CENTRAL VALLEY RECOVERY DOMAIN

5-Year Review:
Summary and Evaluation of

Sacramento River Winter-run Chinook Salmon ESU

National Marine Fisheries Service
Southwest Region
Long Beach, CA

5-YEAR REVIEW
Central Valley Recovery Domain

Species Reviewed	Evolutionarily Significant Unit (ESU) or Distinct Population Segment
Chinook Salmon *(Oncorhynchus. tshawytscha)*	**Sacramento River Winter-run Chinook Salmon ESU**

1.0 GENERAL INFORMATION

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1.2 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 (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 west coast salmon and steelhead occurred in 2005 and 2006. This document summarizes NMFS's 5-year review of the ESA-listed Sacramento River (SR) winter run Chinook Salmon Evolutionarily Significant Unit (ESU).

1.2.1 Background on Listing Determinations

Under the ESA, a species, subspecies, or a distinct population segment (DPS) may be listed as threatened or endangered. To identify the proper taxonomic unit for consideration in an ESA listing for salmon we draw on our "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (ESU Policy) (56 FR 58612). According to this policy guidance, populations of salmon substantially reproductively isolated from other con-specific populations and representing an important component in the evolutionary legacy of the biological species are considered to be an ESU. In our listing determinations for Pacific salmon under the ESA, we treated an ESU as constituting a DPS, and hence a "species."

In 2006, we announced that NMFS would apply the joint U.S. Fish and Wildlife Service-National Marine Fisheries Service DPS policy (61 FR 4722) rather than our agency's ESU policy to populations of West Coast steelhead (*O. mykiss*). Under this policy, a DPS of steelhead must be discrete from other con-specific populations, and it must be significant to its taxon. A group of organisms is discrete if it is ''markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors" (61 FR 4722). According to the DPS policy, if a population group is determined to be discrete, we must then consider whether it is significant to the taxon to which it belongs. Considerations in evaluating the significance of a discrete population include: (1) persistence of the discrete population in an unusual or unique ecological setting for the taxon; (2) evidence that the loss of the discrete population segment would cause a significant gap in the taxon's range; (3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere outside its historical geographic range; or (4) evidence that the discrete population has marked genetic differences from other populations of the species.

Artificial propagation (fish hatchery) programs are common throughout the range of ESA-listed West Coast salmon and steelhead. On June 28, 2005, we announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204). Specifically, this policy: (1) establishes criteria for including hatchery stocks in ESUs and DPSs; (2) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (3) requires that hatchery fish determined to be part of an ESU or DPS to be included in any listing of those units; (4) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (5) 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 was part of an ESU or DPS, NMFS convened the Salmon and Steelhead Hatchery Advisory Group (SSHAG), which evaluated all hatchery stocks and programs and divided them into 4 categories (SHAGG 2003):

Category 1: The hatchery population was derived from a native, local population; is released within the range of the natural population from which is was derived; and has experienced only relatively minor genetic changes from causes such as founder effects, domestication or non-local introgression.

Category 2: The hatchery population was derived from a local natural population, and is released within the range of the natural population from which is was derived, but is known or suspected to have experienced a moderate level of genetic change from causes such as founder effects, domestication, or non-native introgression.

Category 3: The hatchery population is derived predominately from other populations that are in the same ESU/DPS, but is substantially diverged from the local, natural population(s) in the watershed in which it is released.

Category 4: The hatchery population was predominately derived from populations that are not part of the ESU/DPS in question; or there is substantial uncertainty about the origin and history of the hatchery population.

Based on these categorical delineations, hatchery programs in SSHAG categories 1 and 2 are included as part of an ESU or DPS (70 FR 37204) although hatchery programs in other categories may also be included in an ESU or DPS.

Because the new hatchery listing policy changed the way NMFS considered hatchery fish in ESA listing determinations, we conducted new status reviews and ESA-listing determinations for West Coast salmon ESUs and steelhead DPSs using this policy. On June 28, 2005, we issued final listing determinations for 16 ESUs of Pacific salmon (including the Sacramento River winter-run Chinook salmon ESU) and on January 5, 2006 we issued final listing determinations for 10 DPSs of steelhead.

1.3 Methodology used to complete the review

Section 4(c) (2) of the ESA requires 5 year reviews for all species once listed to determine if a change in status is necessary. A Federal Register notice was published on March 18, 2010 (75 FR 13082) that announced the initiation of 5-year reviews for west coast salmon and steelhead and also opened a 60-day public comment period to solicit information relevant to the reviews. The Southwest Region (SWR) coordinated informally by letter with State and tribal co-managers to ensure those co-managers were informed about the 5-year reviews and had an opportunity to provide any comments or information. All relevant public comments were considered as part of this review.

Following the public comment period, three key steps were taken to complete the 5-year review for the SR winter-run Chinook salmon ESU. First, the Southwest Fisheries Science Center (SWFSC) reviewed all new and substantial scientific information generated since the last west coast status review and produced an updated biological status summary report for this ESU and all other listed salmon and steelhead in California (herein referred to as the "viability report"). The purpose of the viability report (Williams et al. 2011) was to assess whether or not the biological status of this ESU and the other listed salmon and steelhead had changed since the last status review was conducted. Second, staff from the Central Valley Office (CVO) of the Protected Resources Division (PRD) reviewed the viability report and assessed whether the five ESA listing factors (threats) had changed substantially since the 2005 listing determination for this ESU. To assess whether the five listing factors had changed substantially since 2005, several key documents were reviewed including the Federal Register notices listed in Tables 1 and 2 and other relevant documents including:

(1) Central Valley Salmon and Steelhead Public Draft Recovery Plan (NMFS 2009a)
(2) Biological Opinion on the Long-term Operations of the Central Valley Project and State Water Project (NMFS 2009b)
(3) Listen to the River: An Independent Review of the CVPIA Fisheries Program (Cummins et al. 2008)
(4) Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin (Lindley et al. 2007)
(5) What caused the Sacramento River fall Chinook stock collapse? (Lindley et al. 2009)
(6) Migration and survival of juvenile salmonids in California's Central Valley and San Francisco estuary; 2007 and 2008 data (MacFarlane et al. 2008)

Finally, staff from the CVO considered the viability report, the five factor analysis update including current threats to the species, and relevant conservation measures before making a recommendation about whether the listing status of the ESU or its geographic boundaries should be changed. In the CVO a team of three biologists formed the core working group that assimilated information from various sources to support this review and the reviews of Central valley spring-run Chinook salmon and Central Valley steelhead.

Other information sources reviewed pertaining to the ESA status of this ESU included:

- Draft Winter-run Recovery/Management Plan (NMFS 1997);
- Harvest and hatchery assessments (NMFS staff report 2010);
- Recent ocean harvest biological opinion pertaining to the protection of Winter-run Chinook salmon (NMFS 2010b);
- peer-reviewed scientific publications;
- grey literature (agency annual reports);
- annual abundance estimates from the California Department of Fish and Game (DFG 2010);
- previous status review for the ESU (Good et al. 2005).
- final rule listing the winter-run Chinook salmon as endangered (70 FR 37160) (June 28, 2005);
- final rule designating critical habitat for the winter-run Chinook salmon (58 FR 33212) (June 16, 1993).

All literature and documents used for this review are on file at the SWR's CVO and Long Beach Office.

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

1.4.1 Federal Register (FR) Notice citation announcing initiation of this review

75 FR 13082; March 18, 2010

1.4.2 Listing history

The SR winter-run chinook salmon ESU was first listed as "threatened" in 1989 under an emergency rule (Table 1). In 1994, NMFS reclassified the ESU as an endangered species due to several factors, including: (1) the continued decline and increased variability of run sizes since its listing as a threatened species in 1989; (2) the expectation of weak returns in coming years as the result of two small year classes (1991 and 1993); and (3) continuing threats to the species. On June 14, 2004, NMFS proposed to reclassify the ESU as threatened (69 FR 33102; June 14, 2004) primarily because of increasing run sizes and the implementation of numerous conservation efforts in the Central Valley. Following the comment period on the proposed reclassification and additional analysis, NMFS issued a final listing determination on June 28, 2005 (see Table 1) concluding that the ESU was "in danger of extinction" due to risks associated with its reduced diversity and spatial structure, and therefore, warranted continued listing as an endangered species under the ESA (70 FR 37160. This ESU is also listed as "endangered" species under the State of California's endangered species law (California Endangered Species Act or CESA).

Table 1. Summary of the listing history under the Endangered Species Act for the SR winter-run Chinook salmon ESU.

Salmonid Species	ESU Name	Original Listing	Revised Listing(s)
Chinook Salmon *(O. tshawytscha)*	**Sacramento River Winter-run Chinook salmon**	**FR notice:** 54 FR 32085 **Date listed:** 8/4/1989 **Classification**: *Threatened (emergency interim rule)*	
			FR notice: 55 FR 10260 **Date listed:** 3/20/1990 **Classification**: *Proposed Threatened*
			FR notice: 55 FR 12191 **Date listed:** 4/2/1990 **Classification**: *Threatened (emergency interim rule)*
			FR notice: 55 FR 46515

			Date listed: 11/5/1990 **Classification**: *Threatened*
			FR notice: 57 FR 27416 **Date listed:** 6/19/1992 **Classification**: *Proposed re-classification Endangered*
		FR notice: 69 FR 33102 **Date listed:** 6/14/2004 **Classification**: *proposed re-classification* **:** *Threatened*	**FR notice:** 70 FR 37160 **Date listed:** 6/28/2005 **Classification**: *reaffirmed classification* **:** *Endangered*

This ESU includes all fish spawning naturally in the Sacramento River and its tributaries, as well as fish that are propagated at the Livingston Stone National Fish Hatchery (LSNFH) which is operated by the U.S. Fish and Wildlife Service (USFWS) (see 70 FR 37160; June 2005) (Figure 1).

