

1 **A.18 SACRAMENTO RIVER WINTER-RUN**
 2 **CHINOOK SALMON**
 3 **(*ONCORHYNCHUS TSHAWYTSCHA*)**

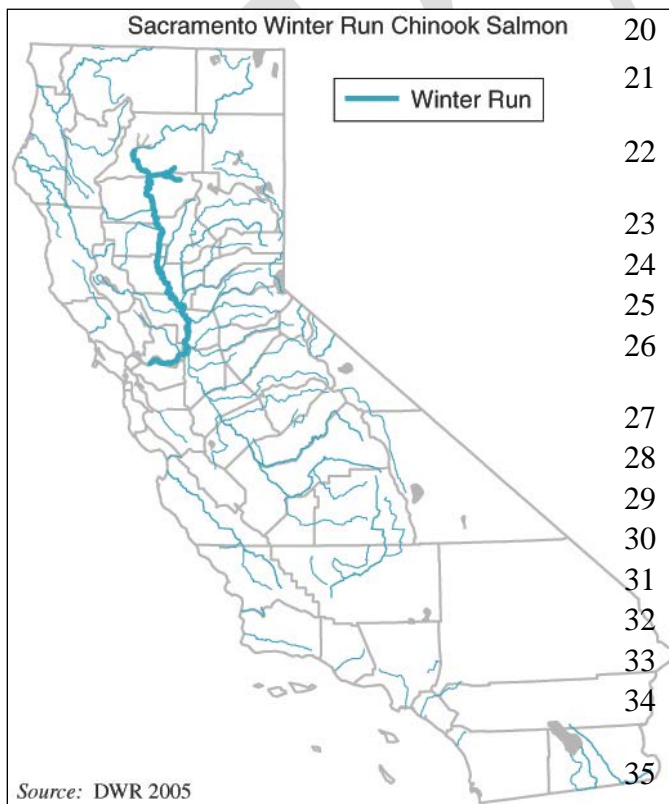


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4 **A.18.1 Legal and Other Status**

5 Central Valley Chinook salmon are composed of several
 6 genetically distinct races. This account focuses on
 7 Sacramento River winter-run, which occurs in the Butte
 8 Regional HCP/NCCP Plan Area.

9 The Sacramento River winter-run Chinook salmon was
 10 federally listed as endangered on April 6, 1990, and the
 11 endangered status was affirmed on June 28, 2005 (NOAA 1990, 2005a). This species was state-
 12 listed as endangered in September 1989. The ESU includes all naturally spawned populations of
 13 winter-run Chinook salmon in the Sacramento River and its tributaries in California, as well as two
 14 artificial propagation programs: winter-run Chinook salmon from the Livingston Stone National Fish
 15 Hatchery (NFH), and winter-run Chinook salmon in a captive broodstock program maintained at
 16 Livingston Stone NFH and the University of California Bodega Marine Laboratory (NOAA
 17 2005a). Because of increased escapement in the past few years, the captive brood stock programs
 18 have been terminated. Critical habitat was established for the winter-run on June 16, 1993 (NOAA
 19 1993) (see Figure A-18 for critical habitat within the Plan Area).



Source: DWR 2005

20 **A.18.2 Species Distribution**
 21 **and Status**

22 **A.18.2.1 Range and Status**

23 The distribution and status information
 24 below was taken from the California
 25 Department of Fish and Game (1995) unless
 26 otherwise noted.

27 Historically, Sacramento River winter-run
 28 salmon spawned in the upper tributaries of
 29 the McCloud River, between Lower Falls
 30 and Big Springs (Hallock and Fisher
 31 1985). In the 1940s, the completion of
 32 Shasta (1943) and Keswick (1950) dams
 33 denied access to the upper Sacramento
 34 River and tributary streams.
 35

