Science, Service, Stewardship

2016 5-Year Review: Summary & Evaluation of Central California Coast Coho Salmon

National Marine Fisheries Service
West Coast Region

April 2016

5-YEAR REVIEW: CENTRAL CALIFORNIA COAST COHO SALMON

Species Reviewed	Evolutionarily Significant Unit or Distinct Population Segment
coho salmon (*Oncorhynchus kisutch*)	Central California Coast (CCC) coho salmon

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1 GENERAL INFORMATION

1.1 INTRODUCTION

Many West Coast salmon and steelhead (*Oncorhynchus sp.*) 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 to the National Marine Fisheries Service's (NMFS) listing of 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. The most recent listing determinations for most salmon and steelhead occurred in 2011. NMFS completed a 5-year status review in 2011 and concluded the status for endangered Central California Coast (CCC) coho salmon should remain the same. This document summarizes NMFS's current 5-year review for the endangered CCC coho salmon.

1.1.1 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 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 and therefore must be included in the listing, 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.

Because the new hatchery listing policy changed the way we considered hatchery fish in ESA listing determinations, in 2005 and 2006 we completed new status reviews and ESA-listing determinations for West Coast salmon ESUs and steelhead DPSs. On August 15, 2011 we completed five year reviews for 11 ESUs of Pacific salmon and 6 DPSs of steelhead (76 FR 50448).

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 that the public submit new information on these species that has become available since our listing determinations in 2011. In response to our request, we received no comments in regards to CCC coho salmon during the public comment period.

To complete the reviews, we first asked scientists from our Southwest Fisheries Science Center (SWFSC) to collect and analyze new information about ESU and DPS viability. To evaluate viability, NMFS 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 SWFSC considered new information on 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. These reports were compiled in a viability assessment report (viability assessment) (Williams *et al*. 2016) and used to inform the review of current status.

To further inform the reviews, we consulted salmon management biologists from the West Coast Region who are familiar with hatchery programs, habitat conditions, dam operations, and harvest management. Salmon biologists met with the SWFSC scientists to review available information on fish distribution and trends; changes to status of listing factors (*i.e.*, habitat destruction, overutilization for commercial purposes, disease and predation pressures, inadequacy of existing regulations, other natural or man-made factors); and protective measures implemented since the last status review.

In preparing this report, we considered all relevant information, including the work of the SWFSC (Williams *et al.* 2016); the recovery plan for the species in question; technical reports prepared in support of the recovery plans for the species in question; the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for CCC coho salmon; and the information and views provided by the geographically based management teams. 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

The CCC coho salmon ESU was originally listed as threatened in 1996 (61 FR 56138). In 2005 following a reassessment of its status and after applying NMFS' hatchery listing policy, we reclassified the ESU as endangered and listed several conservation hatchery programs that were associated with the ESU (70 FR 37160). See Table 1 for details.

Table 1: Summary of the listing history under the Endangered Species Act for CCC coho salmon.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
coho salmon *(O. kisutch)*	**Central California Coast coho salmon**	**FR notice:** 64 FR 56138 **Date:** 10/31/1996 **Classification:** Threatened	**FR notice:** 70 FR 37160 **Date:** 6/28/2005 **Re-classification:** Endangered including hatchery stocks

1.3.3 Associated Rulemaking

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 physical or biological features essential to conservation, and 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 such areas are essential for conservation of the species. We designated critical habitat for CCC coho salmon in 1999.

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 2002, NMFS promulgated 4(d) protective regulations for CCC coho salmon (67 FR 1116). In 2005, the CCC coho salmon ESU was reclassified as endangered, which superseded the 4(d) rule established in 2002 (70 FR 37160).

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

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
coho salmon *(O. kisutch)*	**Central California Coast coho salmon**	ESA section 9 applies; **FR notice:** 67 FR 1116 **Date:** 7/10/2002; **Revised**: Removed with re-classification as endangered 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 the CCC coho salmon ESU. These assessments include status reviews conducted by our Northwest Fisheries Science Center and SWFSC and technical reports prepared in support of recovery planning for this species.

Table 3: Summary of previous scientific assessment for CCC coho salmon

Salmonid Species	ESU/DPS Name	Document Citation
coho salmon *(O. kisutch)*	**Central California Coast coho salmon**	Weitkamp *et al.* 1995 NMFS 2001 Good *et al.* 2005 Bjorkstedt *et al.* 2005 Spence *et al.* 2008 Williams *et al.* 2011. Spence and Williams 2011 Williams *et al.* 2016

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. We assess three criteria to determine a species' priority for recovery plan development, implementation, and resource allocation: (1) magnitude of threat; (2) recovery potential; and (3) existing conflict with activities such as construction and development.

Table 4 lists the recovery priority number for CCC coho salmon, as reported in the most recent report to Congress (Species in the Spotlight: Survive to Thrive, Recovering Threatened and Endangered Species, FY 2013-2014 Report to Congress; available at: http://www.nmfs.noaa.gov/pr/laws/esa/final_biennial_report_2012-2014.pdf).

1.3.6 Recovery Plan or Outline

NMFS issued a Final Recovery Plan for the Evolutionarily Significant Unit of Central California Coast coho salmon in September 2012.

Table 4: Recovery Priority Number and Endangered Species Act Recovery Plan for CCC coho salmon.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plan
coho salmon *(O. kisutch)*	**Central California Coast coho salmon**	1	**Recovery Plan for the Evolutionarily Significant Unit of the Central California Coast coho salmon.** **Plan Status:** Final. **Date:** September 2012. Recovery Plan is available at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/index.html

2 REVIEW ANALYSIS

In this section we review new information to determine whether CCC coho salmon species' delineations remain appropriate.

2.1 DELINEATION OF SPECIES UNDER THE ENDANGERED SPECIES ACT

Is the species under review a vertebrate?

ESU/DPS Name	YES	NO
Central California Coast coho salmon	X	

Is the species under review listed as an ESU/DPS?

ESU/DPS Name	YES	NO
Central California Coast coho salmon	X	

Was the ESU/DPS listed prior to 1996?

ESU/DPS Name	YES	NO	Date Listed if Prior to 1996
Central California Coast coho salmon		X	n/a

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

Not Applicable, because the ESU was listed after the development of the ESU/DPS policy, and thus, followed the policy.

2.1.1 SUMMARY OF RELEVANT NEW INFORMATION REGARDING THE DELINEATION OF THE CCC COHO SALMON ESU

ESU Boundaries

As part of this five year review process, the SWFSC compiled and evaluated new information relevant to the geographic boundaries of all listed ESUs and DPSs in California to determine if potential boundary changes were warranted (Williams *et al.* 2016).

Membership of Hatchery Programs

In accordance with NMFS' 2005 hatchery listing policy, three hatchery stocks (Don Clausen Fish Hatchery Captive Broodstock Program, Scott Creek/Kingfisher Flat Conservation Program, and Scott Creek Captive Broodstock Program) were included in the listed ESU when it was reclassified as endangered in 2005 (70 FR 37160). As part of this 5-year review, we have re-evaluated the status of these hatchery stocks and programs to determine whether they are still operational and if so, whether they have been substantially modified. Based on a review of the available information, these hatchery programs continue to be operational and propagate stocks that are part of this ESU.

2.2 RECOVERY CRITERIA

The ESA requires that NMFS 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.

2.2.1 DO THE SPECIES HAVE FINAL, APPROVED RECOVERY PLANS CONTAINING OBJECTIVE, MEASURABLE CRITERIA?

ESU/DPS Name	YES	NO
Central California Coast coho salmon	X	

NMFS issued a recovery plan for CCC coho in September 2012. This plan includes recovery criteria that are objective and measurable, and that utilize the best available and most up-to-date information on the biology of the species and their habitat.

