDFW 2013). Permitting for these types of habitat restoration projects is streamlined, allowing these actions to be carried out more quickly.

Suction dredge mining restrictions

As part of Oregon Senate Bill 838, between 2014 and 2016, a cap was established on the number of authorizations for suction dredge mining. Beginning in 2016, a five-year moratorium on suction dredge mining will go into effect (ODSL 2013).

Temporary fishing closures

The state of California adopted an emergency regulation that created a process for temporarily closing rivers to fishing in 2015 (California Fish and Game Commission 2015). Closures could go into effect if fish populations in those rivers are at risk due to drought conditions leading to poor water quality or impaired fish passage, or if the adult breeding population level is estimated to be below 500 individuals.

Iron Gate HGMP

On October 31, 2014, NMFS authorized take of listed coho salmon associated with implementation of the Hatchery Genetic Management Plan for the coho salmon program at Iron Gate Hatchery. The goal of operation of this hatchery was once mitigation, but is now to protect and conserve coho salmon genetic resources in the Upper Klamath River. Broodstock pairings will be based on real-time genetic assessment, and operators will use up to 50% natural-origin fish in the broodstock.

Regulation of marijuana cultivation

Recent developments offer promise in the effort to minimize the environmental impacts of marijuana cultivation in California, an industry made up of both legal and illicit operators that has expanded exponentially during the past decade. The North Coast Regional Water Quality Control Board (NCRWQCB) is currently soliciting public comment regarding a proposed waste discharge waiver for state-legal medicinal marijuana cultivation that would manage waste discharge into surface water bodies in a manner similar to other agricultural industries in the state, such as vineyards and grazing. All growers regulated under the waiver program will be required to implement specific Best Management Practices identified by the NCRWQCB, with program compliance verified either through self-reporting (for the smaller farms) to inspection by state agency personnel for larger operations. While the marijuana cultivation waste discharge waiver shows promise toward minimizing water quality-related impacts resulting from marijuana cultivation, the realized benefit may be smaller than anticipated due to the suspected large number of illegal grows (i.e., not for medicinal uses, but for black market sales) and the low likelihood that criminal operators will voluntarily register with a state agency.

Another state development that shows much stronger potential in minimizing marijuana cultivation impacts to the environment is the Medical Marijuana Regulation and Safety Act, which was signed into law in October 2015This new law established a state-controlled regulatory and enforcement program that will control the permitting, regulation, and taxing of the medical marijuana industry. However, the ability of the state to enforce the law and clean up environmental damage from illegal grows was seriously hampered when a tax provision that would have allotted $60 million toward those efforts was stripped from the bills at the last moment. Bolstering the staffs of the state agencies in charge of enforcement (i.e., CDFW and NCRWQCB) is imperative toward the bill’s success, and this issue should be amended in the future to restore enforcement-related funding sources.

Listing Factor D Conclusion

We conclude that the risk to the species’ persistence has decreased slightly based on the improved adequacy of existing regulatory mechanisms noted above. However, many ongoing threats to coho salmon habitat could be ameliorated by strengthening and enforcing existing regulatory mechanisms.

2.3.2.3 Listing Factor E: Other natural or manmade factors affecting its continued existence

Four consecutive years of drought and the past two years of exceptionally high air, stream, and upper ocean temperatures have together likely had negative impacts on the freshwater, estuary, and marine phases for many populations of Chinook and coho salmon and steelhead.

Drought

California has experienced well below average precipitation in each of the past four water years

(2012, 2013, 2014 and 2015), record high surface air temperatures the past 2 water years (2014 and 2015), and record low snowpack in 2015Some paleoclimate reconstructions suggest that the current four-year drought is the most extreme in the past 500 or perhaps more than 1000 years. Anomalously high surface temperatures have made this a “hot drought,” in which high surface temperatures substantially amplified annual water deficits during the period of below average precipitation. Since 2011 summer baseflow has been significantly lower than normal, and the spring recession to low summer baseflow has been happening earlier in the year (Figure 9). The outcome is stressful habitat conditions for coho salmon for a longer period of time, which likely resulted in decreased survival.