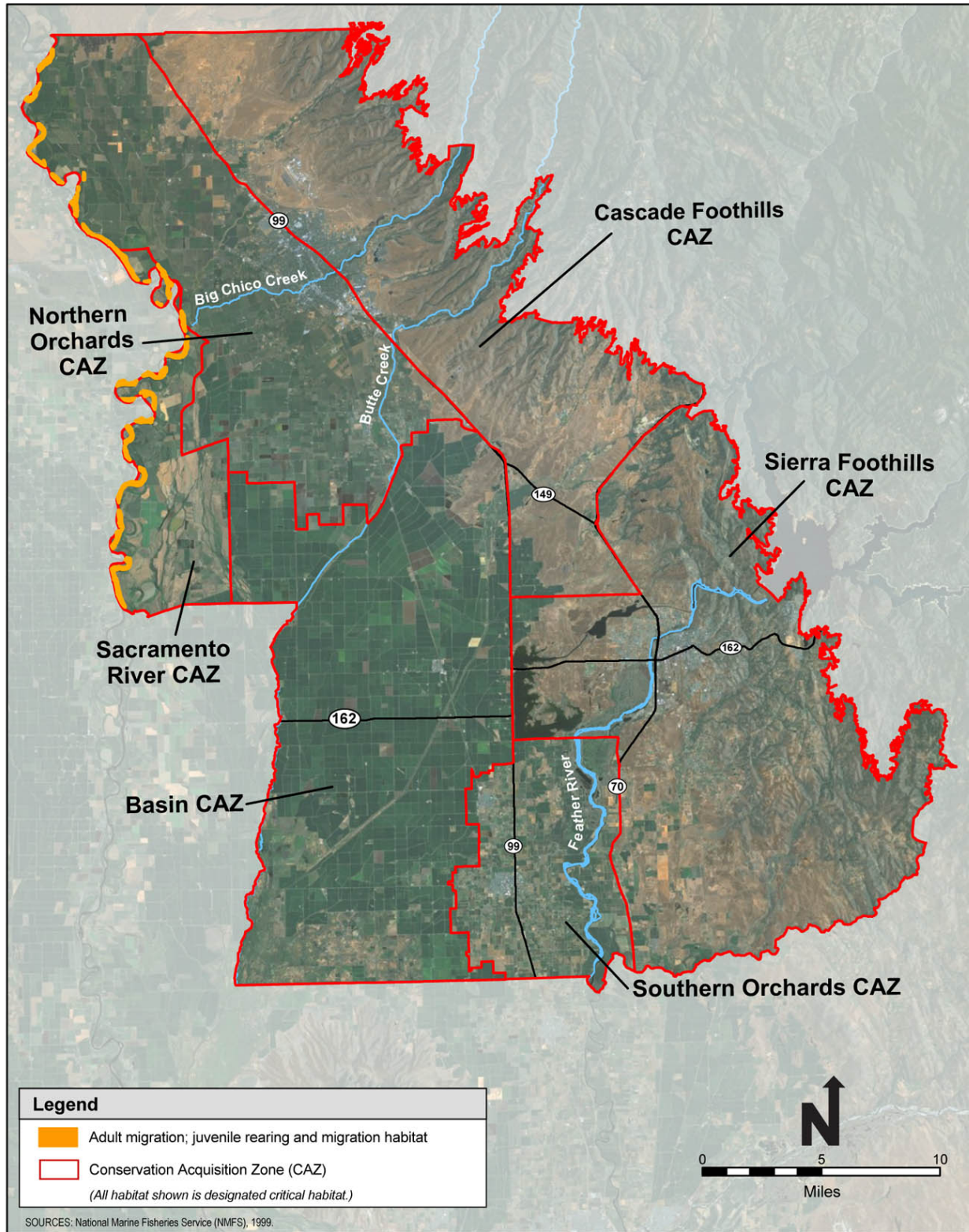


Figure A-18. Central Valley Winter-Run Chinook Salmon Modeled Habitat

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2
3

1 Currently, spawning primarily occurs in the main stem of Sacramento River between Keswick
2 Dam and the Red Bluff Diversion Dam (Hallock and Fisher 1985). Small numbers also spawn in
3 tributary streams including Battle and Mill Creeks (Hallock and Fisher 1985). In the 1960s
4 during high population years, a few winter-run attempted spawning in Deer Creek; however,
5 spawning was unsuccessful, likely due to high water temperatures in the early summer (Hayes
6 and Lindquist 1967). Because large population conditions no longer exist, this species is not
7 likely to spawn in Deer Creek. From 1974 to 1984, winter-run Chinook salmon were
8 occasionally seen in the Calaveras River, a tributary to the lower San Joaquin River. There is
9 considerable debate, however, over whether the river had historical populations of winter-run,
10 given the less suitable environmental conditions, or whether these winter-run fish were strays
11 (DWR 2005).

