National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
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THE DIRECTOR

FEB 12 1993

Mr. David N. Kennedy
Director, Department of Water Resources
1416 Ninth Street
P.O. Box 942836
Sacramento, California 94236-0001

Dear Mr. Kennedy:

Enclosed is a biological opinion that addresses the effects of the Bureau of Reclamation's (Bureau) proposed long-term operation of the Central Valley Project (CVP), in conjunction with the Department of Water Resource's (DWR) long-term operation of the State Water Project (SWP), on Sacramento River winter-run chinook salmon. This opinion was prepared by the National Marine Fisheries Service (NMFS) in response to a request from the Bureau for formal consultation pursuant to section 7 of the Endangered Species Act.

Based on the available information, our biological opinion concludes that DWR's long-term operation of the State Water Project, in conjuction with the Bureau's long-term operation of the CVP, is likely to jeopardize the continued existence of the Sacramento River winter-run chinook salmon. As a result of numerous meetings with the Bureau, DWR, and other Federal and state resource agencies, we have identified a reasonable and prudent alternative that we believe the Bureau, in cooperation with DWR, can implement to avoid jeopardizing winter-run chinook salmon.

However, even with the implementation of the identified reasonable and prudent alternatives, there will continue to be some incidental taking of winter-run chinook salmon as a result of CVP and SWP operations. For this reason, an incidental take statement is included with this biological opinion. The incidental take statement identifies specific terms and conditions that the Bureau and DWR must comply with to minimize the taking of winter-run chinook salmon as a result of long-term CVP and SWP operations.

Consultation must be reinitiated with NMFS if (1) the amount or extent of taking specified in the incidental take statement is exceeded, (2) new information reveals that long-term operation of the CVP may affect winter-run chinook in a manner or to an extent

not previously considered, (3) the action is modified in a manner that causes an effect to the Sacramento River winter-run chinook salmon not previously considered, or (4) a new species is listed or critical habitat is designated that may be affected by the Bureau's actions.

I look forward to your continued cooperation in future consultations.

Sincerely,

William W. Fox, Jr.
(For)

Enclosure

cc: BOR - Roger Patterson

BIOLOGICAL OPINION

FOR THE OPERATION OF THE

FEDERAL CENTRAL VALLEY PROJECT

AND THE

CALIFORNIA STATE WATER PROJECT

NATIONAL MARINE FISHERIES SERVICE

Date: FEB 12 1992

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BIOLOGICAL OPINION

Agency: Mid-Pacific Region, Bureau of Reclamation.

Activity: Central Valley Project, Long-term Operations

Consultation Conducted By: Southwest Region, National Marine Fisheries Service.

Date Issued: 2-12-93

I. BACKGROUND

On February 26, 1991, the National Marine Fisheries Service (NMFS) requested the U.S. Bureau of Reclamation (Bureau), Department of Interior, to formally consult with NMFS pursuant to section 7 of the Endangered Species Act (ESA) to determine whether its operation of the Central Valley Project (CVP) jeopardizes the continued existence of the threatened Sacramento River winter-run chinook salmon. On April 11, 1991, the Bureau agreed to NMFS's request for formal consultation.

To facilitate a better understanding of the many factors influencing the physical and institutional conditions, and decision-making processes underlying the operation of the CVP, the Bureau prepared the "Central Valley Project Operations Criteria and Plan (CVP-OCAP)." Following are the objectives of the plan and criteria:

> "Develop operational plan, including the identification of alternative operations, strategies, and criteria to meet legislative, legal, regulatory, and agreement requirements. The near-term objective is to provide operations information for the Endangered Species Act (ESA) Section 7 consultation. The long-term objective is to integrate Central Valley Project operations plans with the proposed Central Valley Project Water Management Program." (USBR 1991)

NMFS and the Bureau agreed that the scope of this consultation was to include the operation of all CVP units, except the Friant Division, under a full range of hydrologic and storage conditions. It was agreed that the indirect impacts of operation of the Friant Division can be addressed in the discussion of the Delta Division operations. Areas of concern regarding impacts to winter-run chinook salmon include operation of the Shasta Division, Trinity Division, Red Bluff Diversion Dam, and Delta Division.

The Bureau and NMFS had intended to complete formal consultation covering long-term CVP operations under a range of hydrologic and

storage conditions before 1992. However, late in 1991 as CVP operations modeling and other information required for the long-term consultation were being developed, NMFS and the Bureau agreed to separate the consultation regarding 1992 operations from the long-term consultation. In February 1992, the Bureau issued an Interim Central Valley Project Operations Criteria and Plan and a biological assessment concerning the effects of 1992 CVP operations on the winter-run chinook salmon. NMFS issued a biological opinion and incidental take statement for 1992 operations on February 14, 1992. The opinion concluded that the Bureau's proposed operation of the CVP in 1992 was likely to jeopardize the continued existence of the Sacramento River winter-run chinook salmon and offered a reasonable and prudent alternative to avoid jeopardy.

By letter dated September 24, 1992, the Bureau requested initiation of formal consultation on the long-term operation of the CVP and provided drafts of the "Long-term CVP-OCAP" report and biological assessment concerning the effects of long-term operations on the winter-run chinook salmon. On October 30, 1992, the Bureau transmitted to NMFS the final "Long-term Central Valley Project Operations Criteria and Plan" and biological assessment. A companion assessment regarding effects of the combined operations of the CVP and the State Water Project on winter-run chinook salmon in the lower Sacramento River and Sacramento-San Joaquin Delta was prepared by the California Department of Water Resources and transmitted to NMFS in early November of 1992.