2.2.2 ADEQUACY OF RECOVERY CRITERIA

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

ESU/DPS Name	YES	NO
Central California Coast coho salmon	X	

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

ESU/DPS Name	YES	NO
Central California Coast coho salmon	X	

2.2.3 List the Recovery Criteria as They Appear in the Recovery Plan

Evaluating a species' potential for downlisting or delisting requires both an explicit analysis of population or demographic parameters (biological recovery criteria) and the physical or biological conditions that affect the species' continued existence, categorized under the ESA section 4(a)(1) listing factors (listing factor criteria). Together these make up the "objective, measurable, criteria" and the "delisting criteria" required under section 4(f)(1)(B)[1] of the ESA.

Downlisting and delisting criteria are organized by the Section 4(a)(1) listing factors below and include criteria for populations, habitat conditions, threats and implementation of recovery actions. During status reviews or consideration of a downlisting or delisting decision, NMFS will determine whether the populations have achieved viability and if section 4(a)(1) listing factors have been adequately addressed, *i.e.* whether the underlying causes of decline have been addressed and mitigated and are not likely to re-emerge.

CCC coho salmon Biological Recovery Criteria

Downlisting Criterion

Criterion 1: All diversity strata (and 28 focus populations) meet minimum spawner density.

Delisting Criterion

All criterion (below) must be met to delist CCC coho salmon.

Criterion 1: Effective population size per generation > 500 OR Total population size per generation > 2500 for all independent populations.

Criterion 2: No population decline apparent or probable for all independent populations.

Criterion 3: Catastrophic decline not apparent for all independent populations.

Criterion 4: Minimum spawner density achieved for all 28 populations.

[1] See NMFS 2010 and Fund for Animals v. Babbitt 903 F. Supp. 96 (D.D.C. 1995, Appendix B).

Criterion 5: No evidence of adverse genetic, demographic, or ecological effects of hatchery fish on wild populations.

Criterion 6: Populations selected to support connectivity within and between Diversity Strata (*i.e.,* supplemental populations) confirm presence of juveniles or adults for at least one year class over 12 years.

2.3 UPDATED INFORMATION AND CURRENT SPECIES' STATUS

2.3.1 ANALYSIS OF VIABLE SALMONID POPULATION (VSP) CRITERIA

The following ESU summary is taken from the SWFSC's biological viability report. Please see Williams *et al.* 2016, Spence 2016), for a more detailed discussion of CCC coho salmon VSP status.

Information on population status and trends for CCC Coho Salmon has improved considerably since the 2011 status review due to recent implementation of the Coastal Monitoring Program (CMP) across significant portions of the ESU. Within the Lost Coast – Navarro Point stratum, current population sizes range from 4% to 12% of proposed recovery targets, with two populations (Albion River and Big River, respectively) at or below their high-risk depensation thresholds (Figure 1). Most independent populations show positive but non-significant population trends; however, the trend in the Noyo River has been positive for the past 5-6 years. Dependent populations within the stratum have declined significantly since 2011, with average adult returns ranging from 417 in Pudding Creek (42 percent of the recovery target) to no adult returns observed within Usal and Cottaneva creeks. Similar results were obtained immediately south within the Navarro Point – Gualala Point stratum, where two of the three largest independent populations, the Navarro and Garcia rivers, have averaged 257 and 46 adult returns, respectively, during the past six years (both populations are at or below their high-risk depensation threshold) (Figure 1). Data from the three dependent populations within the stratum (Brush, Greenwood and Elk creeks) suggest little to no adult coho salmon escapement since 2011. In the Russian River and Lagunitas Creek watersheds, which are the two largest within the Central Coast strata, recent coho salmon population trends suggest limited improvement, although both populations remain well below recovery targets. Likewise, most dependent populations within the strata remain at very low levels, although excess broodstock adults from the Russian River and Olema Creek were recently stocked into Salmon Creek and the subsequent capture of juvenile fish indicates successful reproduction occurred. Finally, recent sampling within Pescadero Creek and San Lorenzo River, the only two independent populations within the Santa Cruz Mountains strata, suggest coho salmon have likely been extirpated within both basins. A bright spot appears to be the recent improvement in abundance and spatial distribution noted within the strata's dependent populations; Scott Creek experienced the largest coho salmon run in a decade during 2014/15, and researchers recently detected juvenile coho salmon within four dependent watersheds where they were previously thought to be extirpated (San Vincente, Waddell, Soquel and Laguna creeks).

Summarizing the information to inform the larger ESU, most independent CCC coho salmon populations remain at critically low levels, with those in the southern Santa Cruz Mountains strata likely extirpated. Data suggests some populations show a slight positive trend in annual escapement, but the improvement is not statistically significant. Overall, all CCC coho salmon populations remain, at best, a slight fraction of their recovery target levels, and, aside from the Santa Cruz Mountains strata, the continued extirpation of dependent populations continues to threaten the ESU's future survival and recovery.

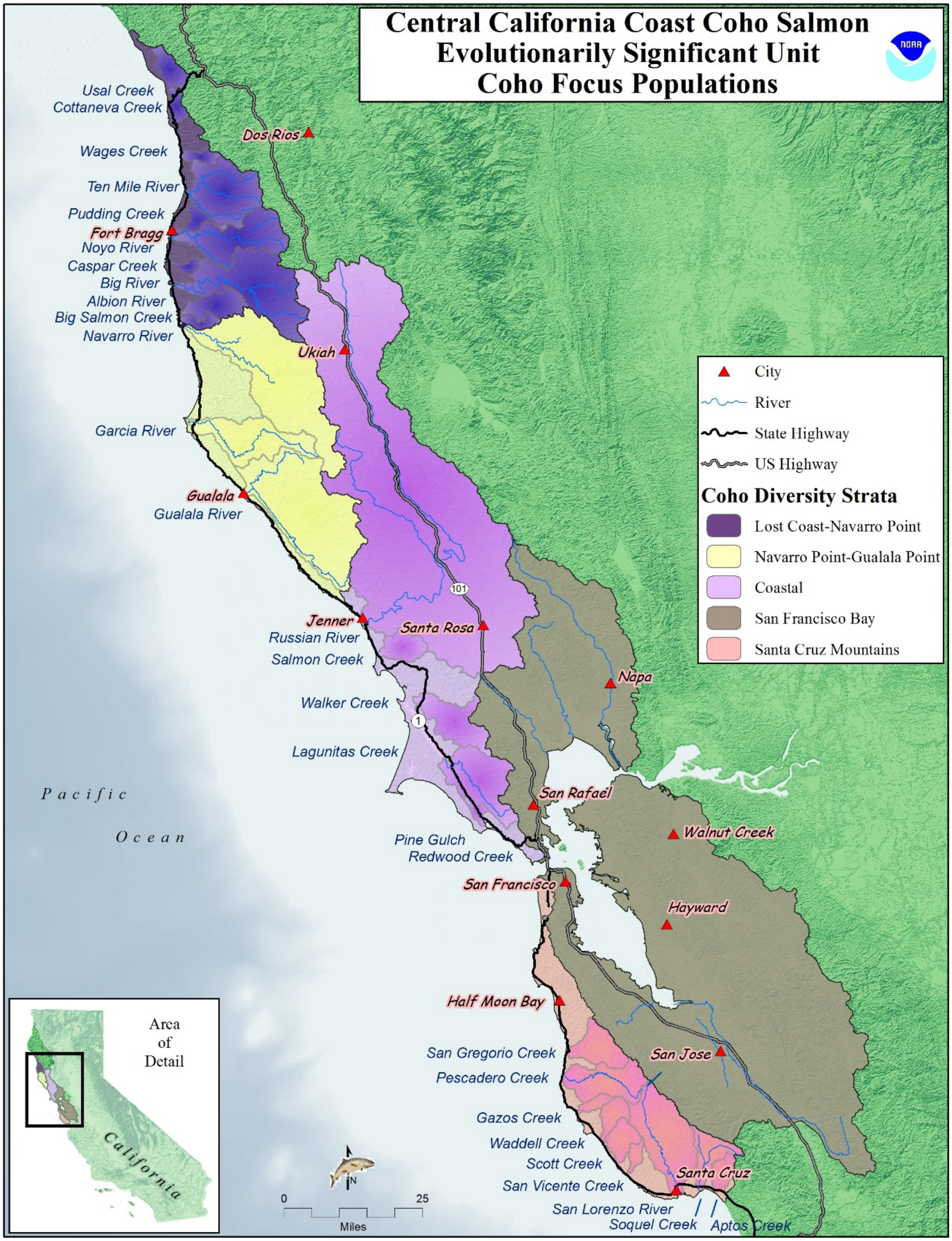

Figure 1: Map of Central California Coast coho salmon with Diversity Strata boundaries.