12 The number of escaped adults in the Sacramento River decreased until 1994, when only 186
13 adults were counted, but has increased since (DFG 2007). In the late 1960s, the number of adults
14 passing Red Bluff Diversion Dam was less than 80,000. During the 1980s, fewer than 5,000 fish
15 were passing through the dam (Hallock and Fisher 1985), and from 1990-1997, fewer than 1,500
16 fish passed the dam each year. Since 1997, the population has increased steadily and, in 2006,
17 an estimated 7,415 fish passed the dam (DFG 2007).

18 **A.18.2.2 Distribution and Status in the Plan Area**

19 Sacramento River winter-run Chinook salmon migrate along the Sacramento River in Butte
20 County, but have not been recorded elsewhere in Butte County by the California Department of
21 Fish and Game (CNDDDB 2006) (Figure A-18).

22 **A.18.3 Habitat Requirements and Special Considerations**

23 The following information was taken primarily from the Resources Agency et al. (1998). The
24 success of immigration and spawning is dependent on water movement and velocity, water
25 depth, substrate composition, and temperature. Spawning takes place in swift, moderately
26 shallow riffles or in areas along fast moving banks with plentiful gravelly substrate. The gravel
27 needs to be clean, loose, and stable for the duration of the larval stage. Pre-spawning or nuptial
28 activity of Chinook salmon requires a territory of 200 to 650 square feet (18.6 to 60.4 square
29 meters) depending on the density of the population. The female will dig a redd, or nest, in the
30 gravel with an average size of 165 square feet (15.33 square meters), and she will deposit several
31 packets of eggs and bury them after they have been fertilized by the male.

32 Spawning locations have a particular balance of water velocity and depth. Water velocity is
33 more critical to the viability of the habitat than water depth. Incubating embryos buried in the
34 gravel require sufficient water flow through the gravel for the supply of oxygen and removal of
35 metabolic wastes. This water flow is governed by the velocity of the water. Water velocity in
36 Chinook salmon spawning areas ranges from 1.0 to 3.5 feet per second (fps) and the optimum
37 velocity is 1.5 fps. Spawning depths fall between 1 to 5 feet (0.3 to 1.5 meter) with a maximum

1 depth observed of 20 feet. A depth of less than 6 inches can be restrictive to Chinook salmon
2 movement.

3 Substrate composition has other key implications in spawning success. The embryos and alevins
4 (newly hatched fish with the yolk sacs still attached) require adequate water movement through
5 the substrate; however, this movement can be inhibited by the accumulation of fines and sand.
6 Higher amounts of sand and fines may prohibit successful embryo incubation and emergence of
7 alevins from the substrate. Generally, the redd should contain less than 5 percent of fines (The
8 Resources Agency 1998).

9 The water temperature is also critical for immigration and spawning of Chinook salmon. This
10 species prefers well-oxygenated water within a range of 57°F to 67°F (8.3°C to 13.9°C) for
11 upstream migration and between 42°F and 56°F (5.6°C and 13.3°C) for spawning. Typically, a
12 temperature of 52°F (11.1°C) is preferred for spawning. Temperatures outside of these
13 thresholds decrease reproductive success.

14 **A.18.4 Life History**

15 The runs of Chinook salmon in California are distinguished by several physical and temporal
16 properties, including the maturity of fish entering fresh water, time of spawning migrations,
17 spawning areas, incubation times, incubation temperature requirements, and migration timing of
18 juveniles (DFG 1995).