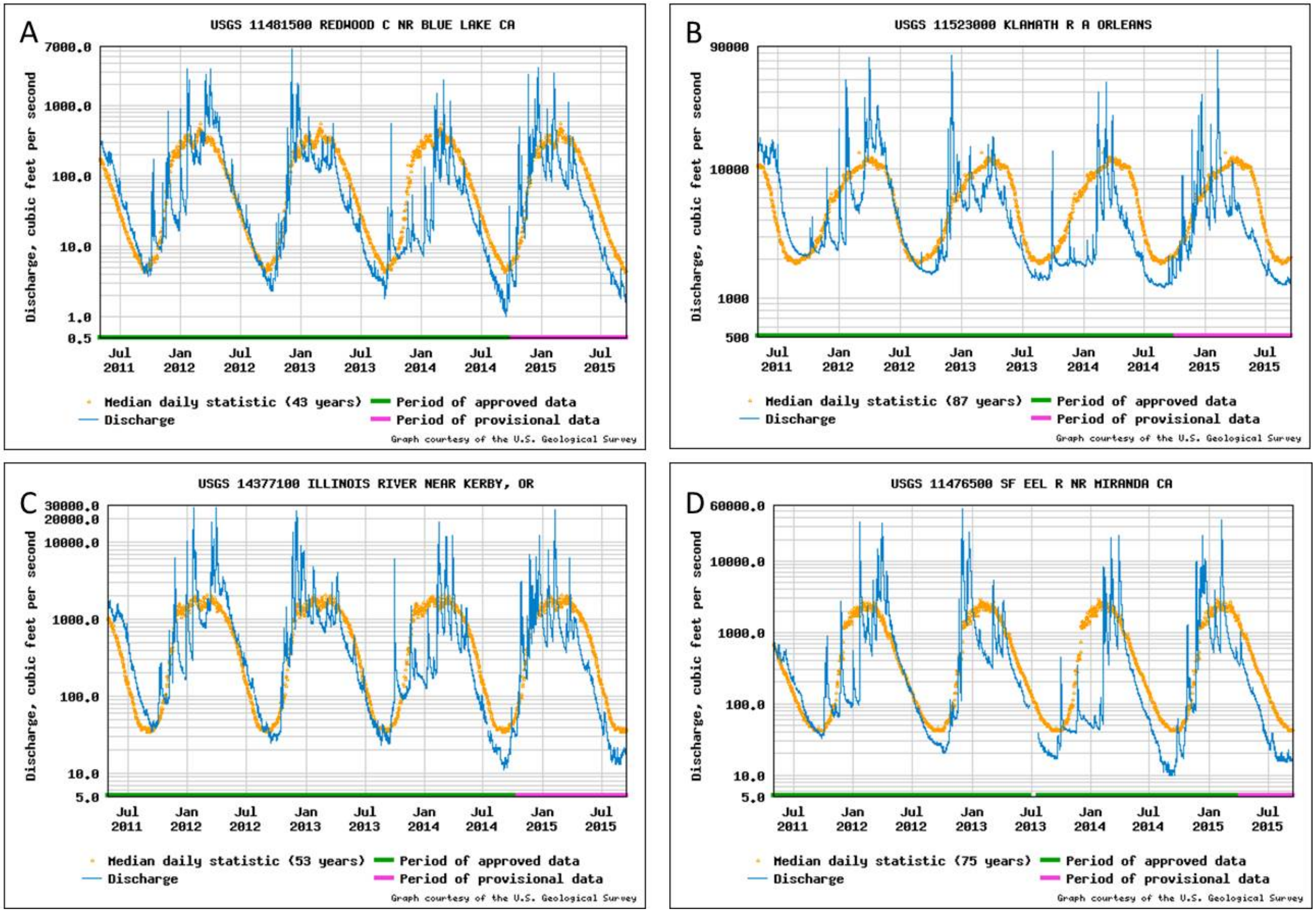

Figure 9: Discharge (cubic feet per second) (blue) observed from June 15, 2011 to September 15, 2015, and median daily discharge for period of record (orange), observed at four gauges: A) Mad River near Blue Lake, CA, B) Klamath River in Orleans, C) Illinois River near Kerby, OR, and D) South Fork Eel River near Miranda, CA. Source: USGS National Water Information System Web Interface (http://waterdata.usgs.gov/), accessed 9/18/2015.