2.3.2 FIVE-FACTOR ANALYSIS

Section 4(a)(1)(b) of the ESA directs us to determine whether any species is threatened or endangered because of any of the following factors: (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) the inadequacy of existing regulatory mechanisms; or (5) 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. The 2011 status review discusses a comprehensive list of threats associated with each listing factor. While that information is still valid, this review is focused on the top three to five threats and how those threats have changed since the previous review.

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, 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 yet 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 will be monitored and evaluated with the aid of new reporting techniques. Generally, it takes one to five decades to demonstrate such increases in viability. Below, we summarize several noteworthy restoration and protection actions implemented since the last review. We also summarize the primary threats to habitat conditions that remain.

<u>Surface and Groundwater Extraction</u>

Existing surface water rights in California have over-appropriated approximately five times the natural mean annual runoff, and account for almost 1000 percent of natural surface water supplies (Grantham and Viers 2014). Although these statistics pertain to the entire state, surface and groundwater resources within the CCC coho salmon ESU are likely overallocated to a similar degree.

Recently signed California legislation may improve the existing over-allocation of the state's groundwater resources, which are often hydrologically linked to surface flow in adjacent stream channels. However, given the current overallocation of surface and groundwater within the state, and the expected long delay (~20 years) in realizing tangible environmental improvement from the Sustainable Groundwater Management Act (SGMA) (see discussion below under Listing Factor D), NMFS believes currently impaired streamflow and habitat conditions will generally persist across the ESU during at least the next decade.

The threat of blocked fish passage resulting from instream diversion structures has likely remained the same since the initial listing of the CCC coho salmon ESU. Many small legacy impediments identified prior to and after listing have been remedied, and modern fish passage standards are now incorporated into new (or rebuilt) diversion designs during Federal and state permitting. However, a significant and growing new threat is the unpermitted damming and diversion of rural streams and rivers for the purpose of irrigating illicit marijuana gardens. Marijuana-related diversion dams were not a significant threat at the time of CCC coho salmon listing, but are likely now the paramount threat to salmonid survival and habitat function in many first and second-order streams located in remote, rural areas.

The number of large dams impounding reservoirs on historic coho streams has not changed since listing, nor has the fact that all of those dams continue to preclude coho salmon passage to historical habitat upstream. Similarly, impacts associated with hydropower production remain largely the same as at the time of listing. Looking forward, the recently approved California State Water Bond (the 2014 Proposition 1) includes $2.7 billion for future reservoir and dam construction; although potential reservoir sites have not yet been identified, the possibility remains that new water storage facilities may be developed within the CCC coho salmon ESU.

<u>Water Quality</u>

Most rivers and streams within the CCC coho salmon ESU are characterized by poor water quality, as defined under the Clean Water Act. The California Regional Water Quality Control Board publishes a "303(d)" list of water bodies within the state that fail to meet specific water quality parameters meant to protect beneficial uses. As can be seen in Table 5, most major rivers within the ESU remain impaired by high sediment levels, high temperatures, and low dissolved oxygen levels.

Table 5: Summary of sediment, temperature and dissolved oxygen limitations within select rivers and streams of the CCC coho salmon ESU. Data gathered from North Coast and Central Coast Regional Water Quality Control Board 303(d) lists, which can be found at http://www.waterboards.ca.gov.

	Albion River	Big River	Gualala River	Navarro River	Lower Russian River	Lagunitas Creek	Pescadero Creek	Scott Creek	Aptos Creek
Sediment/turbidity	X	X	X	X	X	X	X	X	X
Temperature			X	X	X	X		X	
Dissolved Oxygen		X				X	X	X	

Timber Harvest

Timber production is a dominant land use within the northern portion of the CCC coho salmon ESU (*i.e.*, coastal Mendocino County and coastal Sonoma County north of the Russian River), with smaller timber holdings operating in the mountains of Santa Cruz and San Mateo counties. On these timberlands, the generally impaired state of instream aquatic habitat is primarily a legacy effect from logging and yarding practices employed decades ago, when few environmental laws existed and regulatory oversight was limited. Unfortunately, many of these legacy effects [*e.g.*, high instream sediment loads, poor large wood debris (LWD) recruitment, *etc.*] continue to impact CCC coho salmon habitat at the present time, and will likely require decades to naturally "heal" as watersheds evolve and respond to altered geomorphic and hydrologic regimes.

State Forest Practice Rules, which govern timber harvest on private lands (the vast majority of timberland in the CCC ESU), have improved in recent years due to input from NMFS and the California Department of Fish and Wildlife (CDFW), resulting in expanded stream-buffer widths, less damaging harvest techniques, and limits on riparian harvesting, all of which will collectively improve instream and riparian habitat and function over the long-term.

Road building associated with timber harvest, and rural road construction in general, can destabilize hillsides and increase erosional processes that deliver fine sediment to streams and rivers. Poorly designed or constructed stream-crossings can alter stream channel morphology and hydraulic characteristics not only within, but also upstream and downstream of the road crossing. The structure itself, as well as the resulting morphological and hydraulic changes, can often preclude adult and juvenile fish from migrating upstream past the crossing. Due to recent advances in fish passage analysis (*i.e.*, Fish Crossing program) and efforts by timber-land owners to address fish passage barriers occurring on their land, many high-priority blockages have been addressed, although a still greater number of lower-priority sites remain. Overall, given the relatively high awareness that exists currently regarding the importance of fish passage remediation and design by state and Federal regulators, the overall threat of timber roads as a fish passage impediment has likely lessened slightly since CCC coho salmon listing.

Conversely, road-related erosion volume, and the impact the resulting sediment has on instream habitat, is a continuing threat that likely remains at a similar level as when the species was listed. Rehabilitating problem roads is a costly endeavor; decommissioning an old logging road (*i.e.*, outsloping and ripping the road bed, removing culverts and dips, replanting exposed soil, *etc.*) can cost upwards of tens-of-thousands of dollars per mile of road. As a result, road restoration occurs at a slower rate compared to other restoration actions. Thus, while new road construction typically incorporates mitigation measures that minimize erosion, many legacy roads were constructed without those measures and, as a result, will continue to erode and supply sediment to waterways into the future.

<u>Agriculture</u>

Agriculture can degrade coho salmon habitat through fragmentation, water diversions from rivers/streams, and non-point pollutant discharge (*i.e.*, sediment, pesticides, *etc.*). These stressors have likely increased slightly since the previous status review, primarily from an explosion of illicit marijuana cultivation in the northern portion of the ESU, and will likely increase into the future until water scarcity curbs further development (see discussion under "Water Diversions").