19 Adult winter-run Chinook salmon begin their migration into the Sacramento River system in
20 November and continue through May. They travel through the Red Bluff Diversion Dam
21 (RBDD) from mid-December through early August (Hallock and Fisher 1985). The migration
22 through Red Bluff peaks in March and continues through May (Hallock and Fisher 1985).
23 Winter-run Chinook salmon typically spend a long time holding in the river before spawning;
24 however, this can make the female's eggs more susceptible to high stream temperatures (Hallock
25 and Fisher 1985).

26 Spawning typically occurs from mid-April through August and peaks in activity in May and June
27 (Vogel and Marine 1991, Hallock and Fisher 1985). Embryo incubation and emergence of fry
28 takes place from mid-April through mid-October. River rearing of winter-run Chinook salmon
29 juveniles begins at the end of July and continues through May of the following year (Hallock and
30 Fisher 1985).

31 Emigration of fry and smolts occurs from July through March at the RBDD and from September
32 through June in the delta. The fry can emigrate right after emergence, but most hold in the upper
33 Sacramento River for several months. Juveniles spend 5 to 9 months in the river and
34 Sacramento-San Joaquin Estuary before entering the ocean.

1 **A.18.5 Threats**

2 The primary threat to winter-run Chinook salmon is the loss and degradation of spawning
3 habitat.

4 **A.18.5.1 Habitat Loss and Degradation**

5 The construction of Shasta Dam blocked access to the entire historical spawning area of winter-
6 run Chinook salmon (Good et al. 2005). It is likely that there were several independent
7 populations in the Pit, McCloud, and Little Sacramento Rivers that merged into a single
8 population after construction of the dam, drastically reducing genetic diversity of the ESU. Any
9 populations that may have existed in Battle Creek and the Calaveras River have since been
10 extirpated. Dams have altered water temperatures and reduced habitat complexity, which reduce
11 the productivity, abundance, and spatial structure to the genetic diversity of winter-run Chinook
12 salmon. This reduction in genetic diversity in combination with there being only a single
13 population with low numbers puts winter-run ESU at high risk of extinction.

14 In addition to Shasta Dam, the Red Bluff Diversion Dam was considered one of the main reasons
15 for declines in winter-run Chinook salmon numbers. Although the gates of the dam are now
16 required to remain raised during winter-run passage, an estimated 15 percent of fish still cannot
17 pass the dam and must spawn downstream.

18 Winter-run Chinook salmon are further threatened by having only one extant population
19 dependent on artificially created environmental conditions that is low in population size and
20 vulnerable to drought, inadequately screened water diversions, predation at artificial structures
21 and by nonnatives, pollution (e.g., Iron Mountain Mine), adverse flow conditions, high summer
22 water temperatures, unsustainable harvest rates, and passage problems at various structures
23 (Good et al. 2005).

24 **A.18.6 Relevant Conservation Efforts**

25 Since the listing of Sacramento River winter-run Chinook salmon, several habitat and harvest-
26 related problems that were identified as factors contributing to the decline of the species have been
27 addressed and improved through restoration and conservation actions. The reason for initiating
28 restoration actions stems primarily from the following: (1) ESA section 7 consultation Reasonable
29 and Prudent Alternatives on temperature, flow, and operations of the Central Valley Project (CVP)
30 and State Water Project (SWP) (NMFS 2009); (2) Regional Water Quality Control Board
31 decisions that require compliance with Sacramento River water temperature objectives which
32 resulted in the installation of the Shasta Temperature Control Device in 1998; (3) a 1992
33 amendment to the authority of the CVP through the Central Valley Improvement Act to give fish
34 and wildlife equal priority with other CVP objectives; (4) fiscal support of habitat improvement
35 projects from the California Bay Delta Authority (CALFED) Bay-Delta Program (e.g., installation
36 of a fish screen on the Glenn-Colusa Irrigation District diversion); (5) establishment of the

1 CALFED Environmental Water Account ; (6) EPA actions to control acid mine runoff from Iron
2 Mountain Mine; and, (7) ocean harvest restrictions implemented in 1995.