During consultation, NMFS developed biological criteria for the CVP facilities and operations that would protect Sacramento River winter-run chinook salmon. These biological criteria were prepared to assist the Bureau in operation plans that would minimize or avoid impacts to winter-run chinook salmon. Analyses of proposed CVP operating plans covering a range of water year types and initial storage conditions were presented in the "Long-term CVP-OCAP" report and concluded that the Bureau was unable to meet the winter-run chinook salmon biological criteria under several operational scenarios.

On November 19, 1992, NMFS requested the Bureau to perform additional modeling to fully examine the ability of the existing CVP facilities to meet the winter-run chinook salmon biological criteria under all water-year types and storage conditions. On December 22, 1992, NMFS received the results of the Bureau's additional modeling efforts which demonstrated that modification of proposed operations can improve the performance of the CVP to meet the biological criteria. During January 1993, NMFS and the Bureau used results of this additional modeling to develop modified CVP operational plans.

Description of the Central Valley Project (CVP)

The Central Valley Project in California, which is administered by the Bureau of Reclamation, is one of the nation's major water development projects with 20 reservoirs, 500 miles of major canals and aqueducts, and 12 million acre-feet of storage capacity. The Central Valley Basin includes two major watersheds: the Sacramento River in the north, and the San Joaquin River to the south. The combined watersheds extend nearly 500 miles in a northwest-southeast direction. The two river systems join at the Sacramento-San Joaquin Delta, flow through Suisun Bay and Carquinez Straits into San Francisco Bay, and past the Golden Gate to the Pacific Ocean.

Trinity River Division

This division was authorized by Congress in 1955 and completed in 1964. Runoff from the upper Trinity Basin (728 square miles) is stored, regulated, and diverted through a system of dams and reservoirs, powerplants, tunnels, and a siphon to the Sacramento River. The main features of the division are Trinity Dam and Clair Eagle Lake, Trinity Powerplant, Lewiston Dam and Lake, Lewiston Powerplant, Clear Creek Tunnel and Judge Francis Carr Powerhouse, Whiskeytown Dam and Lake, Spring Creek Tunnel and Powerplant, and Spring Creek Debris Dam and Reservoir.

Trinity River water is stored in Clair Eagle Lake (2,448,000 acre-feet capacity) behind Trinity Dam. Lewiston Dam regulates flows in the Trinity River to meet fishery and temperature requirements in the Trinity Basin and provides a forebay for the transbasin diversion of flows through the Clear Creek Tunnel to the Sacramento Basin.

Spring Creek Debris Dam and Reservoir (5,800 acre-feet capacity) control flows from the Spring Creek watershed. Acid mine discharge from Iron Mountain Mine in the Spring Creek drainage is laden with heavy metal contaminants including copper, zinc, and cadmium. Release of contaminants from Spring Creek Reservoir is generally at a controlled rate for dilution in the Sacramento River below Keswick Dam.

Shasta Division

The Shasta Division of the CVP includes California's largest storage reservoir, Shasta Dam and Lake (4,552,000 acre-feet capacity) on the Sacramento River. Completed in 1945, Shasta Dam and Lake made up the first CVP unit constructed by the Bureau. Shasta Dam, which backs up the waters of the upper Sacramento, McCloud, and Pit Rivers (6,665 square miles), controls floodwater and stores winter runoff for irrigation use in the Sacramento and San Joaquin Valleys.

Keswick Dam, located about 9 miles downstream from Shasta Dam, creates an afterbay (23,000 acre-feet capacity) for Shasta Lake and Trinity River diversions, and stabilizes the peak operation water releases from Spring Creek and Shasta powerplants. Anadromous fish trapping facilities at the dam are operated in conjunction with the U.S. Fish and Wildlife Service (FWS). Some of the salmon trapped at the Keswick fish trap are taken for use at the Coleman National Fish Hatchery 25 miles downstream on Battle Creek.

Sacramento River Division

The Sacramento River Division includes the Sacramento Canals Unit and Black Butte Dam and Lake. Authorized in 1950, the Sacramento Canals Unit includes the Red Bluff Diversion Dam, Tehama-Colusa Canal, Corning Canal, and Corning Pumping Plant. The Tehama-Colusa Canal and Corning Canal supply irrigation water to lands in the Sacramento Valley, principally in Tehama, Glenn, Colusa, and Yolo Counties.

The Red Bluff Diversion Dam impounds water in Lake Red Bluff for diversion to the Tehama-Colusa Canal and Corning Canal. Completed in 1964, the dam consists of a concrete gated weir structure 52 feet high and 5,985 feet long. Since it began operation in August of 1966, the waters of the Sacramento River are passed downstream at the dam through a variety of fish facilities and eleven fixed wheel gates. Up to 2,900 cfs (cubic feet per second) of the river can be diverted into canals by gravity when the gates of the diversion dam are lowered. Fish ladders at each abutment provide for upstream passage of anadromous fish around the dam when the gates are lowered. An additional center fish ladder was retrofited on gate 6 of the dam in 1984. When the gates are raised, diversions of up to 125 cfs to the Tehama-Colusa Canal and Corning Canal have been maintained through 100 hp vertical propeller pumps. The original louver fish screens in the headworks of the Tehama-Colusa Canal and Corning Canal were replaced in 1990 by "state-of-the-art" multiple bypass drum screens.

The Bureau is currently proceeding with the development of a pilot pumping plant using state-of-the-art low speed pumps to augment diversion capacity to the Tehama-Colusa Canal when the gates of the dam are raised. This proposed project was the subject of a separate section 7 consultation with NMFS (opinion issued Feb. 2, 1993). Therefore, the potential effects of the pilot pumping plant on winter-run chinook salmon will not be addressed by this biological opinion.