Agricultural acreage within the CCC has likely grown little since CCC coho salmon were listed as endangered in 2005, with some counties witnessing modest gains while others contracted. For example, agricultural acreage[2] in Sonoma County, which likely contains the highest percentage of agricultural acreage within the CCC ESU, increased from 71,017 to 76,283 between 2005 and 2013 (approximately 7.4%) (Sonoma County 2005, 2013). Conversely, the next largest agricultural county overlapping the ESU, Mendocino, experienced a small loss during the same time period (-0.8%) (Mendocino County 2005, 2013). Further south, the coastal areas of San Mateo and Santa Cruz counties that overlap with the CCC ESU contain relatively little agricultural acreage compared to counties north of San Francisco Bay.

Wine grapes were by far the largest agricultural product (*i.e.*, acres planted) in both Sonoma and Mendocino counties. Short-term forecasts call for increased demand for premium wines, which is a large proportion of Sonoma and Mendocino County's production (Silicon Valley Bank 2014). However, demand for premium wine is expected to wane slightly in the coming decades as demographic drivers change (*i.e.*, as retired "baby boomers", who today purchase a significant

[2] Includes fruit, nut, vegetable and field crops, but excludes grazing and pasture lands. Crop reports for 2014 were not available.

portion of premium wine, begin to retire, their lower income may impact those purchases). All told, the results suggest agricultural development will continue at a modest pace within Sonoma County watersheds valued for high-end viticulture, such as the Russian River and Gualala River. In these watersheds, short-term growth may possibly be fueled by increased planting of premium wine grapes following the industry's recent slump following the 2007 economic recession. Slower agricultural growth is likely in the coastal areas of San Mateo and Santa Cruz counties, where viticulture is less prominent.

In addition to traditional agriculture, Marin and Sonoma counties are also home to extensive livestock/dairy industries. Livestock grazing can damage riparian and aquatic habitat when animals are not physically excluded, but are instead allowed to trample and graze within and adjacent to creeks and streams. Where high densities of livestock congregate, animal waste can enter the aquatic environment through either direct defecation by individuals in the water, or indirectly as waste is conveyed downslope following rain/irrigation events. The spatial area within the CCC coho salmon ESU utilized for grazing has likely remained relatively constant since the date the fish were initially listed, and significant progress in protecting riparian habitat has recently been realized. For instance, the Marin County Resource Conservation District has helped a number of landowners properly fence riparian corridors that traverse their grazing lands. Also, Sonoma County recently amended their riparian corridor ordinance to expand and clarify riparian protection requirements during land development activities (*i.e.*, urban development or agricultural grading); however, the ordinance largely "grandfathers" all currently developed parcels, meaning only new development must adhere to the ordinance. So while the threat of grazing on CCC coho salmon and its habitat has likely improved somewhat since listing due to ongoing restoration work and recent county regulations, truly significant improvement will likely prove elusive until all properties are required to adhere to scientifically-justified riparian buffer widths.

Recently, an encouraging development in agricultural production is the growth of certification programs such as "Fish Friendly Farming" and other environmentally sustainable efforts, which encourage farmers to implement practices and technologies that minimize potential impacts to salmon and steelhead habitat. These programs are improving terrestrial and aquatic habitat in the areas where they operate, and their overall efficacy is only limited by the relatively small participation rate of the farming community at large.

The above discussion focuses only on legal, county regulated agriculture. Illegal marijuana cultivation was not identified as a threat at the time of listing, but has recently grown into a leading threat to salmon and steelhead recovery throughout California (especially in Mendocino, Humboldt and Trinity counties). Illegal growers often dam and dewater creek channels to irrigate their marijuana gardens, and pesticides, fertilizers and poisons are commonly used without regard for their impacts on the environment. This illicit agricultural component has likely grown exponentially since listing, and will continue to degrade coho salmon habitat until adequate controls and regulations, such as those that govern legitimate agriculture, are enacted.

Urbanization

Much of the CCC coho salmon ESU overlaps with the greater San Francisco Bay Area, a relatively densely populated area that has experienced steady population growth during the past several decades. As a result, many important coho salmon watersheds that overlap with dense urban areas, such as the Russian and San Lorenzo rivers, continually suffer aquatic habitat degradation resulting from urban stressors. As natural open space is transformed into urban neighborhoods, several hydrologic and aquatic habitat impacts predictably follow. Much of the existing bare soil is replaced by impervious surfaces (*e.g.*, pavement, structure roofs, *etc.*), causing rapid runoff of precipitation and shorter, more intense flood flows. Furthermore, urban development often encroaches onto the floodplain of creeks and rivers, destroying riparian and floodplain habitat important to fish during high flow events, and limiting natural hydraulic/geomorphic processes that create and maintain complex instream habitat. Both point and non-point pollution increases as oils, chemicals (*e.g*, fertilizers, pesticides, *etc.*) and other urban pollutants wash into streams following precipitation events. All of these impacts existed at the time of listing and, due to population growth, have likely worsened since. Although more and more local governments are now attempting to consider the environment in their management and development decisions, urban-related impacts are likely to worsen in the future as the Bay Area population grows by a predicted 30% between the years 2010 and 2040 (ABAG 2013).

Estuary and Wetland Loss Impairments

Lost wetland and estuarine habitat was an identified factor leading to the initial listing of CCC coho salmon, and continues to hinder habitat functionality and productivity at this time. For populations along the coast, estuarine habitats consist primarily of seasonal, "bar-built" lagoons. The lagoons form in spring or summer as sandbars form, separating the freshwater and marine environments. The lagoons can provide a highly productive environment where rearing juvenile salmonids can experience rapid growth and where the brackish waters provide an opportunity for them to acclimate to saltwater prior to ocean entry. Estuary/lagoons and other low elevation flood-prone habitat also function as important over-wintering habitat for juvenile salmonids, especially coho salmon. Past and present land development adjacent to coastal estuaries and lagoons has degraded tidally-inundated habitat, altered natural estuarine processes, and generally impaired water quality.

Since the initial goal of "no net loss" of wetland was promoted by President Bush in 1988, the rate of wetland loss has decelerated during the intervening 25 years. However, despite the improvement in protecting wetlands from development, primarily through Section 404 of the Clean Water Act, the nation remains far from the original goal of no net wetland loss (*i.e.*, even though losses have lessened, they still far outweigh any corresponding gains). Furthermore, the nation's wetland mitigation policy has no way of ensuring the environmental function and benefit derived from wetlands are recognized and preserved under the current regulatory regime. Wetland and estuaries/lagoons provide many critical ecological and physical functions, such as attenuating flooding, facilitating groundwater recharge, and providing highly productive rearing habitat for many aquatic species. However, research suggests many of these functions are permanently lost when replacing natural wetland habitat with artificial or engineered substitutes (Golet 1986), as happens per Clean Water Act mitigation requirements.

Protective Measures

Tribal Fishery Management and Watershed Restoration in the Garcia River Watershed

On November 9, 2014, the Manchester-Point Arena Band of Pomos signed a resolution to work with agencies and abide by state and Federal fishing regulations. Under the resolution, tribal member will not fish for endangered and threatened fish such as coho salmon and steelhead, but instead will accept fish from other sources for ceremonial and other tribal purposes. In addition, fishing IDs will be issued to all tribal members for identification purposes when fishing on tribal land. New fishing information signs have been created for use in the Garcia River watershed, and plans for multi-agency and tribal salmonid monitoring efforts are being formulated. Regarding restoration efforts in the watershed, The Nature Conservancy and the Conservation Fund recently protected over a third of the Garcia watershed through an $18 million conservation agreement that will improve degraded instream and riparian habitat while allowing sustainable timber harvesting and cattle grazing to continue.