One indicator of drought conditions is snowpack and reservoir storage. Snowpack and reservoir storage in California were much lower in 2014 than they were in 2010 (Figure 10), which preceded the start of the drought. Snowpack and reservoir storage are a critical source of water to streams during spring and summer months with little to no rain. The amount of water in many inland streams is limited by some combination of snowpack, reservoir storage, and precipitation. The average rainfall from 2011 to 2014 has been the lowest of any three-year period in the period since 1960 (Figure 11). Individually, 2014 and 2015 have been two of the five driest years on record since 1960 (J. Montesi, NMFS hydrologist, pers. comm. 10/1/15). Water levels at gages reflect ongoing drought conditions. On September 15, 2015, water levels at seven of thirteen water gages in the California range of SONCC coho salmon were at 25% to 75% of historical median levels (Figure 12). An additional three gages were at 10% to 24% of historical median levels, and two gages were at less than 10% of historical median levels.

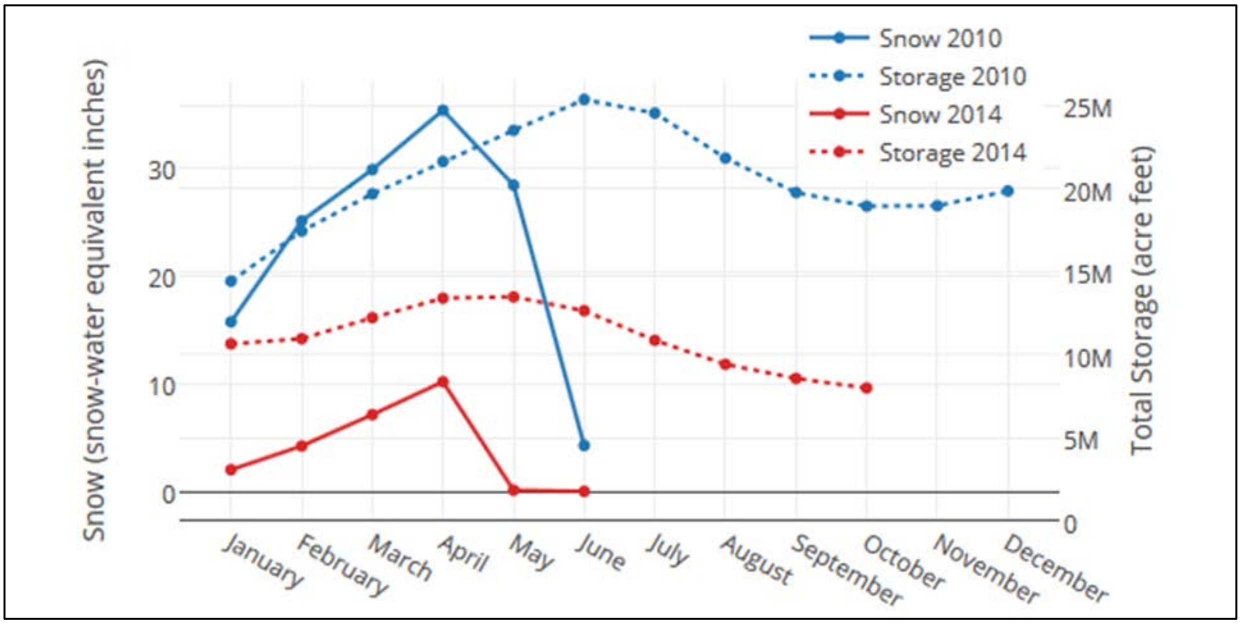

Figure 10. Snowpack and reservoir storage, 2010 vs. 2014. Source: U.S. Natural Resources Conservation Service SNOTEL. Presented by USGS Center for Integrated Data Analytics – http://cida.usgs.gov/ca_drought/, accessed 9/23/15.