The Black Butte Dam and Lake, constructed, operated, and maintained by the Army Corps of Engineers (Corps), is located 9 miles northwest of Orland. It includes facilities for delivery

of water to the South Canal of Orland Project and a water supply to the Sacramento Canals Unit.

American River Division

The American River Division includes the Folsom Unit, Sly Park Unit, and Auburn-Folsom South Unit of the CVP. The Folsom Unit consists of Folsom Dam and Lake, Folsom Powerhouse, Nimbus Dam, Lake Natoma, and Nimbus Powerplant on the American River. The Sly Park Unit includes Jenkinson Lake formed by Sly Park Dam on Sly Park Creek, a low concrete diversion dam on Camp Creek, and Sly Park Conduit. The Folsom and Sly Park Units were added to the CVP in 1949. Auburn-Folsom South Unit consists of Auburn Dam, Powerplant and Reservoir; County Line Dam, Pumping Plant, and Reservoir; Sugar Pine Dam and Reservoir; Linden and Morman Island Pumping Plants; Folsom South Canal; and other necessary diversion works, conduits, and appurtenant works for delivery of water supplies to Placer, El Dorado, Sacramento, and San Joaquin Counties.

Delta Division

The Delta Division provides for export and transport of water from the Sacramento-San Joaquin Delta. The main features include the Delta Cross Channel, Contra Costa Canal, Tracy Pumping Plant, and Delta-Mendota Canal. The Delta Cross Channel, Tracy Pumping Plant, and the Delta-Mendota Canal were completed in 1951 and the Contra Costa Canal in 1948.

The Delta Cross Channel is a controlled diversion channel between the Sacramento River and Snodgrass Slough. Although designed for a capacity of 3,500 cfs, up to 6,000 cfs of water can be diverted through Cross Channel from the Sacramento River to Snodgrass Slough (DWR 1991). From Snodgrass Slough, Sacramento River water flows through natural channels of the lower Mokelumne River to the vicinity of the CVP's Tracy Pumping Plant, the State Water Project's Banks Pumping Plant, and the intake of the Contra Costa Canal at Rock Slough.

The Tracy Pumping Plant consists of an inlet canal, pumping plant, and discharge pipes. At Tracy, up to 4,600 cfs of water can be pumped from the Delta and lifted 197 feet into the Delta-Mendota Canal. The intake canal includes the Tracy Fish Screen which was built to intercept downstream migrant fish so they may be captured and returned to the Delta to resume their journey to the ocean. The Delta-Mendota Canal carries water southeasterly from the Tracy Pumping Plant along the western San Joaquin Valley for irrigation supply, use in San Luis Unit, and to replace San Joaquin River water stored at Friant Dam and used in the Friant-Kern and Madera systems (San Joaquin exchange contracts).

The Contra Costa Canal originates at Rock Slough about 4 miles west of Oakley in the southwestern Delta where it diverts from 50 to 250 cfs of water for municipal, industrial, and irrigation use. Water is lifted 127 feet by a series of four unscreened pumping plants. The canal and pumping plant is technically part of the CVP, but is operated and maintained by the Contra Costa Water District.

State Water Project

The Banks Pumping Plant of the State Water Project generally exports about 6,400 cfs from the Delta into the California Aqueduct near Byron. However, during the spring of 1992, the State installed four new pumps which increases the capacity at the pumping plant to 10,300 cfs. The State is not yet permitted by the Army Corp of Engineers to fully use the new pumps. At the intake to the aqueduct, the State operates the John E. Skinner Fish Collection Facility on Clifton Court Forebay. The forebay serves as a regulating reservoir approximately one mile above the Harvey O. Banks Pumping Plant. The intake complex is often referred to as the State's Byron facilities, named after the nearby village.

The Suisun Marsh Salinity Control Structure on Montezuma Slough was completed in November 1988 and is operated by the California Department of Water Resources from October through May. The primary objective of the structure is to meet water quality criteria established by the California State Water Resources Control Board in Decision 1485 and the Suisun Marsh Preservation Agreement. The gates are operated to tidally pump water from the Sacramento River through Montezuma Slough for provision of less saline water to Suisun Marsh.

West San Joaquin Division

The San Luis Unit of the West San Joaquin Division is the most recently completed link in the CVP and State of California Water Plan. It includes San Luis Dam and Reservoir (joint Federal-State Facility), O'Neill Dam and Forebay (joint Federal-State facility), O'Neill Pumping-Generating Plant, San Luis Pumping-Generating Plant, (joint Federal-State facility), San Luis Canal (joint Federal-State facility), Dos Amigos Pumping Plant (joint FederaL-State facility), Coalinga Canal, Pleasant Valley Pumping Plant, and Los Banos and Little Panoche Detention Dams and Reservoirs (joint Federal-State facility).

East Side Division

The New Melones Unit of the East Side Division consists of the New Melones Dam, Lake, and Powerplant on the Stanislaus River about 60 miles upstream from its confluence with the San Joaquin River. Multi-purpose functions of New Melones Unit include flood

control, irrigation water supply, municipal and industrial water supply, power generation, and recreation.

Operation Agreements, Constraints, and Objectives

Operations Forecasting

Operations forecasting is performed by the Bureau to determine how the current and anticipated water and power resources available to the CVP can best be used to meet project objectives. The Bureau must begin its water allocation planning for a given year well before the conclusion of the rainy season and announce proposed water allocations to contractors in mid-February. Because this water allocation planning and announcement must occur before the Bureau actually knows how much water is in CVP reservoirs, they must predict rainfall, snowmelt and runoff for the remainder of the wet season. Water planners rely upon probability distributions and models based on historical hydrologic data sets to make such predictions (i.e forecasts).