State and Federal Drought Response

In January of 2014, the Governor of California proclaimed a State of Emergency due to drought conditions. In response, NMFS and CDFW developed the Voluntary Drought Initiative Program (VDI). The purpose of the program is to provide incentives to water users in high priority watersheds throughout the State to reduce the negative effects of the drought on salmon and steelhead. The Russian River was designated as one of three top priority watersheds for this program and is the only top priority watershed within the range of CCC coho salmon. To date, 116 VDI agreements have been signed (41 for water conservation and fish rescue, 71 for independent water conservation , and 4 for flow augmentation) – all are located in either Green Valley Creek, Dutch Bill Creek, Mill Creek, or Mark West Creek, except for one flow augmentation agreement in Porter Creek. The 41 water conservation and fish rescue VDI agreements have been signed with CDFW. The 71 independent water conservation agreements represent over 1,900 acres of vineyard, where landowners have pledged to reduce water demand by 25% over 2013 levels. Finally, the 4 flow augmentation agreements increased summer streamflow within Porter, Dutch Bill, and Green Valley creeks, primarily by releasing previously stored water into the stream channel. Stream flow gaging records within the region show measurable improvement in drought conditions for coho salmon within portions of streams covered by the flow augmentation agreements. For the last 5 years, Porter Creek flow has been maintained annually for summer rearing flow in the lower 1.5 miles of stream, and an agreement in Dutch Bill Creek was implemented in 2015 that maintains approximately 1 mile of habitat that would otherwise dewater during drought periods. The two remaining flow augmentation projects in Green Valley Creek contributed to re-wetting of streams in approximately one half mile of stream.

In addition to voluntary efforts, in July of 2015 the State Water Resources Control Board (SWRCB) issued Emergency Enhanced Water Conservation and Additional Water User Information for the Protection of Specific Fisheries in Tributaries to the Russian River (CCR title 23, section 876), which, in part, mandated reductions in water usage in areas identified by NMFS and CDFW as at greatest risk to salmonids due to the drought. Tangible improvements in streamflow resulting from this order have not been observed, but these actions have increased awareness of conservation issues locally and have stimulated much of the VDI participation.

Frost Protection

Water extractions from streams or from hydraulically connected groundwater specifically those aimed at protecting grape vines from frost damage, has the potential to strand newly emerged coho salmon fry during the spring period. On October 1, 2014, the SWRCB Russian River Frost Protection Regulation went into effect. The regulation, which is being phased in over a 3 year period, will minimize harmful stream stage changes by controlling and coordinating "frost protection" diversions. The use of water for frost protection is widespread in the basin and, particularly in spring seasons with many frost events, this regulation is likely to improve fry survival in tributaries and portions of the mainstem where coho salmon spawn and rear.

Russian River Habitat Focus Area

The Russian River watershed was selected as the first Habitat Focus Area under NOAA's Habitat Blueprint. This was an important step to increase the effectiveness of NOAA's habitat conservation science and management efforts by identifying places where NOAA offices work to meet multiple habitat conservation objectives on a watershed scale. As part of the habitat focus area, NOAA has been working to rebuild Russian River salmonids to sustainable levels through habitat protection and restoration. NOAA's National Weather Service has been improving frost, rainfall, and river forecasts in the Russian River watershed through improved data collection and modeling. NOAA's Office of Oceanic and Atmospheric Research is working to increase community resiliency to flooding damage through improved storm planning and water management strategies.

Marijuana Cultivation

Two 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) has implemented a waste discharge waiver for state-legal medicinal marijuana cultivation. The waiver program attempts to regulate and manage waste discharge into surface water bodies in a manner similar to other agricultural industries in the state, such as vineyards and grazing, with a tiered approach that places prospective operations into one of 4 different levels based largely on the areal size of the operation. 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 recent passage of legislation assembling a state-controlled regulatory and enforcement program for the medicinal marijuana industry. The Medical Marijuana Regulation and Safety Act (MMRSA) will create a new state agency that will control the permitting, regulation and taxing of the medicinal marijuana industry. However, given the likely high cost of regulating and enforcing an entirely new (and formerly illegal) industry, the ability of the state to enforce the law and clean up environmental damage from illegal grows will remain uncertain until state funding levels to implement the MMSRA are finalized. Bolstering the staffs of the state agencies in charge of enforcement (*i.e.*, CDFW and NCRWQCB) is imperative toward MMSRA's success in minimizing environmental impacts.

Habitat Restoration

Since the last status review, the state has awarded several million dollars through their Fisheries Restoration Grant Program toward instream and upslope habitat restoration projects within the CCC coho salmon ESU. Project examples include restoring riparian and floodplain habitat in

Lagunitas Creek, decommissioning roads and addressing sediment sources in the Navarro River, and developing a restoration plan for the San Vicente Creek watershed. Further south within lower Scott Creek, a 2014 restoration project reconnected the floodplain with the creek channel through breaching historic levees in multiple locations, enhancing and reconnecting the confluence area at existing tributary drainages, reconnecting a relic backwater scour feature on Queseria Creek (within the Scotts Creek Floodplain), and installing a number of LWD features to create both in-channel habitat and direct flows into the breaches.

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

Overfishing

Overfishing as a threat to CCC coho salmon survival has likely remained a low threat, comparable to that described at the time of listing. Commercial and sport ocean harvest of coho salmon was banned along the entire California coast in 1995, yet a small proportion of coho salmon are incidentally captured and killed as bycatch in other fisheries. However, recent marine exploitation rates for California coho salmon have been below the allowed exploitation rate established by NMFS. For example, the marine exploitation rate of Southern Oregon/Northern California Coast and CCC coho salmon combined during the 2014 season was preliminarily estimated at 4.9%, which is well below the Fisheries Management Plan conservation objective of 13% or less (PFMC 2015). Freshwater fishing for coho salmon has been illegal in California since 1998.

Illegal harvest of CCC coho salmon by sport or commercial fisherman is likely low, given the existing state ban on capturing or possessing the fish in both the ocean and freshwater rivers – state and Federal law includes significant fines for those caught possessing coho salmon in California. A small amount of freshwater poaching may occur, and losing several adult fish could significantly impact population productivity and genetic diversity in watersheds where current abundance is below the "high risk" threshold (per Spence *et al.* 2008). The overall risk of illegal harvest has likely remained much the same since the initial listing of the species.

Scientific Collection

Collection for scientific research, education programs and artificial propagation broodstock is tightly controlled and monitored through the issuance of collection permits by NMFS and CDFW. The previous status review (NMFS 2011) concluded scientific research and educational programs are believed to have had little or no impact on coho salmon populations, and no development during the past five years has altered that determination.

Protective Measures

CDFW, in cooperation with NMFS, recently implemented two measures that will likely lower the chances of incidental CCC coho salmon capture and harvest during recreational freshwater fishing. First, CDFW will no longer fin clip hatchery coho salmon in the CCC coho salmon ESU to avoid anglers confusing the fish with fin clipped steelhead, which are the targeted species. Second, CDFW has amended California sport fishing regulations to include a low-flow fishing closure along the Sonoma and Mendocino county coasts, beginning in winter 2015. The new regulations are intended to minimize over-exploitation of adult steelhead when stream flows recede to a level where capture rates climb sharply, and should have a similar effect in lowering the inadvertent bycatch of CCC coho salmon during the fishery. However, bycatch of CCC coho salmon by fishers targeting steelhead is still a concern during fall/winter baseflow conditions south of San Francisco, where no low flow restrictions exist.