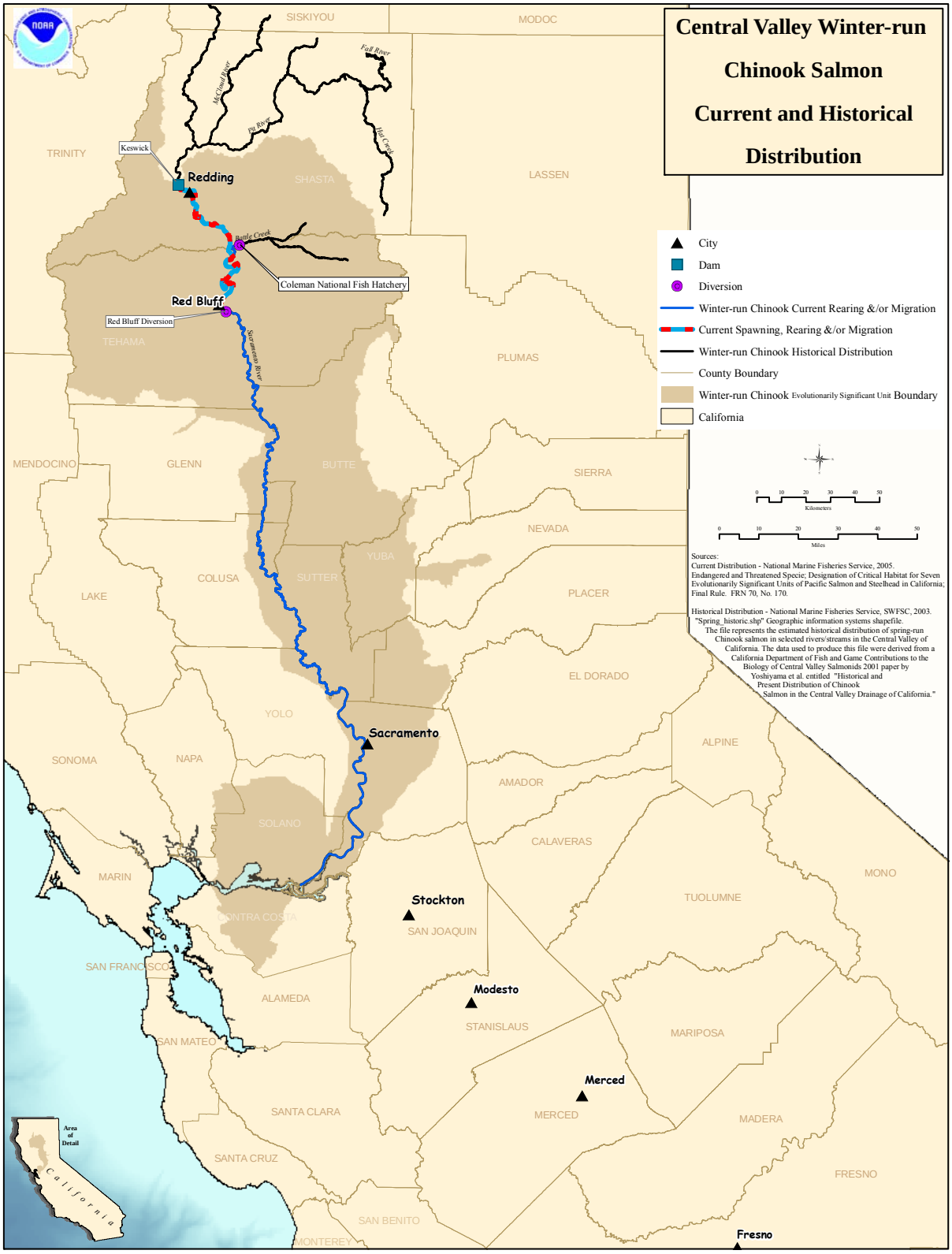


Figure 1. Current and historical SR winter-run Chinook salmon ESU distribution (from Central Valley draft Recovery Plan; NMFS 2009).

1.4.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat for any 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, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. We designated critical habitat for this ESU in 1993 (Table 2).

Section 4(d) of the ESA directs NMFS to issue regulations to conserve species listed as threatened. This applies particularly to "take," which can include any act that kills or injures fish, and may include habitat modification. The ESA prohibits any take of species listed as endangered, but some take of threatened species that does not interfere with salmon survival and recovery can be allowed. In 1990, a 4(d) protective regulation was promulgated for this ESU that applied the section 9 take prohibitions at the time it was originally listed as threatened. This rule was superseded by the 1994 reclassification of the ESU as endangered (Table 2).

Table 2. Summary of 4(d) protective regulations and critical habitat for the SR winter-run Chinook salmon ESU.

Salmonid Species	ESU Name	4(d) Protective Regulations	Critical Habitat Designations
Chinook Salmon *(O. tshawytscha)*	**Sacramento River Winter-run Chinook salmon**	**FR notice:** 55 FR 46515 **Date:** 11/5/1990*****	**FR notice:** 58 FR 33212 **Date:** 6/16/1993

***Note:** The 1990 4(d) rule was later superseded by the 1994 reclassification of this ESU as endangered (see Table 1).

1.3.4 Review History

Numerous scientific assessments have been conducted to assess the biological status of this ESU. A list of those assessments is provided in Table 3.

Table 3. Previous scientific assessments for the SR winter-run Chinook salmon ESU.

Salmonid Species	ESU Name	Document Citation
Chinook Salmon *(O. tshawytscha*	**Sacramento River Winter-run Chinook salmon**	National Marine Fisheries Service. 1996. Recommendations for the Recovery of the Sacramento river Winter-run Chinook Salmon. Recovery Team. Long Beach. CA. 211 pages.
		National Marine Fisheries Service. 1998. Status review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443 pages.

		National Marine Fisheries Service. 1999. Status review update for deferred ESUs of West Coast Chinook salmon (*Oncorhynchus tshawytscha*) from Washington, Oregon, California, and Idaho. Memorandum dated 16 July 1999, to U. Varanasi, Northwest Fisheries Science Center, and M. Tillman, Southwest Fisheries Science Center, from M. Schiewe, Northwest Fisheries Science Center, Montlake, Washington.
		National Marine Fisheries Service. 2003. Draft Report of Updated Status of Listed ESUs of Salmon and Steelhead. NOAA Fisheries, Northwest Fisheries Science Center, Seattle, Washington. (http://www.nwfsc.noaa.gov/cbd/trt/brt/brtrpt.html)
		Lindley, S.T., R. Schick, B.P. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population structure of threatened and endangered Chinook salmon ESU in California's Central Valley basin. NMFS Southwest Science Center NOAA-TM-NMFS-SWFSC-360. Santa Cruz, CA.
		Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.
		National Marine Fisheries Service. 2005. Final assessment of the National Marine Fisheries Service's critical habitat analytical review teams (CHARTs) for seven salmon and steelhead evolutionarily significant units (ESUs) in California. July. Prepared by the NOAA Fisheries, Protected Resources Division, Long Beach, California. Available at: http://swr.nmfs.noaa.gov/chd/CHART%20Final%20Assessment/Final_CHART_Report-July_05.pdf.
		Lindley, S.T., R. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. R. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5(1), Article 4: 26 pages. Available at: http://repositories.cdlib.org/jmie/sfews/vol5/iss1/art4.
		National Marine Fisheries Service. 2010. T. H. Williams, D. A. Boughton, S. T. Lindley, and B. C. Spence. Unpublished draft status review update for Pacific salmon and steelhead under the Endangered Species Act. Southwest Fisheries Science Center, Santa Cruz, CA. September 6, 2010. 109 pages.

1.3.5 Species' Recovery Priority Number at start of 5-year review

NMFS issued guidelines in 1990 (55 FR 24296) for assigning listing and recovery priorities. The recovery priority number is used to assess a species' priority for recovery plan development, implementation, and resource allocation and is based on three criteria: 1) magnitude of threat; 2) recovery potential; and 3) existing conflict with activities such as construction and development. Recovery priority numbers are designated from 1 (highest) to 12 (lowest) based on the criteria listed above. The recovery priority number for this ESU, as reported in the *2006-2008 Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species (available at: http://www.nmfs.noaa.gov/pr/pdfs/laws/esabiennial2008.pdf),* is 3 as shown in Table 4 below.

1.3.6 Recovery Plan or Outline

A draft recovery plan was developed in 1997 for the SR winter-run Chinook salmon ESU, but the plan was never finalized. In 2009, NMFS released a draft multi-species recovery plan that addresses all three listed salmonids in the Central Valley, including this ESU. This draft plan was released for public comment and is undergoing final revisions prior to publication as a final, approved recovery plan. NMFS anticipates the final recovery plan will be released in late 2011.

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plans for the SR winter-run Chinook salmon ESU.

Salmonid Species	Population/ESU trend	Recovery Priority Number	Status of Recovery Plans
Chinook Salmon *(O. tshawytscha)*	**Sacramento River Winter-run Chinook Salmon ESU: Trend: declining**	**Not determined**	Name of Plan: 1997 Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon Plan Status: Preliminary draft, never finalized
Chinook Salmon *(O. tshawytscha)*	**Sacramento River Winter-run Chinook Salmon ESU: Trend: declining**	**3**	Name of Plan: 2009 Public Draft Recovery Plan for the ESUs of Sacramento River Winter-run Chinook Salmon, and Central Valley Spring-run Chinook Salmon, and the Distinct Population Segment (DPS) of the Central Valley Steelhead. Available at: http://swr.nmfs.noaa.gov/recovery/centralvalleyplan.htm Plan Status: Public draft for review October 2009 Final Draft due 2011

2.0 REVIEW ANALYSIS

2.1 Delineation of Species under the Endangered Species Act

2.1.1 Is the species under review a vertebrate?

ESU/DPS Name	YES*	NO**
Sacramento River Winter-run Chinook Salmon ESU	**X**	

** if "Yes," go to section 2.1.2*
*** if "No," go to section 2.2*

2.1.2 Is the species under review listed as a DPS?

ESU/DPS Name	YES*	NO**
Sacramento River Winter-run Chinook Salmon ESU	**X**	

** if "Yes," go to section 2.1.3*
*** if "No," go to section 2.1.4*

2.1.3 Was the DPS listed prior to 1996?

ESU/DPS Name	YES*	NO**	Date Listed if Prior to 1996
Sacramento River Winter-run Chinook Salmon ESU	**X**		**1989**

** if "Yes," give date go to section 2.1.3.1*
*** if "No," go to section 2.1.4*

2.1.3.1 Prior to this 5-year review, was the Distinct Population Segment (DPS) classification reviewed to ensure it meets the 1996 policy standards?

In 1991 NMFS issued a policy to provide guidance for defining ESUs of salmon and steelhead that would be considered for listing under the ESA (56 FR 58612; November 20, 1991). Under this policy a group of Pacific salmon populations is considered an 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. In listing the SR winter-run Chinook salmon ESU, NMFS treated the delineated ESU as a DPS, and hence a "species", under the ESA. Although finalized after the listing of this ESU, the 1996 DPS policy affirmed that a stock of Pacific salmon is considered a DPS if it represents an evolutionarily significant unit (ESU) of a biological species and concluded that NMFS' ESU policy was a detailed extension of the joint DPS policy. In summary, therefore, the ESU meets the 1996 DPS policy standards.

2.1.4 Summary of relevant new information regarding the delineation of the ESU under review

The SR winter-run Chinook salmon ESU is represented by a single naturally spawning population that has been completely displaced from its historical spawning habitat by the construction of Shasta and Keswick Dams. Based on this review, there is no new information indicating that the current freshwater and estuarine geographic boundary of this ESU should be changed or that the population does not constitute an ESU. A few returning adults have been observed passing the Coleman National Fish Hatchery (CNFH) weir on Battle Creek (Table 5), however, the majority of this ESU's spawning population is confined to spawning habitat on the Sacramento River between Keswick Dam and Red Bluff (approximately 44 miles) which is artificially maintained by cold-water releases from Shasta Dam. If SR winter-run Chinook become established in other watersheds, such as Battle Creek, then the ESU boundary may need to be changed.

The U.S. Fish and Wildlife Service (USFWS) manages a conservation hatchery program for this ESU which is located at the Livingston Stone National Fish Hatchery (LSNFH). This hatchery program supplements the natural population according to strict guidelines developed in conjunction with NMFS. Based on a review of available genetic and other information, this hatchery stock was considered part of the SR winter-run Chinook ESU and was listed in 2005 (70 FR 37160). Based on this review, there is no new information indicating that this hatchery stock has diverged significantly from the natural spawning population or that there have been substantial changes in the hatchery management since the last status review.