Under CVP forecasting procedures, the Bureau estimates the probability that runoff through the remainder of the wet season will be greater than or equal to a certain value. This analysis is known as the "probability of exceedance" (e.g. a 90 percent probability of exceedance means that based on historical occurrences, the actual runoff would be less in only 10 percent of the years).

CVP Water Service Contracts

A primary objective of the CVP is provision of water for irrigation and municipal/industrial uses. Water service contracts for the CVP are between the U.S. and individual water users or districts and generally fall within three categories: "water rights settlement contracts", "exchange contracts", and "water service contracts" (see CVP-OCAP pages 12-13, page 62, and pages 76-77).

Water Rights Settlement Contracts: Prior to construction of the CVP, farmers in the Sacramento Valley relied on Sacramento River water to irrigate their land. As the CVP was built, the Bureau entered contractual agreements with existing water right holders (eg. water rights settlements). Most of these agreements established the quantity of water the contractor is permitted to divert under independent senior water rights on a monthly basis and outlined supplemental CVP supply allocated by the Bureau in dry months.

Exchange Contractors: Before completion of Friant Dam on the San Joaquin River in 1947, the Bureau entered into an agreement with irrigators who held rights to use river water. The irrigators

agreed not to exercise their water rights on the San Joaquin in exchange for a similar amount of water pumped from the Delta. Four districts receive water under this exchange contract while other CVP contractors on the east side of the San Joaquin Valley receive San Joaquin River water. However, the exchange contractors retain their underlying water rights.

Water shortage provisions included in the water rights settlement contracts and exchange contracts are based upon the "Shasta Criteria." This criteria allows the Bureau during a critical water year to reduce CVP delivery of water right entitlements by 25 percent. Both Sacramento Basin and San Joaquin exchange contractors must be notified of any shortages in their water supply by no later than February 15 each year. Shortages may not be imposed later than that date, but they may be rescinded at any time the conditions warrant.

The "Shasta Criteria" refers to forecasted inflow to Shasta Lake. When forecasted inflows fall below the defined threshold for a "critical" water year, water deliveries to these water rights contractors may be reduced by 25 percent. The criteria are as follows:

1. The forecasted full natural inflow to Shasta Lake for the current water year, as such forecast is made by the United States on or before February 15 and reviewed as frequently thereafter as conditions and information warrant, is equal to or less than 3,200,000 acre-feet (AF); or

2. The total accumulated actual deficiencies below 4,000,000 AF in the immediately prior water years each of which had inflows of less than 4,000,000 AF, together with the forecasted deficiency for the current water year, exceed 800,000 AF.

Normally, a median forecast (50 percent probability of exceedance) is used to determine the water allocations to water rights settlement contractors and other CVP contractors. A more conservative forecast (90 percent probability of exceedance) was used in water allocation decision-making from 1989 to 1992. Based on this criteria, water rights settlement contract deliveries were reduced in 1977, 1991, and 1992.

<u>Water service contracts</u>: Before construction of the CVP, irrigators on the east and west sides of the San Joaquin Valley and irrigators on the west side of the Sacramento Valley relied primarily on ground water. With completion of the CVP, 130 contractors signed agreements with the Bureau for water deliveries. Several cities have similar contracts. These contracts provide that the Federal Government will make available a certain amount of water for distribution, but quantities can be reduced due to drought or other unavoidable causes at the

discretion of the Bureau. Traditionally, the Bureau notifies its project water contractors of reduced deliveries on February 15. Project water deliveries under long-term contracts were reduced in 1977, 1990, 1991 and 1992.

Upper Sacramento River Temperature Control

In May 1990 the State Water Resources Control Board issued Water Rights Order 90-5 which modified the Bureau's water rights for the Sacramento River. Among other things, this order included temperature objectives for the Sacramento River to protect winter-run chinook salmon. It states the Bureau shall "operate Keswick Dam, Shasta Dam, and the Spring Creek Power Plant to meet a daily average water temperature of 56°F in the Sacramento River at Red Bluff Diversion Dam during periods when higher temperatures will be detrimental to the fishery".

During the past five years, the Bureau in coordination with a multiagency task group (Sacramento River Temperature Task Group) has developed temperature operational plans for the Shasta and Trinity Divisions of the CVP. Temperature operational plans have included releases of water from upper and lower outlets at Shasta Dam, releases from the lower outlet on Trinity Dam, and manipulating the timing of Trinity River diversions and Whiskeytown Reservoir drawdown. The lower outlets on Shasta and Trinity Dams have the ability to access deep, cold water in the reservoirs, but this water flowing through these outlets will be unavailable for hydropower generation. Also, power generation is not possible from upper level outlet releases of warm water on Shasta Dam. Warm water releases from the upper level outlets have been made to conserve cold water in Shasta Lake for temperature control operations during the late summer months and to induce winter-run chinook salmon to spawn as far upstream as possible. From 1987 to 1992, the Bureau has implemented plans to provide for temperature protection for winter-run chinook salmon while still meeting other project purposes (see CVP-OCAP pages 33-36).