Listing Factor C: Disease or predation

Disease

Disease and predation were not considered major factors causing the decline of CCC coho salmon in California at the time of listing. Many common coho salmon disease pathogens exist in wild populations, but increased individual resistance and natural ecological dynamics limit disease outbreaks and any resulting population-level impacts. Conversely, production hatcheries (*i.e.*, those producing fish intended for angling opportunities) likely have increased incidences of disease and related mortality as compared to natural populations, in part due to increased stress from overcrowding and sub-optimal habitat conditions that can lower the natural immunity of individual fish (USFWS 2015). In the wild, disease incidence and severity are likely exacerbated by drought, since low flows and high water temperatures can facilitate the transmission of some pathogens within adult salmon populations (Yurok Tribal Fisheries Program 2004). No quantitative information has emerged since listing that would suggest disease impacts have elevated in the time since, or that disease impacts are a more prominent factor in the present depressed state of the CCC coho salmon ESU.

Predation

Like disease, predation was not considered a significant threat to CCC coho salmon recovery during the past status review (NMFS 2011), and nothing regarding the threat has appreciably changed since that time. Adult and juvenile coho salmon encounter many natural predators, and the resultant loss in abundance and productivity is likely one (albeit a minor one) of myriad stressors preventing the species from attaining population viability. Predation by the state's currently robust (per historical standards) pinniped population likely depresses adult coho salmon escapement primarily in larger river systems where seals/sea lions are more likely to aggregate (*e.g.*, Russian River and San Lorenzo River). However, coho salmon predation rates are likely significantly lower than those experienced by Chinook salmon populations, given the later run-timing of coho salmon that generally coincides with higher river flows and elevated turbidity that offer fish greater refuge from predators. Furthermore, abundant pinnipeds off the California coast are nothing new; huge population growth was spurred by passage of the Federal Marine Mammal Protection Act in 1972, suggesting that whatever impact pinniped predation may have on coho salmon populations has likely been operating at a similar level for decades.

A similar conclusion can likely be reached regarding other predators, both native and invasive. For instance, an indirect effect of urbanization is the resultant increase in opportunistic, generalist predators (*e.g.*, western gulls or raccoons) that utilize anthropogenic resources (*e.g.*, landfills, garbage), to increase their local carrying capacity. For example, Osterback *et al.* (2013) determined that juvenile salmonid mortality from western gull predation in Central California populations was greater than previously estimated.

Protective Measures

Warm Springs Hatchery has updated their disease prevention program to safeguard the Russian River Coho Salmon Captive Broodstock Program. First, annual reporting standards and guidelines will be followed for fish health reports, including results of adult inspections, juvenile monitoring and treatments administered, and pre-liberation examinations for each hatchery program. A cumulative five year disease history will be maintained for each program and reported in annual or other appropriate facility reports. Also, a fish health status of stock is summarized prior to any release or transfer to another facility. Finally, existing facilities will strive for proper water chemistry and characteristics as suggested in IHOT (1995). This may require additional water filtration and disinfection, heating or cooling, degassing and/or aeration, or other modifications to the quantity and quality of an existing water supply, including:

- Pathogen-free water supplies will be explored for each facility, particularly for egg incubation and early rearing.
- Water supplies must provide acceptable temperature regimes for egg incubation, juvenile rearing and adult holding.
- Water supplies will have appropriate water chemistry profiles, including dissolved gases: near saturation for oxygen, and less than saturation for nitrogen.
- Water supplies for egg incubation must not contain excessive organic debris, unsettleable solids or other characteristics that negatively affect egg quality and survival.
- Equipment will be disinfected, including vehicles used to transfer eggs or fish between facilities, prior to use with any other fish lot or at any other location. Disinfecting water should be disposed of in properly designated areas.

- Equipment used to collect dead fish prior to use in another pond and /or fish lot will be sanitized.

Facility upgrades were recently implemented at Kingfisher Flat Hatchery, which produces coho salmon and steelhead for release in Scott Creek (Santa Cruz County). New circular tanks are expected to increase juvenile survival at the facility, while a recently installed water-recirculation system will improve water availability and quality during drought periods when the hatchery's water source may be limited.

Listing Factor D: Inadequacy of existing regulatory mechanisms

Timber Harvest and Land Management

Timber harvest and associated road building was noted as a limiting factor during CCC coho salmon listing in 2005. Federally, the Northwest Forest Plan (NFP) has generally accomplished the goal of slowing aquatic degradation that had been accelerating under previous forest management programs (Reeves 2006). Although the NFP generally contains effective regulations that minimize timber harvest-related impacts that harm coho salmon habitat, its impact within the CCC coho salmon ESU is rather limited given the relatively small percentage of Federal land (approximately 5%).

Concerning State Forest Practice Rules, when Anadromous Salmonid Rules were implemented in 1990, the state Board of Forestry (BOF) changed the definition of Class II-Large watercourses, increasing protections along Class II-Standard watercourses. These changes were intended to provide the regulated timber industry with clarification in how to identify Class II-Large watercourses in the field, and to provide an additional no-cut buffer to certain Class II-Standard watercourses. In addition to these changes, the BOF approved new regulations for logging roads and landings, which address many of the logging road related threats that were identified at the time of listing. Generally speaking, these changes represent a substantial improvement in the Forest Practice Rules. However, when the BOF changed the Class II-Large watercourse definition, they did not expand the protections to lands in the Southern Subdistrict of the Coast Forest. The lack of Class II-Large watercourse protections in the Southern Subdistrict remains a threat to CCC coho salmon in Santa Cruz and San Mateo counties.

Aside from updates to the California Forest Practice Rules, few changes to state land management programs have occurred since the last status review in 2011. Sonoma County adopted their Vineyard Erosion and Sediment Control Ordinance (VESCO) in 2012 that aims to reduce sediment discharge into stream resulting from vineyard and orchard development. While VESCO may minimize potential erosion from these activities, the ordinance nevertheless fails to analyze the impact a vineyard's future water use may have on adjacent streams. San Mateo and Santa Cruz counties have grading ordinances or regulations less protective of aquatic habitat than Sonoma County, and Mendocino County has no ordinance or effective regulatory structure concerning agricultural grading or groundwater development. Similarly, riparian ordinances are common throughout much of the ESU, but the protective stream setbacks generally fall short when compared to those suggested within the scientific literature as protective of instream and riparian habitat and function (*e.g.*, Jones and Stokes 2002). Mendocino County lacks a riparian protection ordinance.

Illegal Marijuana Culture

Regulating and managing marijuana cultivation, while not specifically a land management issue, is nevertheless critically important in the effort to minimize environmental damage resulting from illegal marijuana grows. The issue of marijuana regulation will likely be a contentious topic in the coming few years -- a ballot initiative legalizing recreational use of marijuana is expected on the state ballot in 2016, and a legislative effort to craft a bill legalizing recreational use may gain traction in order to preempt the ballot initiative. While these political efforts may dramatically change the marijuana cultivation landscape in California, the efficacy of any regulatory scheme to minimize grow-related environmental impacts would depend on specific details unknown at this time. Having environmental advocates (*i.e.*, resource agencies or environmental organizations) included as part of any legislative deliberations on the subject is critical toward crafting strong legalization laws that adequately and effectively minimize grow-related impacts.

Federal and State Water Management

Groundwater regulation and management should improve in the coming decades following the 2014 passage of the SGMA; however, surface water throughout the state is heavily over-allocated (Grantham and Viers 2014), and little change to the regulatory status quo concerning surface water rights and permitting is expected in the near future. As the state adapts to future climate variability combined with a period of accelerated population growth, the demands placed upon CCC coho ESU streams and rivers for surface water supplies will likely grow. Most large rivers and stream in the CCC coho ESU are listed by the Environmental Protection Agency and State Water Quality Control Board as impaired for temperature and sediment pollution (per Section 303(d) of the Clean Water Act[3]). Many of the waterbodies listed will have Total Maximum Daily Loads (*i.e.* TMDLs) identified, and an action plan for achieving that load, by 2019, which when implemented will improve coho salmon habitat in affected streams.