Table 5: Summary of recent SR winter-run Chinook salmon ESU natural and hatchery escapement from 2005-2010 in the Central Valley (CDFG 2010a). Latest estimate for 2010 from CDFG letter to NMFS in Williams et al. (2011).

Year	Sacramento River above RBDD	Sacramento River below RBDD	Sum	CNFH transfers	LSNFH transfers	Battle Creek	Grand total
[Dec 2004 - Aug 2005]	15,730	0	15730	36	109	0	15875
[Dec 2005 - Aug 2006]	17,157	48	17205	5	93	1	17304
[Dec 2006 - Aug 2007]	2,487	0	2487	1	54	0	2542
[Dec 2007 - Aug 2008]	2,725	0	2725	0	105	0	2830
{Dec 2008-Aug 2009]	4,537	0	4537	0	121	0	4658
[Dec 2009 - Aug 2010]	1,533	0	1533	0	63	0	1596

2.2 Recovery Criteria

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

ESU/DPS Name	YES	NO
Sacramento River Winter-run Chinook Salmon ESU		**X**

The ESA requires recovery plans to incorporate (to the maximum extent practicable) objective, measurable criteria which, when met, would result in a determination in accordance with the provisions of the ESA that the species can be removed from the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12). NMFS has not yet issued a final approved recovery plan for this ESU. A draft proposed plan was released in 1997 that did have objective, measureable criteria, but that plan was never finalized. The draft proposed criteria from that 1997 plan have been used informally since 1997 (date of first draft plan. The 1997 draft proposed criteria for adult escapement (i.e., number of female spawners equal to 13,000) has not been reached; however, the criterion requiring a positive cohort replacement rate (CRR) was achieved from 1996 to 2005. Since the last status review the CRR has declined to below 1.0 for the period of 2007 through 2010 (Figure 5).

The 2009 draft proposed multi-species recovery plan for Central Valley salmon and steelhead does contain proposed recovery criteria that are objective and measureable. The proposed criteria reflect the best available and most-up-to-date information on the biology of the species and its habitat and address both biological parameters as well as the 5 listing factors. The proposed biological recovery criteria in the draft 2009 recovery plan are based on the Viable Salmon Population (VSP) criteria developed by McElhany et al. (2000).

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most-up-to-date information on the biology of the species and its habitat?

As noted above, a final approved recovery plan has not been released for this ESU. However, the 2009 draft plan does contain recovery criteria that reflect the best available and up-to-date information for this ESU based on the latest VSP criteria.

ESU/DPS Name	YES	NO
Sacramento River Winter-run Chinook Salmon ESU	**N/A**	**N/A**

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

As noted above, a final approved recovery plan has not been released for this ESU. The 2009 draft plan does not specifically address all of the 5 listing factors, but rather comprehensively evaluated all relevant current threats to the ESU and then prioritizes recovery actions that address the 5 listing factors. The draft recovery criteria are based on the VSP criteria for the ESU which when met will indirectly address the listing factors.

ESU/DPS Name	YES	NO
Sacramento River Winter-run Chinook Salmon ESU	**N/A**	**N/A**

2.2.3 List the recovery criteria as they appear in any final or interim recovery plan, and discuss how each criterion has or has not been met, citing information

As noted above, a final approved recovery plan has not been released for this ESU; however, a 2009 draft multi-species plan (i.e., Draft 2009 Central Valley Recovery Plan; NMFS 2009b) has been developed which does contain draft proposed criteria.

The draft plan contains recovery criteria indicating that the SR winter-run Chinook salmon ESU must have three viable populations with each at a low risk of extinction. Criteria for establishing that individual populations are viable were developed by the Central Valley Technical Recovery Team (Lindley et al. 2007) and have been incorporated into the draft recovery plan. The TRT developed two sets of criteria for establishing population viability based on available information. One set of criteria are based on the use of viability or extinction models if data and models are available to assess extinction risk. If such information is not available, the TRT developed a simpler set of criteria that address population size (i.e., effective population size), population decline, catastrophic rate and effect, and hatchery influence. Under this set of criteria, a population would be considered at a low risk of extinction (i.e., defined as < 5 percent chance of extinction within 100 years) if the following criteria are met:

- The effective population size must be > 500, or the population size must be > 2,500
- The population growth rate must show that a decline is not apparent or probable
- There must be no apparent or minimal risk of a catastrophic disturbance occurring
- Hatchery influence must be low, as determined by levels corresponding to different amounts, durations and sources of hatchery strays

2.3 Updated Information and Current Species Status

2.3.1 Analysis of Viable Salmonid Population (VSP) Criteria

This section is primarily based on the status review update prepared by the SWFSC (Williams et al. 2011) for the 5-year review process, but has been supplemented with information developed by CVO PRD staff.

Summary of Previous Biological Review Team (BRT) Conclusions

Good et al. (2005) found that the SR winter-run Chinook salmon ESU was in danger of extinction. The major concerns of the BRT were that there is only one extant population, and it is spawning outside of its historical range in artificially-maintained habitat that is vulnerable to drought and other catastrophes.

Brief Review of Technical Recovery Team (TRT) Documents and Findings

The CV TRT delineated four historical independent populations of the SR winter-run Chinook salmon ESU. The spawning areas of three of these historical populations are above the impassable Keswick and Shasta dams, while the fourth population (Battle Creek) is presently unsuitable for winter-run Chinook salmon due to high summer water temperatures. Lindley et al. (2007) developed viability criteria for Central Valley salmonids which are summarized in Table 17 and Figure 17 of Williams et al. (2011). Using data through 2004, Lindley et al. (2007) found that the mainstem Sacramento River population was at a low risk of extinction. The ESU as a whole, however, was not considered viable because there is only one naturally-spawning population and it is not within its historical range. An emerging concern was the increasing number of LSNFH-origin fish spawning in natural areas, although the duration and extent of this possible introgression was still consistent with a low extinction risk as of 2004.

New Data and Updated Analyses

Since the last status review routine escapement data have collected for this ESU allowing population viability statistics to be updated. The SWFSC's viability report (Williams et al. 2011) presents adult spawner escapement estimates over time for the Sacramento River population and the LSNFH (Figure 3) as well as abundance and trend statistics for the ESU (Table 6). Like many other populations of Chinook salmon in the Central Valley, the SR winter-run Chinook salmon ESU has declined in abundance since 2005 and the 10-year trend in abundance is negative. The average run or population size still satisfies the low risk criterion although the latest return estimate for 2010 (1,533 adults) falls into the moderate risk criterion

($N < 2500$) based on the extinction criteria in Lindley et al. 2007 (Table 7). Although ESU abundance has declined over the past 10 years it has not yet triggered the population decline criterion (Table 7). Since 2000, the proportion of the ESU spawning in the Sacramento River that are of hatchery origin has generally ranged between 5-10% of the total population, but in 2005 it did reach approximately 20% of the population (Figure 4). This is generally consistent with the USFWS's goal to manage the LSNFH program such that hatchery origin fish are less that 20% of the total in-river escapement. In 2010, hatchery fish were estimated to be 12% of the total in-river spawners based on carcass surveys (DFG 2010b).

Figure 2: The average percent hatchery returns of SR winter-run Chinook salmon to the Sacramento River over the last 10 years (approximately three generations) has been 8 percent, still below the low-risk threshold for hatchery influence (Williams et al. 2011).

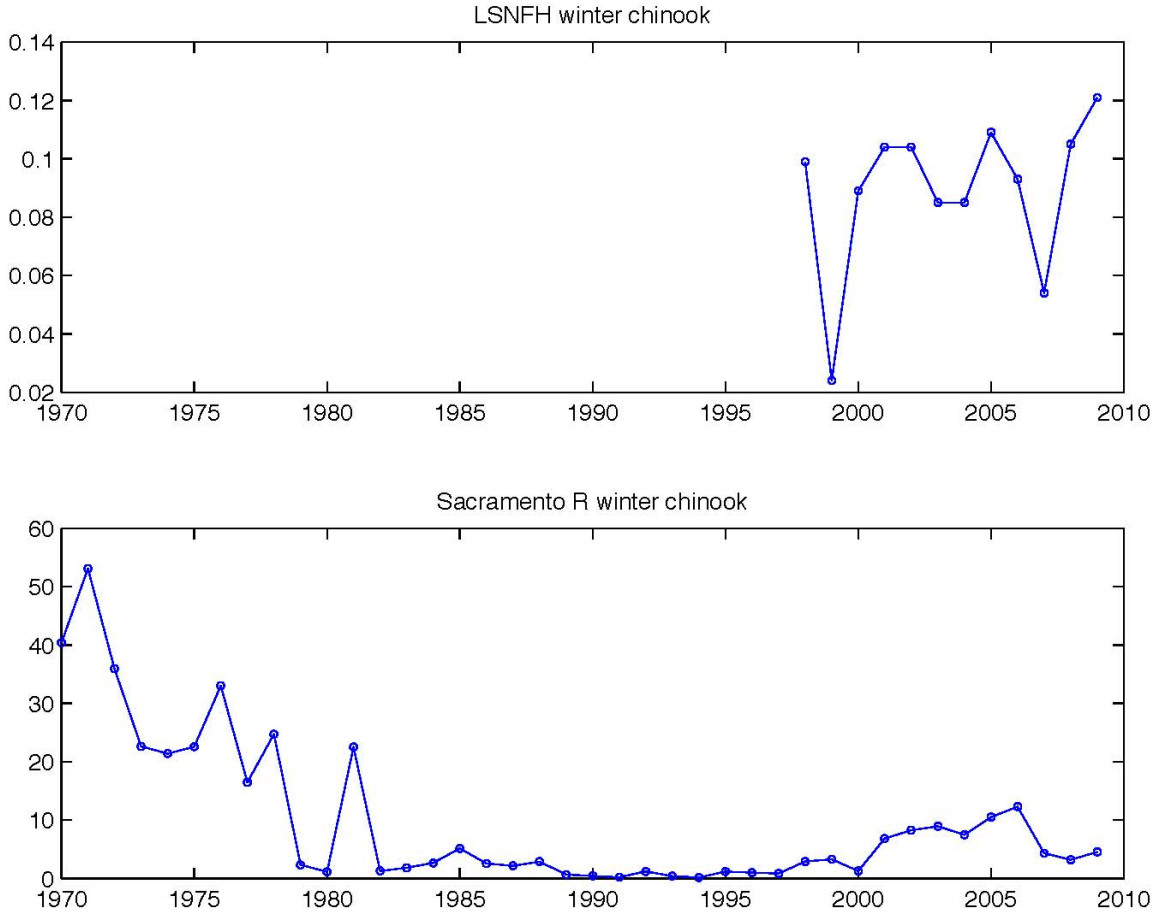


Figure 3: Escapement time series for the SR winter-run Chinook salmon ESU. Counts of the natural spawners are the average of the dam counts at Red Bluff and the carcass survey mark-recapture estimate (when available) (Williams et al. 2011).