3 Results of monitoring at the CVP and SWP fish salvage facility and experimentation over the
4 past several decades have led to the identification of various management actions designed to
5 reduce or avoid the potentially adverse effects of SWP and CVP export operations on salmon.
6 Many of these actions have been implemented through SWRCB water quality permits (D-1485,
7 D-1641), biological opinions issued on project export operations by NMFS, USFWS, and DFG,
8 as part of CALFED programs (e.g., Environmental Water Account), and as part of Central
9 Valley Project Improvement Act actions. As a result of these requirements, multiple
10 conservation efforts exist to enhance habitat and reduce entrainment of Chinook by the SWP and
11 CVP export facilities.

12 The artificial propagation program for winter-run Chinook at Livingston Stone National Fish
13 Hatchery, on the mainstem of the Sacramento River, has operated for conservation purposes
14 since the early 1990s. The increased natural escapement over the last several years has led to the
15 termination of both captive broodstock programs located at the University of California Davis
16 Bodega Marine Laboratory and Livingston Stone National Fish Hatchery.

17 Biological opinions for SWP and CVP operations (e.g., NMFS 2009) and other federal projects
18 involving irrigation, water diversion, and fish passage have improved or minimized adverse
19 impacts to salmon in the Central Valley. In 1992, an amendment through the Central Valley
20 Project Improvement Act gave protection of fish and wildlife equal priority with other CVP
21 objectives. Several other programs that have benefited listed salmonids arose from this Act. The
22 Anadromous Fish Restoration Program is engaged in monitoring, education, and restoration
23 projects designed to contribute toward doubling the natural populations of certain anadromous
24 fish species residing in the Central Valley. Restoration projects funded through the Anadromous
25 Fish Restoration Program include fish passage, fish screening, riparian easement and land
26 acquisition, development of watershed planning groups, instream and riparian habitat
27 improvement, and gravel replenishment. The Anadromous Fish Screen Program combines
28 private, state, and federal funds to prioritize and construct fish screens on major water diversions,
29 mainly in the upper Sacramento River. The goal of the Water Acquisition Program is to acquire
30 water supplies to meet the habitat restoration and enhancement goals of the Central Valley
31 Project Improvement Act, and improve the ability of the U.S. Department of the Interior to meet
32 regulatory water quality requirements. Water has been used to improve fish habitat for Central
33 Valley salmon, with the primary focus on listed Chinook salmon and steelhead, including winter-
34 run Chinook salmon, by maintaining or increasing instream flows (e.g., Environmental Water
35 Account) on the Sacramento River at critical times, and to reduce salmonid entrainment at the
36 SWP and CVP export facilities by reducing seasonal diversion rates during periods when
37 protected fish species are vulnerable to export-related losses.

38 Two programs under CALFED, the Ecosystem Restoration Program (ERP) and the
39 Environmental Water Account, were created to improve conditions for fish, including winter-run

1 Chinook salmon, in the Central Valley. Restoration actions implemented by the ERP include the
2 installation of fish screens, modification of barriers to improve fish passage, habitat acquisition,
3 and instream habitat restoration. Most of these actions address key factors and stressors
4 affecting listed salmonids. Additional ongoing actions include efforts to enhance fishery
5 monitoring and improvements to hatchery management to support salmonid production through
6 hatchery releases.

7 A major CALFED ERP action currently underway is the Battle Creek Salmon and Steelhead
8 Restoration Project. Although winter-run Chinook do not currently inhabit Battle Creek, they
9 did occur there historically. CALFED is funding the establishment of a second independent
10 population of winter-run Chinook salmon in the upper Battle Creek watershed using the artificial
11 propagation program as a source of fish. The project will restore 77 kilometers (km) (48 miles)
12 of habitat in Battle Creek to support steelhead and Chinook salmon spawning and juvenile
13 rearing at a cost of over \$90 million. The project includes removal of five small hydropower
14 diversion dams, construction of new fish screens and ladders on another three dams, and
15 construction of several hydropower facility modifications to ensure continued hydropower
16 operations. This restoration effort is believed to be the largest cold water restoration project to
17 date in North America.