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[3]Information on the 303(d) list can be found at
http://www.swrcb.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

Wetland Protection

As noted earlier, the Federal government's "no net wetland loss" regulations under the Clean Water Act have been largely ineffective at preserving the amount and, more importantly, the ecological functions of wetland habitat in the U.S. Improving wetland protection within the CCC coho salmon ESU will likely be critical in future recovery efforts.

Protective Measures

SGMA, signed into law in January 2015, for the first time in California history regulates and manages the state's groundwater resources to ensure sustainability of the resource. More importantly, 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, SGMA slowly phases in the new regulatory scheme (*e.g.*, overdrafted 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. On a smaller spatial scale, the recently enacted Russian River Frost Protection Regulation will reduce the occurrence of rapid stream dewatering and resultant juvenile salmonid stranding that has been recently documented in certain agriculture-dominated watersheds in the basin. The regulation takes effect for the 2015 frost diversion season (Mar-Apr).

Timberland management within the CCC coho salmon ESU will likely improve after implementation of Mendocino Redwood Company's (MRC) 80-year Habitat Conservation Plan, set to begin in late 2016 or 2017. The plan is intended to improve timber harvest and road building practices across approximately 200,000 acres of private timberland in Mendocino and Sonoma counties. As noted earlier, the state's Forest Practice Rules were updated with more stringent environmental controls for harvesting in riparian areas – unfortunately, those updates were only applied to the northern portion of the CCC coho salmon ESU.

Additionally, some private timber companies are actively restoring damaged aquatic and upslope habitat, for instance by increasing instream LWD volume or abating upslope erosion sources.

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

Drought

California has experienced well below average precipitation in each of the past 4 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 2015 (SWFSC 2015). Some paleoclimate reconstructions suggest that the current 4-year drought is the most extreme in the past 500 or perhaps more than 1000 years (SWFSC 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 (SWFSC 2015).

The effects of this extended drought on water supplies and water temperatures are a major concern for salmonid populations in California. Drought conditions are known to reduce the amount of water available, resulting in reductions (or elimination) of flows needed for adult salmonid passage, egg incubation, and juvenile rearing and migration. The high incidence of illegal stream diversions associated with illegal marijuana cultivation has been especially stressful to salmonid populations during the past four years, since the greatest demand for irrigation water overlaps with the lowest summer baseflows. Drought impacts will likely impact salmonids for several more years, since prolonged above-average precipitation is necessary to bring the state's surface and groundwater reserves back to normal levels.

<u>Climate Change</u>

Recent Trends in Marine and Environmental Conditions

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, and 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) provides a more detailed discussion of these recent climate conditions and expected impacts.

Long-term Climate Change

Climate experts predict physical changes to ocean, river and stream environments along the West Coast that include: warmer atmospheric temperatures resulting in more precipitation falling as rain rather than snow; diminished snow pack resulting in altered stream flow volume and timing; increased winter flooding; lower late summer flows; a continued rise in stream temperatures; increased sea-surface temperatures; increased ocean acidity; sea-level rise; altered estuary dynamics; changes in the timing, duration and strength of nearshore upwelling, and altered marine and freshwater food-chain dynamics (see Williams *et al.* (2016)) for a more detailed discussion of these and other projected long-term impacts due to climate change). These long-term climate, environmental and ecosystem changes are expected to in turn cause changes in salmon and steelhead distribution, behavior, growth, and survival. While an analysis of ESU/DPS-specific vulnerabilities to climate change by life stage has not been completed, Williams *et al.* (2016) summarizes climate change impacts that will likely be shared among salmon and steelhead ESUs/DPSs. In summary, both freshwater and marine productivity and survival tend to be lower in warmer years for most salmon and steelhead populations considered in this assessment. These trends suggest that many populations might decline as mean temperature rises. However, the magnitude and timing of these and other changes, and specific effects on individual salmon and steelhead ESUs/DPSs, remain unclear.

Marine Environment

In marine environments, ecosystems and habitats important to sub adult and adult salmonids are likely to experience changes in temperatures, circulation and chemistry, and food supplies (Feely *et al.* 2004, Brewer and Barry 2008, Osgood 2008, Turley 2008). Poor ocean survival is believed to have been a key factor in the decline of salmonid populations in California since the 1970s (Beamish *et al.* 2009). 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 due to a developing El Nino weather pattern in the eastern Pacific ocean (SWFSC 2015). An increased occurrence of these observed shifts in oceanographic patterns (*e.g.*, sea-surface temperatures, upwelling patterns, sea-level height, *etc.*) can negatively impact food availability, migration patterns, and other biotic and behavioral characteristics of ocean-dwelling CCC coho salmon (Beamish *et al.* 2009).

Small Population Size

Many populations of coho salmon in this ESU have declined in abundance to levels that are well below low-risk abundance targets, and several are, if not already extirpated, likely below the high-risk depensation thresholds specified by Spence *et al.* (2008). These small populations are at risk from natural stochastic processes, in addition to deterministic threats, that may make recovery of this ESU difficult to achieve. As natural populations get smaller, stochastic processes may cause alterations in genetics, breeding structure, and population dynamics that may interfere with the success of recovery efforts and need to be considered when evaluating how populations may respond to recovery actions. Since 2010, adult coho salmon escapement has generally increased within the two largest northern watersheds in the ESU (Russian River and Lagunitas Creek), although the high returns in the Russian River typically corresponded with greater juvenile stocking three years prior (California Sea Grant 2015, Marin Municipal Water District 2013). Further south, adult coho salmon escapement in Scott Creek was poor between 2010 and 2013 (The Nature Conservancy 2014). Even though recent data suggests some CCC coho salmon populations are improving, all populations remain at severely depressed levels, suggesting stochastic processes continue to remain a high threat to the species.

Invasive Species

Aquatic invasive species (AIS), are organisms (plants, animals, or pathogens) that impact the diversity or abundance of native species, the ecological stability of infested waters, and/or the commercial, agricultural, aquaculture or recreational activities dependent on such waters[4]. The myriad of pathways in which AIS can enter and are transported to coastal marine, estuarine, and riverine areas pose a significant management challenge. In coastal marine and fresh water environments, AIS have been shown to have major negative effects on the receiving communities where they often outcompete native species, reduce species diversity, change community structure, reduce productivity and disrupt food web function by altering energy flow among trophic levels (Cohen and Carleton 1995, Cohen and Carlton 1998, Ruiz *et al.* 2000, Stachowicz and Byrnes 2006). There are multiple mechanisms of impact that directly affect salmonids, such as predation and infection (disease and parasitism), and indirectly such as competition, hybridization, and habitat alterations (Mack *et al.* 2000, Simberloff *et al.* 2005).

We need to understand the role of AIS in the decline of threatened and endangered fish across multiple scales (*i.e.*, individual populations, communities, and ecosystem process) in order to effectively manage and recover these species and systems in the face of global climate change and the full suite of stressors. In California, approximately half of the freshwater species, which include aquatic invasive plants, animals, and pathogens, are introduced; and as many as 40 introduced species may be present in individual watersheds. Despite the abundance of AIS (plants and invertebrates taxa), there is limited information to assess their impacts on aquatic ecosystems, thus the associated implications for habitats occupied by threated and endangered salmonids is difficult to determine (Sanderson *et al.* 2009). Over the last five years, NOAA has

[4] The definition of aquatic invasive species is derived from the nonindigenous aquatic invasive species nuisance aquatic prevention and control act of 1990.

made progress on increasing our understanding of AIS data availability, ongoing research, and strategies among relevant NOAA Line Offices. More studies are needed to specifically investigate the impacts of AIS on ESA-listed salmonid populations, their designated critical habitat, and species recovery.