Coordinated Operations Agreement

Because both the CVP and the State Water Project utilize the Sacramento River and the Sacramento-San Joaquin Delta as common conveyance facilities, reservoir releases and Delta export operations must be coordinated to ensure each retains its share of the commingled water and bears its share of the joint obligations to protect beneficial uses. The Coordinated Operations Agreement of 1986 defines the rights and responsibilities of the CVP and State Water Project with respect to inbasin water needs and provides a mechanism to measure and account for those responsibilities. Inbasin use is defined in the agreement as "legal uses of water in the Sacramento Basin including the water required under the provisions of Exhibit A",

where Exhibit A contains the State Water Resources Control Board Decision 1485 Delta Standards. The agreement does not address operation of the Suisun Marsh Salinity Control Gates on Montezuma Slough or Decision 1485 water quality standards for Suisun Marsh (see CVP-OCAP pages 17-19).

Trinity River Instream Flow Requirements

On May 8, 1991, the Secretary of Interior endorsed a position statement developed by the Assistant Secretaries for Fish, Wildlife and Parks; Indian Affairs; and Water and Science to release 340,000 acre-feet of water to the Trinity River for use by the Hoopa Indian Tribe and for fisheries resources of the Trinity River. The position statement expands the commitment to release water to the Trinity River as follows:

> The Bureau of Reclamation is directed to release into the Trinity River in 1991 between 240,000 acre-feet and 340,000 acre-feet depending on the inflow to Shasta Reservoir and using the ramping formula contained in the attached position statement. The Bureau of Reclamation is also directed to release to the Trinity River, during water year 1992-96, at least 340,000 acre-feet for each dry or wetter water year and 340,000 acre-feet in each critically dry year if at all possible. The Assistant Secretaries for Fish and Wildlife and Parks, Indian Affairs, and Water and Science are directed to formulate the 1992-96 flow release agreement by December 1, 1991 (see CVP-OCAP pages 25-26).

Hydropower Requirements

In 1967, the Bureau contracted with the Pacific Gas and Electric Company (PG&E) for the sale, interchange, and transmission of electric capacity and energy. Administered by the Western Area Power Administration, the contract created a "banking" arrangement under which excess CVP energy and capacity are sold to PG&E; in return, PG&E delivers power to CVP customers. By contract with PG&E, the CVP is operated to meet project load and to support Project Dependable Capacity. (Project Dependable Capacity is defined as the lowest electric capacity available with energy support from CVP powerplants in any given month during the most adverse period of streamflow conditions of record after deducting the estimated capacity required for project load during PG&E's peakload period.)

Contract 2948A with PG&E specifies minimum monthly energy requirements for support of Project Dependable Capacity. The power generation required for project load and support of Project Dependable Capacity is especially high from July through October. Due to the extremely high efficiency of the Trinity River

Division powerplants (Trinity, Carr and Spring Creek), the CVP is operated to increase transbasin diversions from the Trinity Basin to the Sacramento Basin during the summer and early fall months (see CVP-OCAP page 16, pages 28-30, and pages 80-82).

Navigation Requirements and Related Issues at Wilkins Slough

As an authorized function of Shasta and Keswick Dams, the Bureau is obligated by the River and Harbors Act of 1937 and subsequent acts to operate Shasta Dam to improve navigation. Rivers and Harbors Committee Document Number 35, 73rd Congress recommended providing channel depths of 5 to 6 feet and 5,000 cfs minimum flow between Sacramento and Chico Landing. However, in 1952, a decision was made not to allocate storage space in Shasta Lake to navigation. In recent years, there has not been any commercial traffic between Sacramento and Chico Landing. Thus, the Corps has not maintained (dredged) this reach to preserve channel depths since 1972. While commercial navigation is no longer a concern on the lower Sacramento River, the 5,000 cfs minimum flow recommendation has served as the basis for design of many irrigation pumping stations in the vicinity of Wilkins Slough, a reach of the Sacramento River immediately upstream of the confluence with the Feather River. To minimize the impact on these irrigators, Shasta and Keswick Dams are normally operated to provide a minimum flow of 5,000 cfs at Wilkins Slough in all but extremely dry years (see CVP-OCAP page 43).

Spring Creek Debris Dam

In January 1980, the U.S. Water and Power Resources Service (now the Bureau of Reclamation), the California Department of Fish and Game, and the State Water Resources Control Board executed a Memorandum of Understanding (MOU) to implement actions to protect the Sacramento River system from heavy metal pollution originating from the Spring Creek watershed. The MOU identified agency actions and responsibilities, established "interim" release criteria, and "emergency" release criteria. The MOU established the following criteria:

1. When Spring Creek Reservoir storage is less than 5,000 AF, or about 86 percent of capacity, concentrations of total copper and zinc in the Sacramento River below Keswick shall not exceed 0.01 and 0.072 mg/l, respectively. [illegible] high, not up?

2. When Spring Creek Reservoir storage exceeds 5,000 AF, emergency water quality criteria will be used due to the threat of an uncontrolled spill from the reservoir. Emergency criteria for total copper and zinc in the Sacramento River below Keswick Dam shall not exceed 0.015 and 0.108 mg/l respectively.

Under the provisions of the Spring Creek MOU, the Bureau agrees to operate according to the above criteria and schedules, provided that such operation will not cause flood control parameters on the Sacramento River to be exceeded or interfere unreasonably with other CVP requirements as determined by the Bureau. The water quality criteria established in the MOU exceeds the metal concentration levels specified by the Sacramento River Basin Plan (see CVP-OCAP pages 43-45).

Anderson-Cottonwood Irrigation District Dam

A contractual agreement between the Federal government and the Anderson-Cottonwood Irrigation District (ACID) requires the Bureau to reduce Keswick Dam releases to accommodate the installation, removal, or adjustment of boards at the ACID diversion dam. The ACID diverts to their main canal from the Sacramento River from this diversion dam. The dam was constructed in 1917 and consists of boards supported by a pinned steel superstructure anchored to a concrete foundation across the river. The boards are manually set from a walkway supported by the steel superstructure. The number of boards set in the dam varies depending upon river flow and desired head in the canal. The contract requires ACID to notify the Bureau each time it intends to install or remove boards from its diversion dam. The Bureau similarly notifies ACID each time it intends to change releases at Keswick Dam (see CVP-OCAP pages 47-48).