18 As part of the CALFED and CVPIA programs, many of the largest water diversions located on
19 the Sacramento River and Delta (e.g., Glenn Colusa Irrigation District, Reclamation District
20 1001 Princeton diversion, RD 108 Wilkins Slough pumping plant, Sutter Mutual Water
21 Company Tisdale pumping plant, Contra Costa Water District's Old River and Alternative Intake
22 Project intake, and others) have been equipped with positive barrier fish screens. However, the
23 majority of smaller water diversions located on the Sacramento River and Delta remain
24 unscreened. Reclamation District 108 has also designed and constructed a new fish screen and
25 pumping plant (Poundstone Pumping Plant) located on the Sacramento River that consolidates
26 and eliminates three currently existing unscreened water diversions. These fish screening
27 projects are specifically intended to reduce and avoid entrainment losses of juvenile winter-run
28 Chinook salmon and other fish inhabiting the river.

29 The Central Valley Salmonid Project Work Team, an interagency technical working group led by
30 DFG, drafted a proposal to develop a Chinook salmon escapement monitoring plan that was
31 selected by the CALFED ERP Implementing Agency Managers for directed action funding.
32 Long-term funding for implementation of the monitoring plan must still be secured.

33 Recent habitat restoration initiatives sponsored and funded primarily by the CALFED ERP have
34 funded 29 projects (approximately \$24 million) designed to restore ecological function to 9,543
35 acres (8,091 acres within the Bay Region and the remaining acres located in the Delta and
36 Eastside Tributaries Regions of the CALFED action area) of shallow-water tidal and marsh
37 habitats within the Bay-Delta. Restoration of these areas primarily involves flooding lands
38 previously used for agriculture, thereby creating additional rearing habitat for juvenile
39 salmonids. Similar habitat restoration is imminent adjacent to Suisun Marsh (i.e., at the

1 confluence of Montezuma Slough and the Sacramento River) as part of the Montezuma
2 Wetlands project, which is intended to provide for commercial disposal of material dredged from
3 San Francisco Estuary in conjunction with tidal wetland restoration.

4 The USEPA's Iron Mountain Mine remediation involves removing toxic metals in acidic mine
5 drainage from the Spring Creek Watershed with a state-of-the-art lime neutralization plant.
6 Contaminant loading into the Sacramento River from Iron Mountain Mine, and other mining
7 operations, have shown measurable reductions since the early 1990s. Decreasing the heavy
8 metal contaminants that enter the Sacramento River should increase the survival of salmonid
9 eggs and juveniles. However, during periods of heavy rainfall upstream of the Iron Mountain
10 Mine, reclamation substantially increases Sacramento River flows to dilute heavy metal
11 contaminants being spilled from the Spring Creek debris dam. This rapid change in flows can
12 cause juvenile salmonids to become stranded or isolated in side channels below Keswick Dam.

13 In 2001, a new fish screen was constructed at the Anderson Cottonwood Irrigation District
14 Diversion Dam and a state-of-the-art fish ladder was installed to address the threats caused by the
15 diversion dam. As described in the final listing determination for the ESU (70 FR 37160), the
16 flashboard gates and inadequate fish ladders at the diversion dam blocked passage for upstream
17 migrant winter-run Chinook. The seasonal operation of the dam created unsuitable habitat
18 upstream of the dam by reducing flow velocity over the incubating eggs, reducing egg survival.
19 Evaluation of the fish ladder is ongoing.

20 To help reduce the effects of the RBDD operation on migration of adult and juvenile salmonids
21 and other species, management has changed in recent years to keep the dam gates open for a longer
22 period of time, thereby facilitating greater upstream and downstream migration. These changes in
23 dam operations have contributed to reductions in juvenile predation mortality. In 2009, USBR
24 received funding for the Fish Passage Improvement Project at the RBDD to build a pumping
25 facility to provide reliable water supply for high-value crops in Tehama, Glenn, Colusa, and
26 northern Yolo counties while providing year-round unimpeded fish passage. This project,
27 expected to be completed in late 2012, will eliminate passage issues for winter-run Chinook
28 salmon and other migratory species.