NMFS recognizes that AIS pose potential risk and may reduce the number of juvenile salmon before they transition to adulthood. The cumulative AIS impacts are potentially quite large and should be considered in conjunction with the more commonly addressed impacts on salmonids. Control and management is necessary in areas where AIS are already established to prevent their further spread and lessen their impacts on native ecosystems.

Hatchery Effects

Hatchery programs can provide short-term demographic benefits, such as increases in abundance, during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of the risk depends on the status of affected populations and on specific practices in the hatchery program. To acknowledge and adequately minimize these risks, NMFS is currently crafting Hatchery Genetic Management Plans (HGMP) for the three coho salmon hatcheries presently operating within the CCC coho salmon ESU.

Protective Efforts

New Zealand Mudsnail (*Potamopyrgus antipodarum*)

The New Zealand Mudsnail is rapidly invading California, in large part because of people not cleaning their field/fishing gear or boats when moving to different a new aquatic location. Once established, the snail will quickly overpopulate an area due to an absence of natural predators. As their population grows, the snails can disrupt the aquatic food chain by displacing other native benthic species, which can limit food availability for juvenile salmon and steelhead. Education and outreach campaigns and signage have brought awareness to the practices needed to clean and remove snails from field gear and boats before going to a new location.

Other Efforts Being Made 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. Throughout the range of salmon ESUs and steelhead DPSs, there are numerous Federal, state, tribal and local programs that protect anadromous fish and their habitat. 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 and steelhead (76 FR 50448), 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 address conservation needs at scales insufficient 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 five factor analysis above, we note the many habitat, hatchery, and harvest improvements that occurred in the past five years. We currently are 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.

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' 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 risk 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.

Assessing changes in the status of CCC coho salmon remains challenging due to the scarcity of long-term datasets for most populations. However, CMP implementation across significant portions of the ESU has resulted in a number of shorter time series that have substantially improved our understanding of current status. The existing data indicate that all independent and dependent populations are well below recovery targets and, in some cases, exceed high-risk thresholds established by Spence *et al.* (2008). Although the longer-term (12-17 year) trends tend to be downward, data from the past 5 years suggest that some populations reached their lowest levels around 2008-2009 and have rebounded slightly since then. An area of particular concern is the downward trends in abundance of virtually all dependent populations across all diversity strata. These trends suggest that dependent populations are less able to maintain connectivity or act as buffers against declines in neighboring independent populations, suggesting that the independent populations are becoming more isolated with time (Spence 2016). Populations continue to be the strongest in the Mendocino County watersheds from the Navarro River northward, and weaker to the south, with the exception of Lagunitas Creek (Spence 2016). The status of coho salmon in the Santa Cruz Mountain stratum, where virtually all observed salmon have been the result of hatchery operations, remains especially dire (Spence 2016).

Although conservation efforts for coho salmon have reduced some threats for this ESU, the threats described in the five listing factor discussion in section 2.3.2 have, with few exceptions, remained unchanged since the last review (NFMS 2011). While historical threats, such as timber harvest and commercial exploitation, have lessened during the past few decades, other previously unidentified threats, often linked to climate change, have worsened, and will likely worsen further in the coming decades. Shifts in oceanographic dynamics, such as sea-surface temperatures, wind patterns, and coastal upwelling, can alter salmon migration patterns and decrease food availability, greatly impacting CCC coho salmon survival in the marine environment. Likewise, shifting temperature and precipitation patterns throughout the western U.S. are expected to significantly alter riverine hydrologic patterns, with warmer winter temperatures leading to less snowpack storage, more intense runoff events, and lower streamflows during dry periods. Recent local and state regulatory efforts may help mitigate the impact of climate change on streamflow, with the state's Sustainable Groundwater Management Act perhaps the most promising. However, the two-decade timeframe for full implementation of the act suggests the expected benefits may not be rapidly forthcoming. Overall, California has been a leader in addressing climate change through innovative technology and regulation, but international solutions are likely necessary given the global nature and extent of the issue.

In summary, the best available information on the biological status of this ESU and the threats facing this ESU indicate that it continues to remain endangered.

2.4.1 ESU/DPS Viability and Statutory Listing Factors

- The Southwest Fisheries Science Center's review of updated information does not indicate a change in the biological risk category for CCC coho salmon since the time of the last status review (Williams *et al.* 2016).

- Our analysis of the ESA section 4(a)(1) factors indicates that the collective risk to CCC coho salmon persistence has not changed significantly since our 2011 final listing determination.

3 RESULTS

3.1 CLASSIFICATION

Listing Status

Based on the information identified above, we determine that no reclassification for CCC coho salmon ESU is appropriate, and therefore the CCC coho salmon ESU should remain listed as endangered.

Hatchery Membership

The CCC coho salmon hatchery programs have not changed substantially from the previous ESA status review. Therefore, we do not recommend any changes in hatchery membership for the CCC coho salmon ESU.

3.2 NEW RECOVERY PRIORITY NUMBER

No change is recommended in the recovery priority number (1) for the CCC coho salmon ESU.

4 RECOMMENDATIONS FOR FUTURE ACTIONS

In our review of the listing factors we identified several actions critical to improving the status of CCC coho salmon. NMFS provided a number of recommended actions in the 2011 status review that are still relevant at this time. In this review, we focus on the most important actions to pursue over the next 5 years.

- Continue and expand conservation hatchery programs intended to prevent extinction and improve distribution, abundance, and genetic diversity of populations while other recovery efforts are underway.
  - Procure funding to expand production at the Russian River coho program facility, with possible stream stocking expansion into the northern portion of the CCC coho salmon ESU.
  - Secure funding to improve operational functionality at the Kingfisher Flat Hatchery (Scott Creek) to prevent broodstock and rearing fish loss, and secure funding to identify new sites for a regional conservation hatchery with a suitable water supply in the Santa Cruz Mountains strata geographic area.
  - Complete Hatchery Genetic Management Plans for existing CCC coho salmon hatchery programs within the ESU.

- Continue and expand restoration and funding partnerships through implementation of priority actions outlined in State and Federal recovery plans for CCC coho salmon and priorities established from the NMFS-CDFW Priority Action Coho Team (PACT) effort. Examples include:
  - Lagoon restoration at Scott Creek in Santa Cruz, California
  - Garcia River estuary restoration, land purchase/easement and stakeholder outreach
  - Ten Mile River Estuary and Winter Refugia Habitat Restoration

- Refine and improve monitoring to inform State and Federal recovery plan criteria and expand needed research in key areas.
  - Secure stable long-term funding for CCC coho salmon monitoring. Long-term dedicated resources are necessary to improve protocols, establish new monitoring locations, and support data collection, evaluation and reporting.
  - Include adult monitoring within every core population, preferably through the use of life-cycle stations. Include the Russian River within the CMP.

  - Expand PIT tag arrays to improve understanding of population structure and natural straying rates within the CCC coho salmon ESU.
  - Convene science panel to evaluate conservation risks and benefits of sandberm breaching under a variety of environmental scenarios. Develop criteria to guide berm breaching decisions at different seasonal time periods.

- Per the Sustainable Groundwater Management Act, engage with local agencies and stakeholders during Groundwater Sustainability Plan development to ensure future groundwater extraction avoids impacting CCC coho salmon aquatic habitat.

- Assist state efforts to minimize the impact of marijuana cultivation on CCC coho salmon and their habitat through state regulation and enforcement.

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National Marine Fisheries Service

5-Year Review

for

Central California Coast Coho Salmon

Conclusion:

Based on the information identified above, we conclude:

- Central California Coast Coho Salmon should remain listed as endangered.

REGIONAL OFFICE APPROVAL

Approve: ______________________

Date: 4/13/16

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