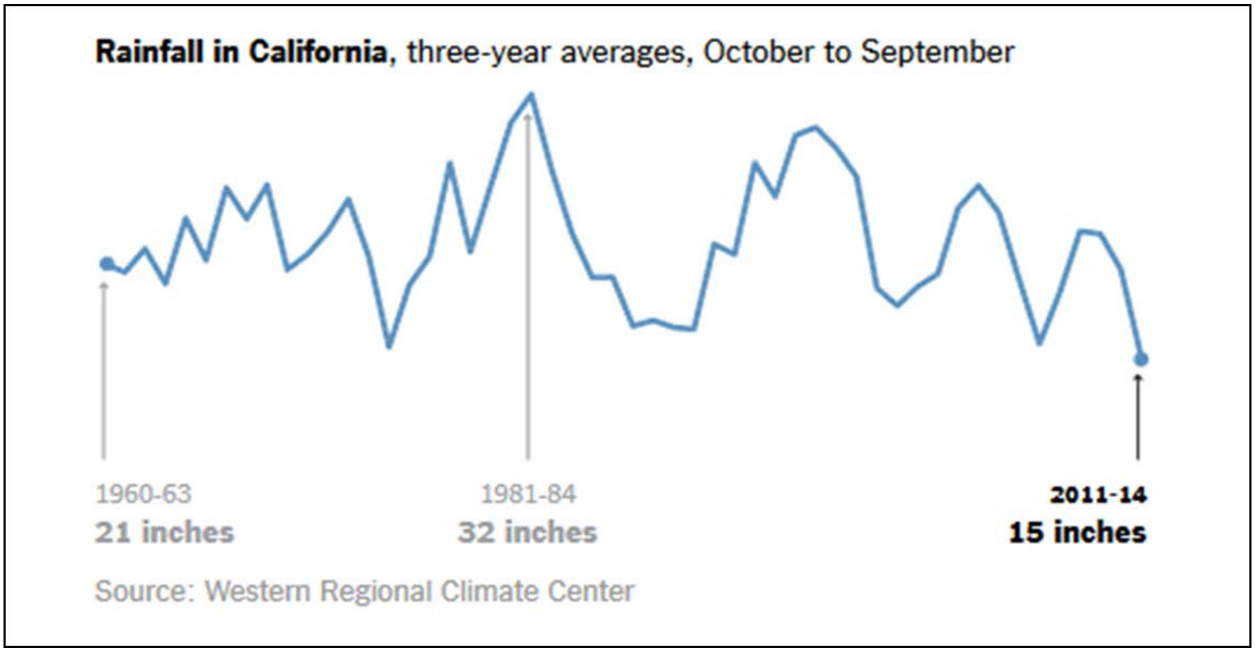

Figure 11. Three-year average of rainfall in California, October to September. Source: Park et al. 2015.

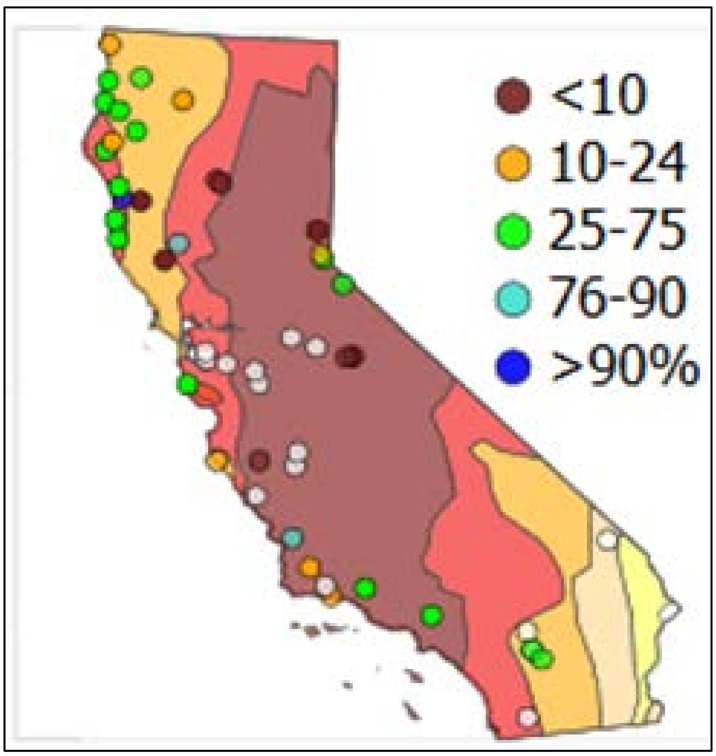

Figure 12. Percent of historical (since 1980) median streamflow for September 15, 2015. Source: U.S. Geological Survey GAGE SII and NWIS. Presented by USGS Center for Integrated Data Analytics. Accessed 9/23/15 from www.cida.usgs.gov/ca_drought/