29 DWR's Delta Fish Agreement Program has approved about \$49 million for projects that benefit
30 salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the
31 agreements inception in 1986. Delta Fish Agreement projects that benefit Sacramento River
32 winter-run Chinook salmon include enhanced law enforcement efforts from San Francisco
33 Estuary upstream into the Sacramento River, spawning gravel augmentations, and habitat
34 enhancement projects. Through the Delta-Bay Enhanced Enforcement Program (DBEEP),
35 initiated in 1994, a team of 10 wardens focus their enforcement efforts on salmon, steelhead, and
36 other species of concern from the San Francisco Estuary upstream into the Sacramento and San
37 Joaquin River basins. Enhanced enforcement programs are believed to have had significant
38 benefits to Chinook salmon attributed to DFG, though results have not been quantified.

1 Harvest protective measures for Sacramento River winter-run Chinook salmon include seasonal
2 constraints on sport and commercial fisheries south of Point Arena in an effort to reduce harvest
3 of winter-run Chinook salmon. Ocean harvest restrictions since 1995 have led to reduced ocean
4 harvest of winter-run Chinook (i.e., Central Valley Chinook salmon ocean harvest index ranged
5 from 0.55 to nearly 0.80 from 1970 to 1995, and was reduced to 0.27 in 2001). The state of
6 California has established specific in-river fishing regulations and no-retention prohibitions
7 designed to protect Sacramento River winter-run Chinook salmon. DFG has implemented
8 enhanced enforcement efforts to reduce illegal harvests.

9 **A.18.7 Species Habitat Suitability Model**

10 **Migration Habitat.** Winter-run Chinook salmon migration habitat is defined as migration
11 habitat delineated by DFG (CNDDDB 2007) and NMFS (1999). The Sacramento River along the
12 western edge of the Plan Area supports upstream migration habitat for winter-run Chinook
13 salmon moving upstream towards spawning habitat and downstream migration of juveniles
14 moving towards the Pacific Ocean. Spawning habitat for winter-run Chinook salmon is located
15 upstream of the Plan Area (Hallock and Fisher 1985). For salmon to access this habitat and for
16 juveniles to move downstream towards the Pacific Ocean, they must use the Sacramento River
17 within the Plan Area as a migration corridor.

18 **Assumptions.** Data from DFG (CNDDDB 2007) and NMFS (2005) were used for this model
19 because these agencies are the state and federal agencies, respectively, responsible for managing
20 winter-run Chinook salmon and, as such, are considered to be the authorities on the distribution
21 of the species and its habitat.

22 **A.18.8 Recovery Plan Goals**

23 A proposed recovery plan has been prepared for winter-run Chinook salmon and recovery goals
24 have been established for the species. A new draft multi-species Recovery Plan for Central
25 Valley salmonids is under development by NMFS and is expected to be completed in June 2007,
26 with the final plan completed in December 2007.

27 The delisting criteria for the Sacramento River winter-run Chinook salmon population are
28 summarized below (NMFS 1997):

- 29 1. The mean annual spawning abundance over any 13 consecutive years shall be 10,000
30 females. The geometric mean of the Cohort Replacement Rate over those same 13 years
31 shall be greater than 1.0. Estimates of these criteria shall be based on natural production
32 alone and shall not include hatchery-produced fish. The variability in Cohort Replacement
33 Rate is assumed to be the same as or less than the current variability.
- 34 2. There must be a system in place for estimating spawning run abundance with a standard error
35 less than 25 percent of the estimate, on which to base the calculation of the population
36 criteria. If this level of precision cannot be achieved, then the sampling period over which

1 the geometric mean of the Cohort Replacement Rate is estimated must be increased by one
2 additional year for each 10 percent of additional error above 25 percent.

3 Recovery goals must ensure that natural populations are large enough to avert the risks
4 associated with small population size. The numeric goals described above provide the means of
5 assessing whether the winter-run Chinook salmon population has reached a viable, self-
6 sustaining level. Accordingly, both the natural cohort replacement rate and spawner abundance
7 must be evaluated. This is because a high replacement rate with few parent spawners does not
8 necessarily indicate recovery of the population. Conversely, an abundant spawning population
9 may not indicate a recovered population if the cohort replacement rate was negative (i.e., a
10 declining population).

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