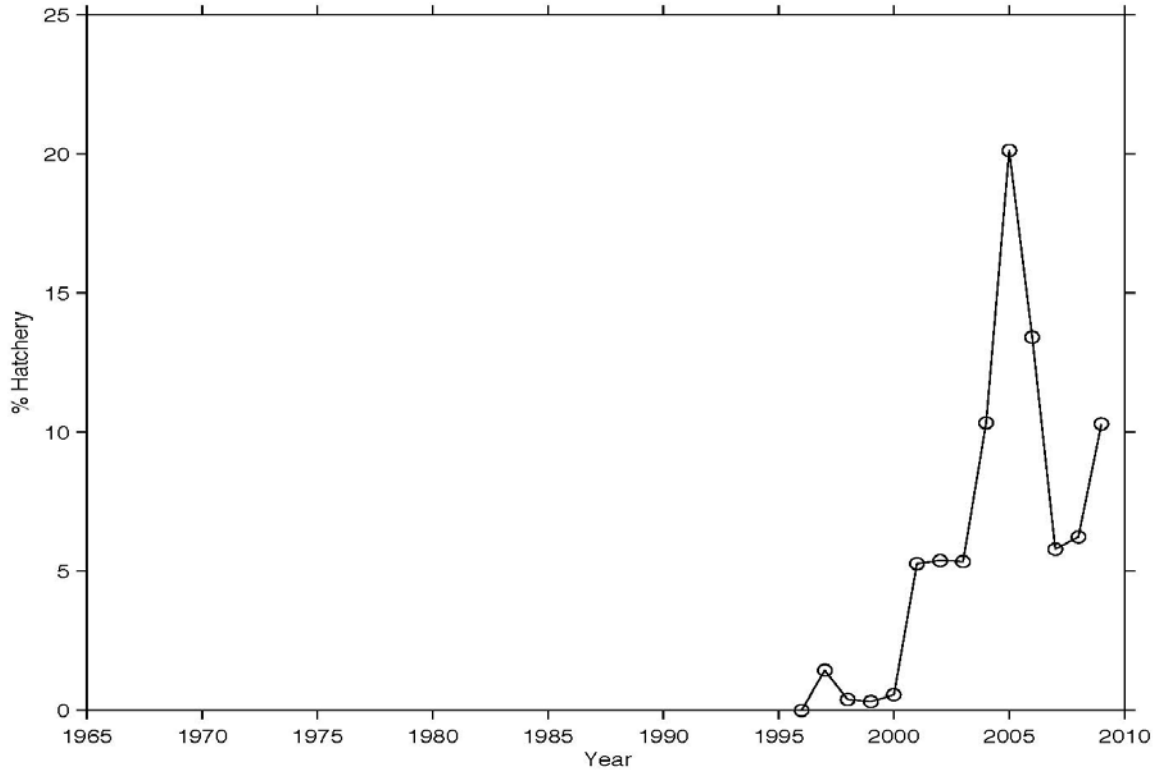


Figure 4: Percentage of SR winter-run Chinook salmon ESU spawning in the Sacramento River that are of hatchery origin (NMFS 2010a).

Table 6: Viability metrics for the SR winter-run Chinook salmon ESU (source: Williams et al. 2011)

Population	$\hat{S}$	N	10-year trend (95% CI)	Recent Decline (%)
LSNFH	93.3	280	0.001 (-0.059, 0.060)	9.8
Sacramento R.	4020	12040	0.026 (-0.156, 0.207)	38.0

Note: The mean run size ($\hat{S}$) is computed as the mean of up to the three most recent generations if that much data are available. Mean population size (N) is estimated as the product of the mean run size and the average generation time ($\hat{S}_t \times g$).

Table 7. Criteria for assessing the level of risk of extinction for populations of Pacific salmonids. Overall risk is determined by the highest risk score for any category (Lindley et. al. 2007).

	Risk of Extinction		
Criterion	High	Moderate	Low
Extinction risk	> 20% within 20 years	> 5% within 100	< 5% within 100

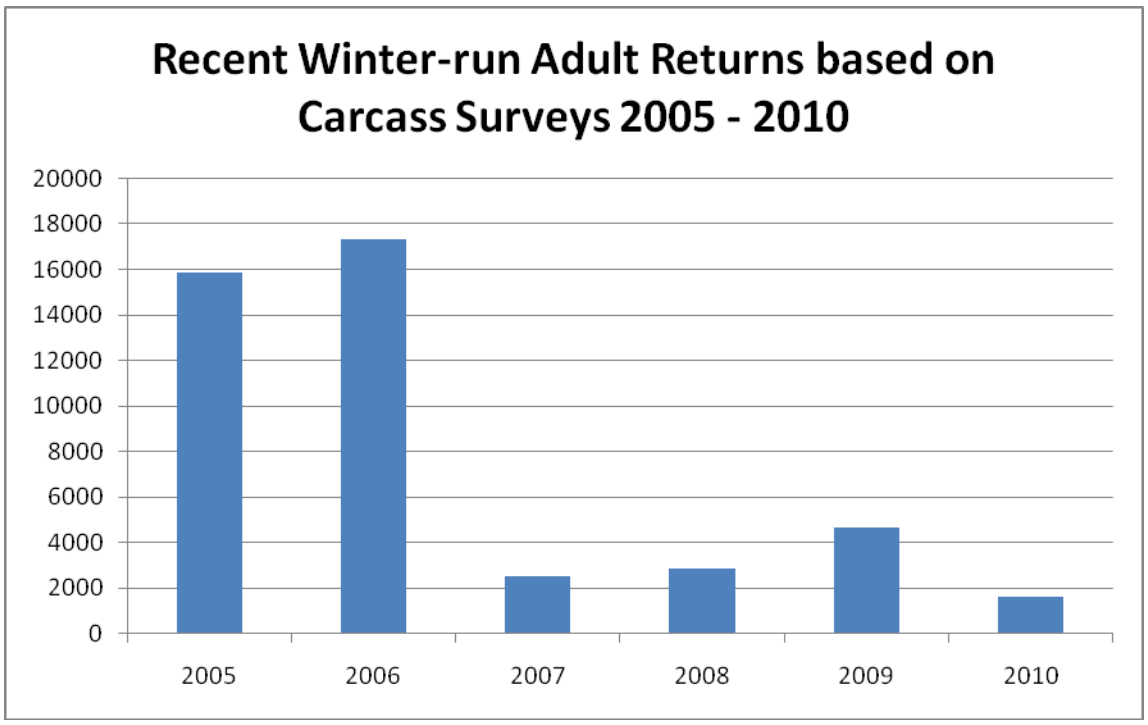
from PVA		years	years
	– or any ONE of –	– or any ONE of –	– or ALL of –
Population size[a]	$N_e \leq 50$	$50 < N_e \leq 500$	$N_e > 500$
	–or–	–or–	–or–
	$N \leq 250$	$250 < N \leq 2500$	$N > 2500$
Population decline	Precipitous decline[b]	Chronic decline or depression[c]	No decline apparent or probable
Catastrophe, rate and effect[d]	Order of magnitude decline within one generation	Smaller but significant decline[e]	not apparent
Hatchery influence[f]	High	Moderate	Low

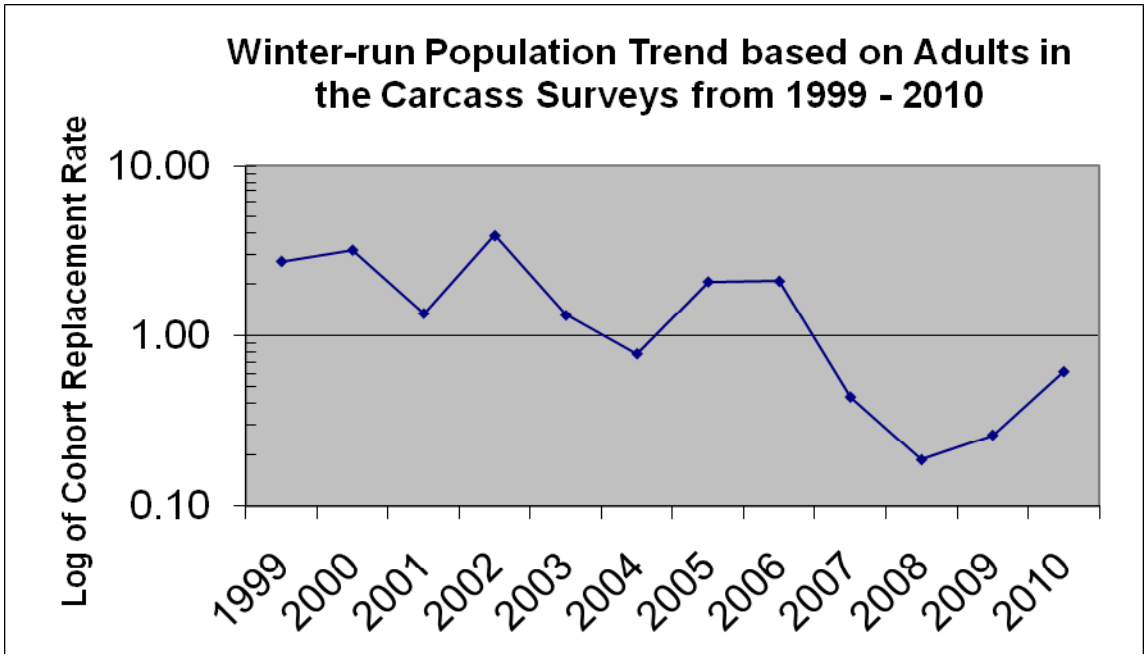
a - Census size N can be used if direct estimates of effective size N_e are not available, assuming $N_e/N = 0.2$.
b - Decline within last two generations to annual run size ≤ 500 spawners, or run size > 500 but declining at ≥ 10% per year. Historically small but stable population not included.
c - Run size has declined to ≤ 500, but now stable.
d - Catastrophes occurring within the last 10 years.
e - Decline < 90% but biologically significant.
f - See Williams et al. 2011 for assessing hatchery impacts.
A population viability analysis (PVA) can be also included for consideration, but must estimate an extinction risk <5% within 100 years *and* all other criteria must be met. If discrepancies exist between PVA results and other criteria, results need to be thoroughly examined and potential limitations of either approach are carefully identified and examined.

The effective population size criteria in the second row of Table 7 relate to loss of genetic diversity. The effective population size, *Ne*, is smaller than the population census size *N* due to variation in reproductive success among individuals. For Chinook salmon, *Ne*/*N* ranges from 0.06 to 0.29. *Ne* can be estimated from detailed demographic or genetic data. Very small populations, for example with *Ne* < 50, suffer severe inbreeding depression, and normally outbred populations with such low Ne have a high risk of extinction from this inbreeding (Lindley et al. 2007).

Relative to the years of critically low abundance in the 1980s and early 1990s, the natural spawning component of the ESU has exhibited marked improvements in abundance and productivity (Figure 3). However, the natural population size peaked in 2006 (17,205), and has since experienced a sharp decline in the past four years (Figure 5). Preliminary estimates for escapement in 2010 indicate the natural population has declined to 1,596 spawners (CDFG letter 2010b) which is the lowest level in the past 10 years (Figure 3). The population growth

rate or cohort replacement rate (CRR) for this ESU has been negative for the past 4 years (Figure 6) indicating it has been declining and is not self-sustaining.