II. PROPOSED ACTIVITY

This biological opinion addresses the proposed long-term operation plan of the CVP. Most of this information has been provided to NMFS in the "Long-term CVP-OCAP" report and biological assessment of October 1992 for typical water year operating plans covering a range of initial reservoir storage conditions combined with different water year types. This range of hydrologic conditions has been organized by the "Long-term CVP-OCAP" report into 20 different "operational environments". The 20 combinations (operational environments) of four different initial reservoir storage conditions (low, low medium, high medium, and high) and five different water year types (extreme critical, critical, dry, above-normal, wet) are presented in Table 1.

TABLE 1
CVP OPERATIONAL ENVIRONMENTS
Combinations of Initial Reservoir Storage and Water Year Type

CVP-OCAP Operational Environment	Water Year Type and Sacramento River Index (SRI)	Initial Reservoir Storage in Shasta Lake million acre-feet (MAF)
W-HI	Wet (SRI=23.8)	High (Shasta = 3.2 MAF)
W-HM	Wet (SRI=23.8)	High Med (Shasta = 2.5 MAF)
W-LM	Wet (SRI=23.8)	Low Med (Shasta = 2.0 MAF)
W-LO	Wet (SRI=23.8)	Low (Shasta = 1.7 MAF)
A-HI	Above (SRI=15.8)	High (Shasta = 3.2 MAF)
A-HM	Above (SRI=15.8)	High Med (Shasta = 2.5 MAF)
A-LM	Above (SRI=15.8)	Low Med (Shasta = 2.0 MAF)
A-LO	Above (SRI=15.8)	Low (Shasta = 1.7 MAF)
D-HI	Dry (SRI=12.5)	High (Shasta = 3.2 MAF)
D-HM	Dry (SRI=12.5)	High Med (Shasta = 2.5 MAF)
D-LM	Dry (SRI=12.5)	Low Med (Shasta = 2.0 MAF)
D-LO	Dry (SRI=12.5)	Low (Shasta = 1.7 MAF)
C-HI	Critical (SRI=8.8)	High (Shasta = 3.2 MAF)
C-HM	Critical (SRI=8.8)	High Med (Shasta = 2.5 MAF)
C-LM	Critical (SRI=8.8)	Low Med (Shasta = 2.0 MAF)
C-LO	Critical (SRI=8.8)	Low (Shasta = 1.7 MAF)
EC-HI	Ex.Critical (SRI=5.7)	High (Shasta = 3.2 MAF)
EC-HM	Ex.Critical (SRI=5.7)	High Med (Shasta = 2.5 MAF)
EC-LM	Ex.Critical (SRI=5.7)	Low Med (Shasta = 2.0 MAF)
EC-LO	Ex.Critical (SRI=5.7)	Low (Shasta = 1.7 MAF)

For each operational environment, the Bureau has proposed a typical operational plan designed to meet CVP project purposes. The operational plan for a specific operational environment has been termed "operational case".

Appendix B of the "Long-term CVP-OCAP" report displays the characteristics associated with 18 operational cases proposed by the Bureau. Additional information has been provided to NMFS pursuant to a written request on November 19, 1992 and verbal requests on December 22, 1992 and January 8, 1993.

Each year, the Bureau prepares forecasts of runoff for each CVP water supply reservoir to assist in the development of CVP operational forecasts. Runoff forecasts are initially computed in February. They are based on precipitation and runoff conditions through January 31 plus February snow course measurements. Operational forecasting is performed seasonally, monthly, weekly or daily to determine how the current and anticipated water and power resources available to the CVP can best be used to meet project objectives.

The February 15 forecasts of runoff and CVP operations are used to determine the first water allocations announcement for the current year. Based on the "Shasta Criteria", water rights settlement contractors are notified no later than February 15 of any shortages in their water supplies. The "Long-term CVP-OCAP" report describes past water delivery decisions by the Bureau which have been based on the median forecast (50 percent probability of exceedance) in most years and a conservative forecast (90 percent probability of exceedance) in drier years. However, the report does not define the criteria for use of one forecast over the other and the Bureau has not described which runoff forecast will serve as the basis for future water allocation decisions (see CVP-OCAP pages 75-80).

Trinity River Division

Trinity and Lewiston Dams

In response to the May 8, 1991, position statement endorsed by the Secretary of Interior, the Bureau proposes an annual release of 340,000 acre-feet of water to the Trinity River below Lewiston Dam between March 1 and February 28. Proposed annual transbasin exports from the Trinity Basin through the Clear Creek Tunnel to the Sacramento Basin range from 1.04 million acre-feet (wet water year with high initial storage) to 188 thousand acre-feet (above normal water year with low initial storage) as measured at Judge Francis Carr Powerhouse.

To provide for management of temperature conditions in the Sacramento River, the Bureau proposes to coordinate the timing of

exporting Trinity River water to coincide with needs for temperature control on the Sacramento River. In addition, the Bureau proposes to release water from the low level outlet at Trinity Dam when effective for temperature control on the Sacramento River (see CVP-OCAP pages 25-28; biological assessment page 5-3).