The combination of low precipitation and high temperatures favored elevated stream temperatures, and these have been documented to be extreme in some watersheds. Concerns over a high potential for fish kills in the Klamath Basin were also high in the summers and autumns of 2014 and 2015 because of high stream temperatures and elevated presence of pests and pathogens detected in salmon, and these concerns prompted emergency reservoir releases (USGS 2015) that were aimed at lowering downstream temperatures to alleviate this risk.

Ocean Conditions and Marine Survival

2014-15 exceptionally warm ocean conditions in the NE Pacific

Much of the northeast Pacific Ocean, including parts typically used by California salmon and steelhead, experienced exceptionally high upper ocean temperatures beginning early in 2014 and areas of extremely high ocean temperatures continue to cover most of the northeast Pacific Ocean. A "warm blob" formed offshore of the PNW region in fall 2013 (Bond et al. 2015). Off the coast of Southern and Baja California, upper ocean temperatures became anomalously warm in spring 2014, and this warming spread to the Central California coast in July 2014In fall 2014, a shift in wind and ocean current patterns caused the entire northeast Pacific domain to experience unusually warm upper ocean temperatures from the West Coast offshore for several hundred kilometers. In spring, 2015 nearshore waters from Vancouver Island south to San Francisco mostly experienced strong and at time above average coastal upwelling that created a relatively narrow band (~50 to 100 km wide) of near normal upper ocean temperatures, while the exceptionally high temperature waters remained offshore and in coastal regions to the south and north.

Expectations for future climate risks and impacts already in the pipeline for West Coast salmon

Adult coho salmon returns this fall/winter and in the fall 2016/winter 2017 have likely been negatively impacted by poor stream and ocean conditions. Adult coho salmon returns for this fall (next winter) and for the next 2 to 3 years (depending on ocean residence times, maturing in 2015, 2016, 2017 and 2018) have likely been negatively impacted by poor stream and ocean conditions.

The expected effects of the 2015/16 tropical El Niño are likely to favor a more coastally oriented warming of the NE Pacific this fall and winter that will persist into spring 2016. Next spring's ocean migrants will likely encounter an ocean strongly influenced by (if not dominated by) a subtropical food web that favors poor early marine survival for coho salmon.

NOAA's Climate Prediction Center (CPC) forecasts a 95% likelihood that the tropical El Niño event will persist through the winter of 2016, and they predict a high likelihood for this event to alter North Pacific and Western US climate for the next few seasons. Seasonal climate forecasts issued by CPC in mid-September 2015 show increased odds for typical El Niño fall/winter climate conditions that include above average fall and winter temperatures in West Coast states, increased odds for below normal precipitation in the Pacific Northwest (especially large increases in the odds for a dry fall/winter in the interior Columbia Basin), and increased odds for a wet fall in Southern California, and a wet winter in all of California. Because El Niño events favor fall/winter periods with an especially strong Aleutian Low pressure anomaly centered in the Gulf of Alaska, the “warm blob” of exceptionally warm upper ocean temperatures off the PNW coast is expected to weaken considerably.

In contrast, exceptionally warm ocean temperatures between Central, Southern, and Baja California and Hawaii are expected to remain elevated for the next few seasons. El Niño-related changes in wind and related ocean current patterns are expected to cause a coast-wide warming of upper ocean temperatures from Alaska south to Mexico, but confined to a relatively narrow band within ~ 100 miles of the coast.

In summary, the strong El Niño event is predicted to substantially reduce the odds for a repeat of the extreme warmth of the past 2 winters, extreme precipitation deficit experienced in California the past 4 winters, and the extreme warmth of the offshore waters of the Northeast Pacific Ocean that have persisted for most of the past 2 years. The past 2 years have also seen persistence in the warm phase Pacific Decadal Oscillation (PDO) pattern of North Pacific Ocean temperatures. The warm phase of the PDO is likely to continue for another year because of it strong tendency for persistence and the expected El Niño influences on the Aleutian Low and related ocean currents from October 2015 through April 2016.