Figures 5 and 6. Recent SR winter-run Chinook salmon ESU escapement and population growth rates (source; CDFG 2010a and 2010b).

The SR winter-run Chinook salmon ESU continues to be at a high risk of extinction and there is no new information indicating that extinction risk has declined (Williams et al. 2011). The abundance of the ESU did increase during the early 2000s, but has since declined in more recent years during periods of unfavorable ocean conditions (2005-06) and drought (2007-09). The ESU is likely at lower risk of extinction with the LSNFH program than it would be with just a single naturally-spawning population, at least in the near term; however, longer term reduction in risk and improved status of the ESU will depend on the successful re-establishment of another low-risk population in a historically used area (e.g., Battle Creek). Williams et al. (2011) concluded that the ESU remains in danger of extinction and will so until additional low-risk populations are re-established within its historical spawning range.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

Section 4(a)(1) of the ESA and the listing regulations (50 CFR Part 424) set forth procedures for listing species. NMFS must determine, through the regulatory process, if a species is endangered or threatened based upon any one or a combination 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 education purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or human-made factors affecting its continued existence.

Previous reviews of this ESU identified a wide range of factors as being responsible for its decline including: blockage of access to historic habitat, other passage impediments, unscreened water diversions, heavy metal pollution from mine runoff, disposal of contaminated dredge sediments in San Francisco Bay, ocean harvest, predation, drought effects, juvenile losses at the CVP and SWP Delta pumping facilities; and elevated water temperatures in spawning grounds. Since 1994 many factors have been addressed, or at least impacts have been reduced, through regulatory and other mechanisms (e.g., reduced harvest impacts, Iron Mountain Mine clean up, screening of water diversions, altered CVP water operations that improve passage and reduce predation, and construction of a temperature control device on Shasta Dam). In the last status review, Good et al. (2005) described numerous threats to this ESU, but chief among them was that it was comprised of only one population which was very small and wholly dependent on artificially created spawning and rearing conditions (i.e., cold water releases below Shasta Dam). New information relating to each of these five listing factors is discussed below including discussion of important conservation efforts being made to protect the species where appropriate.

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range

Loss of Historical Spawning Habitat

Loss of historic spawning habitat for this ESU remains a major threat as it did in previous reviews, as Keswick and Shasta Dams completely displace the naturally spawning population to the mainstem Sacramento River downstream of the two dams. This population is artificially

maintained through cold water releases from the reservoir behind Shasta Dam that create spawning and rearing habitat in the reach between Redding and the Red Bluff Diversion Dam. Important conservation measures that may eventually improve access to historical spawning habitat include those contained in NMFS' 2009 Central Valley Project-State Water Project (CVP-SWP) biological opinion (NMFS 2009a) and the Battle Creek Restoration program described below. However, these measures are still in the pilot stage and are not likely to be completely implemented for several years and their success is uncertain.

NMFS 2009 biological opinion on the long-term operations of the Central Valley Project and State Water Project

NMFS' 2009 biological opinion addresses the long term operations of the Central Valley Project (CVP) and State Water Project (SWP) and contains several mandatory actions that are intended to ensure the continued existence of the ESU is not jeopardized and that its critical habitat is not destroyed or adversely affected. Actions described in the biological opinion that are intended to improve spawning and rearing habitat include:

* Implementation of Shasta Reservoir storage plans and Keswick Dam release schedules and procedures designed to provide cold water for spawning and rearing [underway];
* Modification of Red Bluff Diversion Dam gate operations such that they are open from September 1 through June 14 each year to improve upstream migration for adults as well as downstream survival of juveniles [underway]. By May 2012 the diversion dam must be operated with the gates out year-round;
* Funding to assist in completing the Battle Creek Restoration Project [underway];
* Funding to support the CVPIA Anadromous Fish Screen Program [underway];
* Modification of the Delta Cross Channel gate operations
* Habitat restoration of 17,000 – 20,000 acres of seasonally inundated floodplain habitat in the lower Sacramento River basin to improve juvenile salmonid rearing starting in 2013 [underway]; and
* Implementation of multiple actions to improve flow (reduce negative flows at Old and Middle River) and habitat conditions in the Delta to improve juvenile survival [underway].

In addition to these habitat improvement actions, the biological opinion includes a phased fish passage program that is intended to ultimately expand habitat for this ESU into areas upstream of Shasta Dam on the Sacramento River. This fish passage program includes habitat evaluations above the dam through January 2012, pilot reintroductions from January 2012 through January 2015, and implementation of the long-term program by January 31, 2020.

Battle Creek Salmon and Steelhead Restoration Project

This restoration project will eventually remove five dams on Battle Creek, install fish screens and ladders on three dams, and end the diversion of water from the North Fork to the South Fork. When the program is completed, a total of 42 miles of mainstem habitat and six miles of tributary habitat will be opened up to anadromous salmonids, including the SR winter-run Chinook salmon ESU. Phases lA (North Fork Battle Creek actions) and 1B (a tailrace connector project) have been funded; Phase 2 (South Fork Battle Creek actions) has not been

completely funded. Wildcat Diversion Dam on the North Fork of Battle Creek was removed in 2010. Phase 2 is scheduled to be completed between 2012 and 2014. A plan for the re-introduction of SR winter-run Chinook salmon has not been developed; however, a few adult spawners have already been observed returning to Battle Creek (Table 5).

Degradation of Remaining Available Habitat

Previous status reviews (NMFS 1998, NMFS 1999, and Good et al. 2005) have concluded that the remaining spawning and rearing habitat for this ESU is severely degraded. Continued threats to its habitat include, but are not limited to: (1) impaired water temperatures, (2) impaired water quality from pesticide and herbicide use, (3) degradation of freshwater rearing habitat from levee protection that has simplified riverine habitat and disconnected rivers from the floodplain, (4) new water diversion sites, and (5) loss of estuarine rearing habitat in the Delta. Several years of drought and poor ocean conditions since 2005 have exacerbated the already degraded habitat conditions for this ESU and other salmonids in the Central Valley.

Cummins et al. (2008) attributed the much reduced biological status of Central Valley salmon stocks, and their habitat, to the construction and operation of the CVP and SWP:

> "*Construction and operation of the CVP and SWP have altered flows, reduced water quality, and degraded environmental conditions and reduced habitat for fish and wildlife in the Central Valley from the headwaters to the Delta. This includes the native anadromous fish of the Central Valley -- winter, spring, fall and late-fall chinook, steelhead and sturgeon. Adult runs that once numbered in the millions have been reduced to thousands or less.*
>
> *The transformation of the natural Sacramento/San Joaquin river systems into a massive water storage and delivery system includes dams and diversions that have blocked access for anadromous salmonids to much of their historical habitat. Development of the CVP and SWP has significantly modified the natural hydrologic, geomorphic, physical and biological systems. The modified river system significantly impacts the native salmon and steelhead production as a result of fragmented habitats, migration barriers, and seasonally altered flow and habitat regimes*."

Since 2005, threats to this ESU that have been reduced or eliminated include: pollution from Iron Mountain Mine pollution resulting from Environmental Protection Agency remediation projects; improved passage and reduced predation at Red Bluff Diversion Dam resulting from implementation of NMFS' 2009 CVP-SWP biological opinion; and reduced ocean harvest impacts resulting from increased regulatory restrictions (harvest impacts were essentially zero in 2008 and 2009 due to closed seasons). Other important conservation efforts aimed at reducing threats to this ESU are discussed below.

Bay Delta Conservation Plan

The purpose of the Bay Delta Conservation Plan (BDCP) is to help recover threatened,

endangered, and sensitive species, including the SR winter-run Chinook salmon ESU, and their habitats in the Delta in a way that also will provide for a reliable water supply. A proposed BDCP water conveyance system would include new points of diversion in the north Delta in concert with improvements to the current through-Delta water export system in the south Delta. Actions under discussion include operation of a dual conveyance system, habitat restoration in the Delta, and measures to reduce other stressors to the Delta ecosystem and covered species. A multi-agency group of stakeholders led by the Bureau of Reclamation, DWR, USFWS and NMFS, in cooperation with the California Department of Fish and Game (DFG), USEPA and USCOE is developing alternatives for an environmental impact statement. BDCP is in a developmental stage and its implementation is uncertain. Any new benefits or threats to this ESU resulting from implementation of the BDCP would not occur for many years. A first draft of the plan was released in 2010 (BDCP 2010).

CVPIA Anadromous Fish Restoration Program

The Central Valley Improvement Act (CVPIA) established the Anadromous Fish Restoration Program (AFRP) in 1992 with the goal of making "all reasonable efforts to at least double natural production of anadromous fish in California's Central Valley streams on a long-term, sustainable basis". Anadromous fish covered under AFRP include all races of Chinook salmon (including the SR winter-run Chinook salmon ESU), steelhead, sturgeon, striped bass and American shad. The program is administered jointly by the Bureau of Reclamation and USFWS. Approximately $15 million/year of CVPIA restoration funds have been used for the purpose of protecting, restoring, and enhancing special-status species and their habitats in areas directly or indirectly affected by the CVP. Through the AFRP, Federal funding for beneficial projects include annual spawning gravel augmentation, instream flow management (i.e., use of 800 thousand acre feet of CVPIA b(2) water from the Central Valley Project), and habitat restoration projects (e.g., Battle Creek, Clear Creek, and Butte Creek). The Anadromous Fish Screen Program also works to optimize fish screen funds with partnership-based sources such as Wildlife Conservation Board, CDFG, and the Ecosystem Restoration Program (see below) and local sources. These fish screen projects are important for protecting ESA listed salmonids such as the SR winter-run Chinook salmon ESU.

Ecosystem Restoration Program

The Ecological Restoration Program (ERP) has completed seven years of an ambitious 30-year plan to restore ecological health and improve water management in the San Francisco Bay and Sacramento-San Joaquin Delta. Under the 2000 CALFED Record of Decision (ROD), the DFG fulfills the role as the State's Implementing Agency for ERP and is currently managing more than 85 ongoing and approximately 10 newly funded projects. The ERP enables actions from all of its program elements to be completed in compliance with the Federal ESA, the California Endangered Species Act, and California's Natural Communities Conservation Planning regulations. The objectives of the ERP are to: 1) prepare comprehensive ecosystem restoration plans for the Sacramento and San Joaquin Rivers, 2) support scientific reviews, and 3) coordinate fish screen and fish passage projects with the AFRP, CVPIA, and other stakeholders to achieve DFG fish passage goals.