Shasta Division

Shasta Reservoir Storage

The Bureau proposes to operate the reservoir level to meet the needs of the CVP (i.e., water delivery to irrigation districts, flood control, D-1485 water quality standards, etc.). Predicted end-of-water year storage in thousands of acre-feet (TAF) for Shasta Lake under the full range of hydrologic and storage conditions varies from 3.1 million acre-feet to 1.0 million acre-feet (see CVP-OCAP page 68). The Bureau's proposal does not specify a minimum carryover storage level.

In addition, the Bureau proposes to consider use of the Coordinated Operations Agreement during Delta "balanced" conditions to temporarily bank water in Shasta Reservoir by shifting in time the sharing of release requirements between Shasta and Oroville reservoirs. Delta "balanced" conditions occur when Delta inflows plus unregulated flow approximately equal Sacramento Valley in-basin uses plus exports. When the option is available, the Bureau proposes use Folsom storage withdrawal in lieu of Shasta storage withdrawal to meet in-basin and Delta requirements during winter, spring and early summer (see biological assessment page 5-2).

Minimum Streamflows

Pursuant to Water Rights Order 90-5, the Bureau maintains a minimum release of 3,250 cfs at Keswick Dam and Red Bluff Diversion Dam from September 1 through the end of February in all water years except critical dry years. From March 1 to August 31 during a normal year, the Bureau maintains a minimum release of 2,300 cfs at Keswick Dam. During critical dry years as defined by the "Shasta Criteria" minimum flows at Keswick are as follows:

December 1 through February 28	2,000 cfs
March 1 through August 31	2,300 cfs
September 1 through November 30	2,800 cfs

The range of predicted water releases to the Sacramento River at Keswick Dam under the full range of hydrologic and storage conditions are presented in Table 2.

TABLE 2
RANGE OF PREDICTED WATER RELEASES
TO THE SACRAMENTO RIVER AT KESWICK DAM

Month	Low (cfs)	High (cfs)
October	3,750	7,613
November	3,750	7,360
December	3,750	12,360
January	3,250	12,360
February	3,250	16,205
March	3,000	11,384
April	3,250	10,705
May	6,884	13,043
June	8,282	12,944
July	9,455	14,997
August	8,209	13,311
September	5,954	9,017

Source: Biological Assessment, October 1992.

The Bureau proposes to review the objective for Sacramento River minimum flow prior to each fall and winter. The Bureau's review will consider the needs to provide water downstream to achieve the temperature and release stability objectives of biological criteria in relation to the need to provide for conservation of water for the upcoming year (see CVP-OCAP page 36; biological assessment page 5-3).

Seasonal Fluctuations and Ramping of Streamflows

Water Rights Order 90-5 imposed the following conditions on the reduction of streamflows at Keswick Dam (ramping):

1. Releases shall not be decreased more than 15 percent in a twelve-hour period.

2. Releases shall not be decreased more than 2.5 percent in a one-hour period.

3. This term shall not be in effect during flood control events or other unforeseen emergency conditions.

Whenever possible, the Bureau proposes to decrease river flows at night to minimize impacts on the Sacramento River fishery. During normal non-emergency operations, no maximum rate of increase has been established. The Bureau generally schedules large increases at night to minimize impacts on the public.

From October 15 to December 31, the Bureau attempts to minimize changes in releases from Keswick Dam to provide stable flow conditions for fall-run chinook salmon reproduction. Normally, releases from Keswick Dam are reduced to the minimum fishery release requirement by October 15 of each year (see CVP-OCAP pages 37-38).

Wilkins Slough

Wilkins Slough is located immediately upstream of the confluence with the Feather River. While commercial navigation is no longer a concern on the lower Sacramento River, the 5,000 cfs minimum flow has served as the basis for design of many irrigation pumping stations on this reach of river. Diverters are able to operate for extended periods at flows as low as 4,000 cfs at Wilkins Slough, but pumping operations become severely affected at flows lower than this. After consultation with the Corps, the Bureau proposes to adopt a minimum flow criterion of 4,000 cfs or less if feasible at Wilkins Slough to permit retention of storage in Shasta when it would have a beneficial effect on temperature control (see CVP-OCAP page 43; biological assessment page 5-3).

Temperature Control

The Bureau has proposed to provide for management of temperature conditions in the upper Sacramento River while still meeting other project purposes. With the use of a chinook salmon temperature-mortality model, the Bureau has proposed to optimize the survival of winter-run chinook salmon eggs and larvae after water allocations have been made to CVP contractors.

The chinook salmon temperature-mortality model utilizes the results of the Bureau's predictive temperature model to estimate the proportion of a total spawn lost to elevated temperatures. The Bureau has used this model in combination with Shasta Dam upper-level and lower-level outlet releases to optimize survival of winter-run chinook salmon. Reservoir releases through the lower-level (742 foot elevation) and upper-level (942 foot elevation) outlets of Shasta Dam bypass the powerplant and result in a loss of hydroelectric generation.

Within the limits imposed by water allocations to CVP contractors, the Bureau proposes to provide for temperature control in the upper Sacramento River by scheduling releases from the powerplant bypasses on Shasta Dam and coordinating the timing of Trinity River water exports to the Sacramento River. Predicted water temperatures for six locations in the upper Sacramento River under proposed CVP operational cases are presented in Appendix C of the "Long-term CVP-OCAP" report.

In addition, the Bureau proposes to continue annual coordination with a multiagency task group (Sacramento River Temperature Task Group) to discuss operational alternatives, new objectives, biological information, and a status report on water temperatures. The task group will assist the Bureau to develop an operational plan for temperature control prior to submittal of an annual report on the operation plan to the State Water Resources Control Board (generally on or before June 1 of each year). Experimental measures and facilities to access cold water reserves in the lower levels of Shasta, Lewiston, and Whiskeytown reservoirs will continue to be investigated and implemented (see CVP-OCAP pages 33-36 and pages 73-74; biological assessment page 5-3).