Climate Change

California has experienced well below average precipitation in each of the past four water years (2012, 2013, 2014, and 2015), record high surface air temperatures the past two water years (2014 and 2015), and record low snowpack in 2015. Anomalously high surface temperatures have made this a “hot drought,” in which high surface temperatures substantially amplified annual water deficits during the period of below average precipitation. These climate anomalies have likely had negative impacts on the freshwater, estuary, and marine phases for many populations of Chinook salmon, coho salmon, and steelhead. These impacts are not yet fully apparent in the adult return data that form the basis of our status reviews, but will likely be manifested in the return data over the next several years.

The strong 2015-2016 El Niño event is predicted to substantially reduce the odds for a repeat of the extreme warmth of the past two winters, extreme precipitation deficit experienced in California the past four winters, and the extreme warmth of the offshore waters of the Northeast Pacific Ocean that have persisted for most of the past two years. The past two years have also seen persistence in the warm phase Pacific Decadal Oscillation (PDO) pattern of North Pacific Ocean temperatures. The warm phase of the PDO is likely to continue for another year because of it strong tendency for persistence and the expected El Niño influences on the Aleutian Low and related ocean currents in the next six months.

Williams et al. (2016) provide a more detailed discussion of these recent climate conditions and expected impacts.

Summary of Science on Hatchery Impacts

There are three hatcheries in the SONCC coho salmon ESU and all three are included in the ESA-listed ESU. The hatcheries include Cole River Hatchery on the Rogue River, Iron Gate Hatchery on the Klamath River, and Trinity River Hatchery on the Trinity River. One key development since the previous assessment in 2010 is the completion of the Hatchery Genetic Management Plan (HGMP) for the Iron Gate Hatchery (CDFW 2014) that moves the operation of this hatchery from a mitigation hatchery to one now operated to protect and conserve the genetic resources of the Upper Klamath population unit of the SONCC coho salmon ESU. Included in the HGMP are defined monitoring and evaluation activities to evaluate effects of the hatchery activities on the abundance, productivity, spatial structure, and diversity, and the magnitude or relative impact of the hatchery program on other actions that influence SONCC coho salmon. The implementation of the HGMP is a positive step toward meeting viability targets for the Upper Klamath population unit, the diversity stratum, and the ESU. An HGMP is being developed for the Trinity River Hatchery and is not in place at this time. Cole River Hatchery is operated as a harvest program (ODFW 2015) used for augmentation of fishing and harvest opportunities, and mitigation for the loss of habitat resulting from dam construction in the Rogue and Applegate rivers. An HGMP was completed in 1999. The hatchery stock is managed as an integrated stock. Approximately 75,000 smolts are released on-site, all fish are fin-clipped and 25, 000 are coded-wire tagged (ODFW 2015). The coho salmon program at Cole River Hatchery does provide monitoring opportunities related to ocean distribution and harvest. Future development of a HGMP for Trinity River Hatchery will help ensure that hatchery operations for coho salmon are focused on aspects that protect and conserve the genetic resources of the local population units of the SONCC coho salmon ESU. The HGMP will include defined monitoring and a plan for future evaluation of the effects of the hatchery activities on the abundance, productivity, spatial structure, and diversity of SONCC coho salmon. This monitoring and evaluation will also assess the magnitude or relative impact of the hatchery program on other actions that influence SONCC coho salmon.

Fire

California wildfire incidence has been very high in 2015, in the midst of the fourth year of drought. Between January 1 and July 11, the number of wildfire responses was 1,000 more than the average number of responses in previous fire years (Park et al. 2015). Elevated fire frequency and intensity will continue to degrade stream conditions through sedimentation and loss of riparian vegetation, and therefore, represents a growing threat to this ESU.

Depensation

Depensation occurs when populations are reduced to very low densities and their per capita growth rates decrease. Depensation arises from a variety of mechanisms (e.g., failure to find mates and therefore reduced probability of fertilization, failure to saturate predator populations [Liermann and Hilborn 2001]). Populations that are below their depensation threshold are also at a higher risk of extinction because of these mechanisms (Williams et al. 2008).