Program activities for 2010-2011 include work in the following areas:

- *Bay-Delta Conservation Plan*
- *Contaminants and Water Quality*
- *Ecosystem Restoration Program's 2010-2011 Proposal Solicitation Package (PSP)*
- *Non-Native Invasive Species Program*
- *Performance Measures*

Since 2000, the ERP has funded 490 projects in the Central Valley for a total of approximately $629 million of which about 75% are complete. These projects have met or exceeded nearly 80% of the 119 milestones for the first stage of the program. The ERP has protected or restored more than 150,000 acres of habitat including the following actions:

- Contributed to the restoration and protection of 8,000 acres of wetlands in San Pablo Bay and Suisun Marsh
- Protected more than 11,000 acres and 18 river miles for riparian and shaded-riverine-aquatic habitat restoration
- Enhanced or restored more than 3,900 acres and 59 miles of riparian and riverine aquatic habitat
- 500 acres of fresh emergent wetland in the San Joaquin River Region were enhanced, protected, and/or restored
- Installed or improved 70 fish screens (11 that draw >250 cfs)
- Restored stream habitats and removed impediments to salmonid passage in critical areas including: Clear Creek, Battle Creek, Cottonwood Creek, Tuolumne River, Cosumnes River, Mokelumne River and the Merced River.
- Protected 16,000 acres of agricultural land largely through conservation easements with private landowners.

Draft 2009 Central Valley Salmon and Steelhead Recovery Plan

A public draft recovery plan for Central Valley salmon and steelhead was released by NMFS in 2009 (NMFS 2009b). This plan is intended to serve as a road map for recovering SR winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead. The plan contains prioritized actions based on a comprehensive threats assessment. While the plan itself does not include dedicated funding for recovery efforts, it will help guide conservation planning efforts including those carried out under the large comprehensive programs discussed above.

While some conservation measures have been successful in improving habitat conditions for SR winter-run Chinook salmon since the species was listed in 1989 and the last status review in 2005, fundamental problems still remain with the quality of the species remaining habitat (see Lindley et al. 2009 and Cummins et al. 2008). Overall, major habitat expansion and restoration for this species will require access to blocked habitat (i.e., fish passage) above several rim dams in the Central Valley and restoration of large areas of the Delta (e.g., Yolo Bypass, Suisun Marsh). In summary, the loss of historical habitat and the degradation of remaining habitat both continue to be major threats to the SR winter-run Chinook salmon ESU.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes

Harvest Impacts

The SR winter-run Chinook salmon ESU has a more southerly ocean distribution relative to other California Chinook stocks and as a result is primarily impacted by fisheries south of Point Arena, California. A significant portion of the ocean harvest impact on this species used to occur in the February and March recreational fisheries in this area, but those fisheries have essentially been closed since 1990 for that reason. The age-3 (fully vulnerable) ocean fishery exploitation rate estimates for the period from 2000–2007 and have remained stable and averaged about 17% (Figure 7). The rates for 2008 and 2009 will clearly be much lower because the ocean fisheries were closed south of Point Arena in those years. Freshwater harvest of this species was largely eliminated in 2002 when the opening of the Sacramento River recreational fishing season was adjusted so that the fishery would have only limited overlap with the spawning migration and spawning period of this ESU.

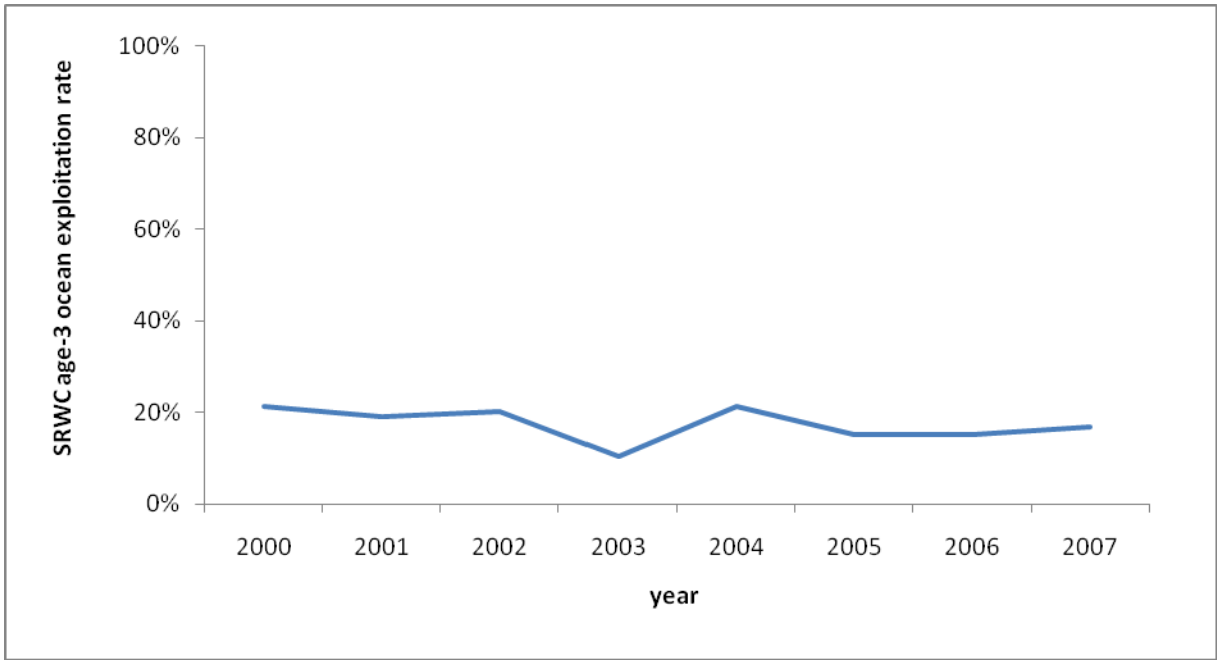


Figure 7. SR winter-run Chinook salmon age-3 ocean exploitation rate for the years 2000–2007 (O'Farrell et al. 2010).

Since 2005, NMFS has issued a new biological opinion (NMFS 2010) addressing the ocean harvest impacts to this ESU from commercial and sport fisheries. This biological pinion concluded the fisheries jeopardized the species, and therefore, imposed further restrictions on the minimum retention size and fishing effort that are expected to reduce ocean harvest impacts.

In summary, the available information indicates that the level of ocean fishery impacts on this ESU have not changed appreciably since the 2005 status review (Good et al. 2005) although they are expected to be much reduced in 2008 and 2009 because of ocean fishery closures.

2.3.2.3 Disease or predation

Naturally occurring pathogens pose a greater threat to this ESU than other Central Valley Chinook salmon runs since it is comprised of only a single population and its abundance is very low. As the population abundance continues to be low or possibly even decline further the probability increases that disease outbreak could significantly impact the remaining wild population. Artificially propagated Chinook salmon have been impacted by disease outbreaks (such as the Infectious Hematopoietic Necrosis Virus and Bacterial Kidney Disease) at some Central Valley hatcheries and therefore potential disease outbreaks at the LSNFH could pose a risk to wild fish. There is no evidence of any such disease outbreaks at the LSNFH since the last status review.

Predation is an ongoing threat to this ESU, especially in the lower Sacramento River and Delta where there are high densities of non-native (i.e., striped bass, small-mouth bass, and large-mouth bass) and native species (e.g., pikeminnow) that prey on outmigrating juvenile salmon. The presence of man-made structures in the freshwater habitat likely contribute to increased predation levels by altering the predator-prey dynamics that often favor predatory species. In the Sacramento River, removal of the gates at the RBDD minimizes predation impacts on this ESU at that location. In the ocean, and even the Delta environment, salmon are also common prey for harbor seals, sea lions, and killer whales.

Lindley and Mohr (2003) examined the effects of predation by striped bass, including the effects of stocking striped bass, on the extinction probability of the SR winter-run Chinook salmon ESU. Their Bayesian model was slightly more complex than that of Botsford and Brittnacher (1999) and included a step change in population growth rate reflecting the various conservation measures that were implemented in the early 1990s. Model results indicated the probability of quasi-extinction was high even taking into account conservation measures, particularly if the striped bass population were allowed to increase.

Disease and predation are persistent problems that can adversely affect this ESU. There is no new information indicating that disease impacts or risks have changed since the last review. However, there is some indication that predation may represent a greater threat than was previously thought to be the case. Recent acoustic tag studies (Michel 2010) showed high losses near RBDD and an analysis by Kimmerer and Brown (2006) indicate that freshwater survival is much lower in the Sacramento River than other rivers. This lower survival rate could be due to an increase in predation or the metabolic rate for predators (i.e., due to warmer water temperatures). However, predation at RBDD and in the lake formed by the dam when the gates are in place during the summer months should decrease in the future as the gates will only be in place for a limited period of time starting in 2010 and will be out year-round by May of 2012. Although reducing predation at RBDD will benefit juveniles passing downstream at that location, it is unclear to what extent this will decrease overall predation of this ESU in the Sacramento River and Delta.

2.3.2.4 Inadequacy of existing regulatory mechanisms

Water Quality Regulation

Laws intended to protect California's water quality include the federal Clean Water Act and Porter-Cologne Act (California Water Code). Agencies implementing these laws have directed considerable attention to salinity regulation in the Delta in order to ensure that freshwater is available for irrigating agricultural lands and for municipal and industrial uses. Poor water quality in the Delta resulting from agricultural and urban sources is a factor contributing to the ongoing collapse of the Delta ecosystem, which was detected when four pelagic fish species simultaneously and dramatically declined in abundance in 2002. Stronger implementation and enforcement of the Clean Water Act and the Porter-Cologne Act are needed in order to control agricultural (e.g., pesticides) and urban (e.g., ammonium) water pollution throughout the Central Valley.

Species Identification for Regulatory Purposes

Monitoring and identification of juvenile SR winter-run Chinook salmon is based on size-at-length growth curves developed in the early 1990s for the upper Sacramento River (Fisher 1992). A modified growth curve was developed for the Delta. The growth curves are not adjusted annually for differences in emergence timing or poor rearing conditions. Problematic with these growth curves is overlap between the individual salmon races. The existing regulatory mechanisms are based on identification to race. Identification of juvenile salmonids entrained at SWP and CVP export pumps is likely only 50 percent accurate using length-at-date curves based on the latest genetic analysis (unpublished data). Determining survival through the Delta, entrainment losses at the Delta export pumps, the proportion of fish that enter the interior Delta, and eventual survival to the ocean, all depend on accurate means of identification and the ability to discriminate SR winter-run Chinook salmon from other Central Valley chinook races. Better methods of non-lethal identification need to be developed so that juvenile salmon in the Central Valley can be effectively protected under the ESA.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Artificial Propagation Programs

Captive broodstock and conservation hatchery programs were established for the SR winter-run Chinook salmon ESU in the early 1990s. The captive broodstock program was originally located at the Bodega Marine Laboratory and the hatchery program was initially established at the Coleman NFH and then later re-located to the LSNFH. These programs were established to augment the naturally spawning population in the Sacramento River as well as to provide a captive broodstock in case the natural population was unexpectedly decimated. Strict guidelines have been in place for the number of hatchery fish that can be spawned together with naturally spawning fish; however, the genetic integrity of the natural population is still threatened from having passed through several population bottlenecks in the 1990's when the population numbered less than 200 individuals. The captive broodstock component of the

conservation hatchery program at the LSNFH was discontinued in January 2005 and the final captive broodstock fish were utilized for a research study in 2006.

The naturally spawning population of this ESU has been supplemented by the LSNFH program since the mid 1990's when the population was severely depleted. Several innovative propagation techniques and genetic markers were developed to guide what is considered a very successful conservation program. USFWS is cautious of domestication effects on the wild population, and is taking steps to minimize them. Studies indicate that the survival rate appears to be higher for hatchery fish than wild fish indicating high mortality in the early life stages of the naturally spawning population. Since 2001, hatchery-origin fish from LSNFH have represented more than 5 % of the natural spawning run and in 2005 it exceeded 18 % of the spawning run (Figure 4). If the proportion of hatchery origin fish in the spawning population continues to exceed 15 %, Lindley et. al. (2006) indicated that the ESU could be reclassified as being at a moderate extinction risk. The proportion of hatchery fish in the 2010 spawning population was estimated to be 12.5 % (CDFG 2010b). As of 2010, only wild (non-clipped) fish are being spawned for LSNFH production in an effort to decrease domestication effects in the naturally spawning population. The hatchery production goals (~200,000 sub-yearling smolts), and broodstock collection target currently remain unchanged.

At the time of the last status review, NMFS determined that the LSNFH stock was part of the SR winter-run Chinook salmon ESU. In making the 2005 listing determination for this ESU, NMFS considered the effects of this hatchery program on the viability of the naturally spawning population. In general, our assessment concluded that this program increased the abundance of the ESU, but did not have any beneficial impacts on productivity, spatial structure or diversity of the natural spawning population. Overall, we concluded that the LSNFH program provided limited benefits to the ESU. The LSNFH program that was listed in 2005 continues to be operated in a similar manner and meets the criteria of category 1a hatchery stocks. Category 1a stocks are characterized by no more than minimal divergence between the hatchery stock and the local natural population(s) and regular, substantial incorporation of natural origin fish from the native natural population into the hatchery broodstock.

Newly Identified Manmade Factors

Since 2005, the Pacific Fishery Management Council has identified 10 additional manmade threats to Chinook salmon as part of a 5-year review of Essential Fish Habitat for Chinook salmon in the Central Valley (NMFS 2010c). These new threats include:

- Pile driving
- Over-water structures (e.g., docks, boats ramps, water intakes, etc.)
- Alternative energy development (wave generators)
- Liquefied natural gas projects
- Desalination projects
- Power plant intakes
- Pesticide and herbicide use (agricultural and urban runoff)
- Flood control maintenance (levee repairs)
- Culvert construction

- Climate change

Climate Change

Climate change is expected to have a major impact on the recovery of this ESU because of its reliance on cool water releases from the Shasta reservoir to provide suitable downstream water temperatures for spawning and early rearing in the Sacramento River. Lindley et al. (2007) summarized several studies (Hayhoe et al. 2004, Dettinger et al. 2004, Dettinger 2005, Van Rheenen et al. 2004, Knowles and Cayan 2002) that describe how anthropogenic climate change is expected to alter the Central Valley and the possible effects to anadromous salmonids from the predicted climate changes. Climate model results for the Central Valley are broadly consistent in that they predict future temperatures will warm significantly, total precipitation may decline, the variation in precipitation may substantially increase (i.e., more frequent flood flows and critically dry years), and snowfall will decline significantly (Lindley et al. 2007). Not surprisingly, future climate change-driven temperature increases are expected to further limit the amount of suitable habitat available to anadromous salmonids. The potential for more frequent flood flows might be expected to reduce the abundance of populations as egg scour becomes a more common occurrence. The increased frequency of critically dry years also would be expected to reduce salmonid abundance since low flows in the Central Valley during juvenile rearing and outmigration periods are associated with poor survival (Kjelson and Brandes 1989, Baker and Morhardt 2001, Newman and Rice 2002). In addition to habitat effects, climate change may also impact Central Valley salmonids through fish community effects. For example, warmer water temperatures would likely increase the abundance and metabolism of predators leading to increased predation and reduced juvenile salmonid survival (Vigg and Burley 1991). Peterson and Kitchell (2001) showed that on the Columbia River, pikeminnow predation on juvenile salmon during the warmest year was 96 % higher than during the coldest year. In summary, climate change is expected to exacerbate existing stressors and pose new threats to Central Valley salmonids, including the SR winter-run Chinook salmon ESU, by reducing the quantity and quality of inland freshwater habitat (Lindley et al. 2007).

Drought Conditions

Climate change models predict that drought conditions will occur more often and with greater severity in the future. California just ended a three-year period of drought that reduced the water supply in Central Valley to the lowest level in 10 years. Demand for water continues to increase for both agriculture and urban supplies. There are no new reservoirs being built to meet the increased demand for water and to hedge against the impacts of drought. Hydrologic modeling completed for the operation of the CVP and SWP (NMFS 2009a) showed that drought conditions lasting 3 years or more limit the ability of Shasta Reservoir to release cold water to support spawning of SR winter-run Chinook salmon throughout the summer months. Lindley et al. (2009) found that the last 3 years of drought conditions contributed to the decline of Chinook salmon in the Central Valley as a result of low flows, reduced freshwater habitat, and higher water temperatures. Drought conditions also favor introduced warm water species (e.g., striped bass, largemouth bass, and smallmouth bass) that prey on juvenile salmonids and lead to the proliferation of aquatic weeds and algae that reduce the quality of rearing habitat.

SR winter-run Chinook salmon are particularly susceptible to drought conditions because all of their historical spawning habitat is blocked by dams and the remaining population that spawns in the upper Sacramento River is completely dependent on cold water releases from Shasta Dam.

Ocean Conditions

The last five years has been a period of widespread decline in all Central Valley Chinook salmon stocks including the SR winter-run Chinook salmon ESU. An analysis by Lindley et al. (2009) found that unusual oceanic conditions led to poor growth and survival for juvenile salmon produced in the Central Valley during the spring of 2005 and 2006 and these conditions most likely contributed to the declining abundance of this ESU.

Natural variation in ocean conditions (e.g., sea surface temperature, upwelling, food productivity) is common and can have a significant impact on Chinook salmon survival during the marine phase of their lives. This ESU spends the majority of its life (2 out of 3 years) rearing in the ocean, and therefore, ocean conditions will have an important influence on its survival and the abundance of returning adult spawners. The unusual ocean conditions that occurred in 2005 and 2006 resulted in poor fall-run Chinook returns in 2008 and 2009 (Lindley et al. 2009). The reduced survival of the 2004 and 2005 broods was attributed to weak upwelling, warm sea surface temperatures, low prey densities, and poor feeding conditions when these fish entered the ocean in 2005 and 2006. When poor ocean conditions are combined with drought conditions in the freshwater environment the productivity of Chinook salmon populations (and likely steelhead populations) is significantly reduced. Despite complete closures of the commercial and recreational fisheries in 2008 and 2009 the SR winter-run Chinook ESU continued to decline (Figures 5 and 6), possibly indicating ocean conditions may be more significant than ocean harvest rates. Lindley et al. (2009) concluded that late-fall, winter and spring Chinook salmon in the Central Valley were not as strongly affected by recent changes in ocean conditions as the Sacramento River fall-run Chinook salmon. This illustrates how Chinook life-history diversity (as exhibited by the different runs of Central Valley Chinook salmon) may buffer environmental variation. Increasing the wild component of these diverse runs (e.g., late-fall, winter and spring-run) could potentially minimize the impacts of poor ocean conditions. Future variation in ocean conditions, particularly variation that leads to reduced ocean survival, is expected to cause significant stress on this ESU which is already at very low levels of abundance and which is comprised of a single population that is reliant on water releases from Shasta reservoir.

2.4 Synthesis

The SR winter-run Chinook salmon ESU was first listed as threatened in 1989 and then reclassified as endangered in 1994. The ESU consists of only one naturally spawning population that spawns in the upper Sacramento River. Critical habitat includes the entire mainstem Sacramento River (including riparian habitat along the bank) from Keswick Dam downstream to and including the Delta. There is no new information indicating the ESU boundary should be changed; however, if a new population is established in Battle Creek or if

the ESU is reintroduced above Shasta Dam, the existing ESU boundary will need to be re-examined.

The Central Valley Technical Recovery Team delineated four historical independent populations of this ESU. The spawning areas for three of these historical populations are above the impassable Keswick and Shasta dams, while fourth population (Battle Creek) is presently unsuitable for winter-run Chinook salmon due to high summer water temperatures. Lindley et al. (2007) developed viability criteria for Central Valley salmonids and using data through 2004 found that the mainstem Sacramento River population was at low risk of extinction. The ESU as a whole, however, could not be considered viable because there is only one naturally-spawning population, and it is not within its historical range.

Long-term population monitoring shows that abundance of this ESU has decreased since the last status review. The most recent population estimate for 2010 of 1,596 adults is the lowest in the past 10 years. Consistent with this downward population trend, the ESU has experienced a negative growth rate over the last 4 years. The decline in abundance is of concern, but must be considered in the context of marine survival conditions which have been poor in recent years despite substantially curtailed ocean harvest levels over most of the same period. The SWFSC's viability report concluded that the ESU remains in danger of extinction and will remain so until multiple viable, low-risk populations are re-established within its historical spawning range (Williams et al. 2011).

Many of the factors originally identified as being responsible for the decline of this ESU are still present though in some cases they have been reduced by regulatory actions (e.g., NMFS CVP-SWP biological in 2004 and 2009, an ocean harvest biological opinion in 2010, and actions implemented under the CVPIA). An analysis by Kimmerer and Brown (2006) indicates that ocean harvest, RBDD operations, and elevated water temperatures are the most significant threats facing this ESU. Despite efforts to reduce these and other threats (e.g., controlling water temperatures with cold water releases, annual spawning gravel augmentation, additional water to stabilize mainstem flows, re-operation of the RBDD dates, harvest restrictions, and reduction in Delta export pumping) the ESU has continued to decline in abundance. A recent CVPIA peer review concluded that despite these and other conservation efforts the AFRP has fallen short of meeting the program's doubling goals for this species and other Central Valley salmonids Cummins et al. 2008). One of the key uncertainties are freshwater and marine survival rates. Recent acoustic tag studies indicate that freshwater survival may be much lower than previously thought (<10% instead of 50%) indicating that juvenile production at least to the Delta could be overestimated. Potential causes of higher mortality rates include increased predation from introduced species (e.g., striped bass, largemouth bass, smallmouth bass), poor water quality from pesticide and herbicide runoff, lack of food from loss of riparian community (due to rip-rap and levee protection), and diversion of juveniles into less productive areas of the Delta. Harvest related impacts have generally remained the same or declined since the last status review primarily because of ocean fishery closures in 2008 and 2009 and a significantly limited the fishery in 2010. Similarly, impacts from predation and diseases have generally remained unchanged since the last status review. In contrast, impacts from factors such as drought, climate change and poor survival conditions have increased since the last status review and most likely have contributed substantially to the declining abundance of the ESU.

A summary of how the five ESA listing factors have changed since the 2005 status review are presented in Table 8.

Table 8. Summary of how each listing factor for the SR winter-run Chinook salmon ESU has changed since the 2005 status review.