Although long-term spawner data are not available for many populations within the range of the

SONCC coho salmon ESU, available information indicates that 20 of the 26 independent populations that make up the SONCC coho salmon ESU are at high risk of extinction because the number of spawners is likely below the depensation threshold (NMFS 2014). There has been no significant difference in the number of spawners at monitored sites over the last five years, so there is no evidence that threat from small population size has changed since the last status review. However, the cohorts that experienced drought conditions and poor ocean conditions as juveniles have not yet returned to rivers. We anticipate SONCC coho salmon spawner abundance will decline in coming years due to reduced survival resulting from the drought and poor ocean conditions. If this occurs, the threat from depensation will increase in the future.

Efforts to protect the species

When considering whether to list a species as threatened or endangered, section 4(b)(1)(A) of the ESA requires that NMFS take into account any efforts being made to protect that species. There are numerous Federal, state, tribal and local programs that protect anadromous fish and their habitat throughout the range of ESA-listed salmon and steelhead. The proposed listing determinations for West Coast salmon and steelhead (69 FR 33102) reviewed these programs in detail.

In the final listing determinations for salmon (70 FR 37160) and steelhead (71 FR 834), we noted that while many of the ongoing protective efforts are likely to promote the conservation of listed salmonids, most efforts are relatively recent, have yet to demonstrate their effectiveness, and for the most part do not address conservation needs at scales sufficient to conserve entire ESUs or DPSs. Therefore, we concluded that existing protective efforts did not preclude listing several ESUs of salmon and several DPSs of steelhead.

In our above five-factor analysis, we note the many habitat, hydropower, hatchery, and harvest improvements that occurred in the past five years. We are currently working with our Federal, state, and tribal co-managers to develop monitoring programs, databases, and analytical tools to assist us in tracking, monitoring, and assessing the effectiveness of these improvements.

Listing Factor E Conclusion

New information available since the last status review indicates that significant negative changes to these natural factors have occurred. Although the magnitude of the effects to the ESU are unknown, the unprecedented drought and poor ocean conditions have likely resulted in significant declines in SONCC coho salmon survival and therefore affect the persistence of the SONCC coho salmon ESU.

2.4 Synthesis

The ESA defines an endangered species as one that is in danger of extinction throughout all or a significant portion of its range, and a threatened species as one that is likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range. Under ESA section 4(c)(2), we must review the listing classification of all listed species at least once every five years. While conducting these reviews, we apply the provisions of ESA section

4(a)(1) and NMFS's implementing regulations at 50 CFR part 424.

To determine if a reclassification is warranted, we review the status of the species and evaluate the five factors, as identified in ESA section 4(a)(1): (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; and (5) other natural or man-made factors affecting a species continued existence. We then make a determination based solely on the best available scientific and commercial information, taking into account efforts by states and foreign governments to protect the species.

The updated status review completed by our Southwest Fisheries Science Center indicates that there has been no improvement in the status of SONCC coho salmon in the last five years. The SONCC coho salmon ESU continues to be at risk of extinction. Twenty-four out of thirty-one independent populations are at high risk of extinction, six are at moderate risk of extinction, and none is at low risk of extinction. All core populations (those intended to serve as anchors for recovery) are thousands of adults short of the numbers needed for them to play their role in recovery of the entire ESU.

Our analysis of the ESA section 4(a)(1) factors indicates there is heightened risk to the SONCC coho salmon ESU's persistence since our last status review in 2011. Drought conditions have persisted in four of the last five years and are ongoing. These conditions are unprecedented in the time since SONCC coho salmon have been listed, and have likely resulted in reduced juvenile survival and stressful rearing conditions in nearly all parts of the ESU range. Those juveniles that survived the stressful freshwater conditions may have also faced poor ocean conditions, the results of which will only be apparent once these year classes return as adults. There have been no notable regulatory changes in the last five years, which would significantly improve the outlook for this species. Numerous habitat restoration projects have been completed in many rivers and streams in the SONCC coho salmon range, but many more are needed to achieve the scale of habitat changes needed for this species to recover.

After considering the biological viability of the SONCC coho salmon ESU and the status of its ESA section 4(a)(1) factors, we conclude that there has been no improvement in the status of the SONCC coho salmon ESU since it was last reviewed in 2010-2011. The biological benefits of habitat restoration and protection efforts have yet to be fully expressed, and will likely take one to two decades to result in measurable improvements to population viability. Regardless, it is essential that these efforts continue and are expanded to the greatest extent possible.

The SONCC coho salmon ESU is currently considered likely to become endangered within the foreseeable future in all or a significant portion of its range. Of particular concern is the low number of adults counted entering the Shasta River in 2014-15. The lack of increasing abundance trends across the ESU for the populations with adequate data are of concern. Moreover, the loss of population spatial scale estimates from coastal Oregon populations is of great concern. The new information since Williams et al. (2011) while cause for concern, does not appear to suggest a change in extinction risk at this time.

2.4.1 ESU Delineation and Hatchery Membership

Recent genetic analysis indicates that the current ESU boundaries do not need to be changed. The SONCC coho salmon hatchery programs have not changed substantially from the previous ESA status review to suggest that their level of divergence relative to the local natural populations has changed.

2.4.2 ESU Viability and Statutory Listing Factors

The Southwest Fisheries Science Center's review of updated information (Williams 2015) does not indicate a change in the biological risk category of SONCC coho salmon since the time of the last status review (Williams et al. 2011).

Our analysis of ESA section 4(a)(1) factors indicates that the collective risk to the SONCC coho salmon's persistence has not changed significantly since our 2011 status review. However, the overall level of concern has increased based on likely effects from increased water withdrawal in many areas and on drought conditions, and there has been no apparent trend toward recovery since listing.

3. Results

3.1 Classification

3.1.1 Listing Status

Based on the information identified above, we recommend that the SONCC coho salmon ESU remain classified as a threatened species.

3.1.2 ESU Delineation

Based on the information identified above, no changes are needed to the ESU delineation.

3.1.3 Hatchery Membership

The SONCC coho salmon hatchery programs have not changed substantially since the previous ESA status review to suggest that their level of divergence relative to the local natural populations has changed. Therefore, we conclude that no changes in hatchery membership for the SONCC coho salmon ESU are needed.

3.2 New recovery priority number

Since the previous five year review, NMFS revised the SONCC coho salmon ESU recovery priority number from one (NMFS 2009b) to a new recovery priority number of five (NMFS 2015a) as listed in Table 4 of this document.

4. Recommendations for future actions

Over the next five years, the most important action to safeguard SONCC coho salmon against extinction is to ensure sufficient instream flows. The most important areas to carry out these actions are those that currently support coho salmon.

- Conduct studies to determine how much instream flow coho salmon need for recovery. State governments should use their existing authorities to ensure these sufficient flows remain in the rivers by regulating, monitoring, and enforcing water rights and water diversions.
- Increase voluntary water conservation measures and incentives (e.g., storage, forbearance) where coho salmon currently occur.

In addition, implementation of the following actions where SONCC coho salmon occur is of great importance to their survival and recovery.

- Increase habitat complexity. Re-establish off-channel winter rearing habitat, increase the amount of stream-estuary ecotone habitat available to coho salmon, and add structure to channels to form pools, increase complexity, and sort sediment. Revise regulations to make them more protective of beavers.
- Re-establish and expand ODFW's coho salmon population-specific fish and habitat monitoring in the Oregon portion of the ESU to include all core populations.
- Establish at least one life cycle monitoring station in the Eel River in order to inform marine and freshwater survival rates.
- Revise Oregon's Forest Practices Act and the Oregon Agricultural Water Quality Management Act so that these activities do not limit recovery of SONCC coho salmon.
- Remove four dams on the Klamath River.
- Implement emergency efforts (e.g., rescue rearing, broodstock supplementation) to prevent local extinction of high-risk independent populations
- Ensure sufficient funds are available to fully enforce regulation of environmental impacts of marijuana cultivation, especially water use, and to fund cleanup of existing marijuana grow sites.

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National Marine Fisheries Service 5-Year Review

SONCC Coho Salmon

Conclusion:

Based on the information identified above, we conclude:

The SONCC coho salmon ESU should remain listed as threatened

REGIONAL OFFICE APPROVAL

Approve: ______________________________ Date: 5/25/16

Alecia Van Atta
California Coastal Office
West Coast Region
NOAA Fisheries