LISTING FACTOR	CHANGE SINCE 2005 Review
Present or threatened destruction, modification, or curtailment of habitat or range	Very limited habitat expansion. Some habitat restoration through CVP-SWP biological opinion may occur this year in Battle Creek. Overall, no major change in this listing factor since 2005.
Overutilization for commercial, recreational, scientific, or education purposes	Continued restrictions in the ocean harvest and closed seasons have reduced the impacts. Overall, improvement since 2005.
Disease or predation	Predation has been reduced at some diversions like RBDD, but continues to be a major source of loss in the Delta at Clifton Court Forebay and may increase with climate change. Overall, no major change since 2005.
Inadequacy of exiting	No evidence suggests that the impact of this listing factor on winter-

regulatory mechanisms	run has substantially changed since 2005.
Other natural or manmade factors	Poor ocean conditions in 2005 and 2006, likely reduced the abundance of winter-run returning to spawn in 2007 and 2008. From 2007 through mid-2009 ocean conditions were good for salmon. From mid-2009 through April 2010, ocean conditions were poor, but improved dramatically after April. Drought conditions from 2007-2009, likely reduced the abundance of those brood years, which would impact the abundance of returning adults in 2010 and 2011. The Central Valley has had wetter conditions since water year 2009.

In summary**,** the most recent biological information suggests that the extinction risk of this ESU has increased since the last status review and that several of the listing factors have contributed to the decline, including recent years of drought and poor ocean conditions. The best available information on the biological status of the ESU and continuing and new threats to the ESU indicate that its ESA classification as an endangered species is appropriate. Long term recovery of this ESU will require improved freshwater habitat conditions, abatement of a wide range of threats, and the establishment of a second population in Battle Creek or elsewhere. In planning to reintroduce a second population into Battle Creek, special attention will need to be given to the potential effects of climate change on instream flows and temperatures since there will be limited ability to control these factors with reservoir releases.

3.0 RESULTS

3.1 Classification Recommendation:

Based on a review of the best available information, we recommend that the SR winter-run Chinook salmon ESU remain listed as an endangered species.

3.2 New Recovery Priority Number

We recommend changing the NMFS recovery priority number for this ESU from 3 to 1 in order to reflect the recent decline in abundance, the new threats identified in the EFH review (NMFS 2010), and the continued high risks facing this single population ESU.

3.3 ESU Boundary and Hatchery Stocks

Available genetic and other information supports the current boundary of this ESU, and therefore, we recommend no changes in the ESU boundary. The LSNFH program has not changed substantially from the previous ESA status review, and therefore, we recommend that it remain part of the listed ESU.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

We recommend several high priority future actions for the conservation of this ESU including: (1) finalizing the Central Valley draft Recovery Plan, (2) implementing actions identified in the 2009 OCAP biological opinion, (3) establishing a second viable population in Battle Creek, and (4) reducing annual harvest impacts from the ocean fishery. Detailed recommendations for these actions are described below:

- Finalize the draft Central Valley Recovery Plans. Coordinate and integrate high priority recovery plan actions into watershed planning documents and establish technical teams responsible for implementing restoration actions required under NMFS and USFWS biological opinions. Encourage agency and stakeholder participation with technical teams responsible for restoration projects within tributary spawning areas, mainstem rivers, and in the Delta.

- Implement long-term actions pursuant to NMFS' 2009 CVP-OCAP biological opinion which protect or improve survival of this ESU including:
    - Fish passage above Shasta Dam
    - Removal of RBDD gates on a year round basis
    - Restoration of floodplain habitat in the lower Sacramento River
    - Increase positive flows through the south Delta juveniles are present

- Implement Battle Creek restoration and fish passage with a goal of establishing a second viable population. By the end of 2011 develop a re-introduction plan for Battle Creek using hatchery broodstock from LSNFH. The plan should consider the best alternative (i.e., eggs, juveniles, or adults) and logistics for successful restocking in areas that have adequate habitat conditions (e.g., sufficient cold water and rearing habitat). Implement the re-introduction plan by May 2012 using an inter-agency technical team comprised of hatchery and fishery experts from USFWS, DFG, NMFS, Reclamation, and DWR. In the interim, provide passage upstream of the Coleman Hatchery weir for any adults that might naturally stray into Battle Creek.

- Pursuant to NMFS's 2010 Harvest Management Plan develop annual assessments of the population abundance to determine a level of sustainable commercial and recreational harvest in the ocean. This assessment will involve the SWFSC developing models capable of projecting harvest impacts. Harvest restrictions such as reduced effort and size limits will be recommended annually to the Pacific Fisheries Management Council based on various population and environmental metrics (e.g., growth rate, escapement, ocean conditions).

- Determine freshwater and marine survival rates for estimating juvenile production and smolt to adult return rates. This is the first step required in life-cycle models that are currently being used to assess the impact of future actions (e.g., BDCP, water project operations, ocean harvest rates). This will require acoustical tag studies on wild fish as well as analysis of existing coded-wire tag data from hatchery reared fish. Some of these studies have already been completed, but are not yet published.

- Compile the genetic information collected by DWR from the Delta Fish Facilities for the last 5 years into a report with recommendations on how to best use that information to improve monitoring of juveniles and incidental take reporting.

5.0 REFERENCES

Bay-Delta Conservation Plan (BDCP). 2010. A preliminary working draft. November 18, 2010. See the California Department of Water Resources website: http://baydeltaconservationplan.com/BDCPPlanningProcess/ReadDraftPlan/ReadDraftPlan_copy1.aspx

Kimmerer, W. and R. Brown. 2006. Winter Chinook salmon in the Central Valley of California: Life history and management. Draft report prepared by the CALFED Science Advisors. August 2006. 54 pages.

California Department of Fish and Game (CDFG) 2010a. Annual spawner escapement estimates for all rivers in the Central Valley. GrandTab. September 2010. http://www.calfish.org/Programs/AdditionalPrograms/CDFGFisheriesBranch/tabid/104/ItemId/123/Default.aspx

California Department of Fish and Game (CDFG) 2010b. Letter from Terry Foreman, Chief Fisheries Branch to Rod McInnis, Regional Administrator, NMFS concerning the Sacramento River Winter-run Chinook Escapement Estimate for 2010, dated December 8, 2010. 3 pages.

Cummins, K, C. Furey, A. Giorgi, S. Lindley, J. Nestler, J. Shurts. 2008. Listen to the River: An Independent Review of the Central Valley Project Improvement Act Fisheries Program prepared for the USBR and USFWS. December 2008. 100 pages.

Fisher, F. 1992. Chinook Salmon, *Onchorhynchus tshawytscha*, growth and occurrence in the Sacramento – San Joaquin River System. CDFG, Inland Fisheries Division, 45 pages.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-66, 598 p. (Biological Review Team findings in support of the 2005/2006 final listings)

Lindley, S. T., and M. S. Mohr. 2003. Modeling the effect of striped bass (*Morone saxatilis*) on the population viability of Sacramento River winter-run chinook salmon (*Oncorhynchus tshawytscha*). Fishery Bulletin 101: 321–331.

Lindley, S.T., R. Schick, B.P. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population structure of threatened and endangered Chinook salmon ESU in California's Central Valley basin. NMFS Southwest Science Center NOAA-TM-NMFS-SWFSC-360. Santa Cruz, CA.

Lindley, S.T., R. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. R. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5(1), Article 4: 26 pages. Available at: http://repositories.cdlib.org/jmie/sfews/vol5/iss1/art4.

Lindley, S.T., C.B. Grimes, M.S. Mohr, W. Peterson, J. Stein, J.T. Anderson, L.W. Botsford, D. L. Bottom, C.A. Busack, T.K. Collier, J. Ferguson, J.C. Garza, A.M. Grover, D.G. Hankin, R.G. Kope, P.W. Lawson, A. Low, R.B. MacFarlane, K. Moore, M. Palmer-Zwahlen, F.B. Schwing, J. Smith, C. Tracy, R. Webb, B.K. Wells, and T.H. Williams. 2009. What caused the Sacramento River fall Chinook stock collapse? Pre-publication report to the Pacific Fishery Management Council. March 18. 57 pages plus a 61-page appendix.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. NOAA Tech. Memo. NMFS-NWFSC-42. U.S. Dept. of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service. 156 pages.

Michel, J. Cyril. 2010. River and estuarine survival and migration of yearling Sacramento River Chinook Salmon (*Onchorhynchus tshawytscha)* smolts and influence of environment. Masters Thesis submitted to University of California at Santa Cruz, CA. 130 pages.

O'Farrell, M.R., M.S. Mohr, and A.M. Grover. 2010. Sacramento River winter Chinook cohort reconstruction: analysis of ocean fishery impacts. Report in preparation. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California.

National Marine Fisheries Service. 2005b. Final assessment of the National Marine Fisheries Service's critical habitat analytical review teams (CHARTs) for seven salmon and steelhead evolutionarily significant units (ESUs) in California. July. Prepared by the NOAA Fisheries, Protected Resources Division, Long Beach, California. Available at: http://swr.nmfs.noaa.gov/chd/CHART%20Final%20Assessment/Final_CHART_Report-July_05.pdf.

National Marine Fisheries Service. 1997. Draft Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. Southwest Region. Long Beach, CA. 217 pages

National Marine Fisheries Service. 2009a. Biological Opinion on the Operating Criteria and Plan (OCAP) for the long-term operations of the Central Valley Project and State Water Project with recommendations for Essential Fish Habitat. Sacramento Protected Resources Division. Issued June 4, 2009. 844 pages.

National Marine Fisheries Service. 2009b. Public Draft Recovery Plan for the Evolutionary Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of the Central Valley Steelhead. Sacramento Protected Resources Division. October 2009. 253 pages. http://swr.nmfs.noaa.gov/recovery/centralvalleyplan.htm

National Marine Fisheries Service. 2010a. Authorization of ocean salmon fisheries pursuant to the Pacific Coast Salmon Fishery Management Plan and additional protective measures as it affects Sacramento River Winter-run Chinook salmon. ESA section 7, biological opinion on ocean harvest of Winter-run Chinook salmon. Protective Resources Division, Southwest Region. Issued March 30, 2010. 95 pages. Long-Beach, CA.

National Marine Fisheries Service. 2010c. Draft for public review. Pacific Coast Salmon Essential Fish Habitat Review to the Pacific Fishery Management Council. September 13, 2010. Northwest Region, Portland, OR. 43 pages.

Williams, T. H., S. T. Lindley, B.C. Spence, and D.A. Boughton. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Southwest. 17 May 2011 – Update to 5 January 2011 report. National Marine Fisheries Service. Southwest Fisheries Science Center. Santa Cruz, CA.

NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW
Central Valley Recovery Domain
Sacramento River winter-run Chinook Salmon

Current Classification: Endangered

Recommendation resulting from the 5-Year Review: Retain current ESA classification as endangered and current ESU boundary. Continue to include LSNFH population in ESU.

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, NOAA Fisheries

Approve: _____ Date: _____

Cooperating Regional Administrator, NOAA Fisheries

_____Concur _____ Do Not Concur

Signature_____ Date_____

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

_____Concur _____ Do Not Concur

Signature_____ Date_____