Spring Creek Debris Dam

To minimize spill effects, the Bureau proposes to 1) operate to minimize risk of uncontrolled spill, and 2) during a spill, coordinate response with the California Department of Fish and Game, NMFS, FWS, California Department of Water Resources, U.S. Environmental Protection Agency, and the California Regional Water Quality Control Board.

The Spring Creek Debris Dam Memorandum of Understanding identifies actions and responsibilities for each agency and establishes release criteria based on allowable concentrations of total copper and zinc in the Sacramento River below Keswick Dam (see section on Spring Creek Debris Dam in Background: Operation Agreements, Constraints and Objectives). However, the MOU does not obligate the Bureau to meet the interim or emergency release criteria if such operation of CVP facilities will cause flood control parameters on the Sacramento River to be exceeded or interfere unreasonably with other project requirements as determined by the Bureau (see CVP-OCAP pages 43-45 and pages 70-71; biological assessment page 5-2).

Anderson-Cottonwood Irrigation District Dam

The Bureau proposes to meet the contractual obligations with ACID by manipulating Keswick Dam releases to the extent reasonably needed to facilitate installation, removal or adjustment of boards. Around April 1 of each year, ACID will erect the diversion dam by raising the steel superstructure, installing the walkway, and then setting the boards in place. Around November 1 of each year, the reverse process is performed. During the irrigation season, adjustments of the boards may be needed due to changes in releases at Keswick Dam. Because this work on the dam can not be accomplished safely at flows greater than 6,000 cfs, the Bureau proposes to limit Keswick releases at the request of the ACID to 5,000 cfs for 5 days to facilitate installation or removal of the dam (see CVP-OCAP pages 47-48 and page 74).

The proposed flow reduction schedule for in-season adjustments of the flashboards at the dam has not been specified by the Bureau. In past years, flows have been decreased by 5,000 to 6,000 cfs overnight and increased to former levels the following night to accommodate an in-season flashboard adjustment and minimize impacts to downstream water deliveries (H. Rectenwald, personal communication).

Sacramento River Division

Red Bluff Diversion Dam

In May 1988, the Bureau entered into a 4-year Cooperative Agreement with the California Department of Fish and Game, NMFS, and FWS to implement actions to benefit winter-run chinook salmon in the Sacramento River (Ten Point Winter-Run Chinook Salmon Restoration Plan). Among other things, the agreement called for the raising of the gates at Red Bluff Diversion Dam from December 1 to April 1 to facilitate upstream migration of adult winter-run chinook salmon. The agreement allowed the Bureau to alter the actual gate opening and closing dates, and periodically close the gates between December 1 and April 1 depending upon weather

conditions and irrigation demands by water users in the Tehama-Colusa Canal and Corning Canal service areas.

Although the Cooperative Agreement expired in 1992, the Bureau has agreed to continue to operate the dam to facilitate upstream passage of winter-run chinook salmon. The Bureau proposes to maintain the gates in the raised position from November 1 through April 30 of each year with provision in March and April for intermittent closures to permit recharge of the canal system. The biological assessment of October 1992 indicated the proposed intermittent closure may extend for up to week per month. The Bureau proposes to operate the dam with the gates closed from May 1 to October 31 of each year (see CVP-OCAP pages 48-49; biological assessment page 5-1).

On January 20, 1993, the Bureau proposed a special amendment to the provision for intermittent gate closure for 1993. During 1993 the Bureau proposes a provision to allow for closure for up to a two-week period once during the five week period of March 27 through April 30. This two-week period would include the amount of time required to restore Lake Red Bluff and to draw it down to restore river conditions (Draft memo from J. Burke dated 1/20/93).

In addition, the Bureau is currently proceeding with development of a pilot low-speed pump project and other means to augment diversion capacity to the Tehama-Colusa Canal during the period the gates of the dam are raised. The proposed pilot low-speed pumping plant will diminish the potential for intermittent gate closures in March and April and may allow the gates of the dam to remain in a raised position for up to 8 months (see biological assessment page 5-1). The pilot pumping plant is scheduled for completion during the spring or summer of 1994. This project was the subject of a separate section 7 consultation with NMFS Which was concluded on February 2, 1993.

Delta Division and State Water Project

Delta Cross Channel

The Bureau proposes to operate the Delta Cross Channel with the gates open except under the following circumstances (see CVP-OCAP page 60; biological assessment page 5-4):

1. Flows in the Sacramento River exceed 25,000 cfs,

2. On request by California Department of Fish and Game (for up to 20 days) when Sacramento River flows are above 2,000 cfs pursuant to D-1485, and

3. During periods of significant emigration of winter-run chinook salmon juveniles based on observations and information from Delta monitoring program. These gate closures would be subject to interruption under conditions whereby control of Delta water quality could not be reasonably achieved by other means.

Tracy, Banks, and Contra Costa Pumping Plants

Both the CVP and State Water Project propose to operate the Tracy and Banks pumping plants to meet water demands south of the Delta. Water export operations are to be managed under "balanced" conditions (for definition of "balanced conditions" see section on Shasta Reservoir Storage in Proposed Activity: Shasta Division). Export facilities will be operated in accordance with the Coordinated Operations Agreement (see CVP-OCAP pages 56-61; biological assessment page 5-4).

Tables 3, 4 and 5 present the predicted range of Delta water exports (total acre-feet in thousands) under the various hydrologic and storage conditions.

TABLE 3
TRACY PUMPING PLANT (CVP)
Predicted Monthly Operating Range

Month	Low (TAF)	High (TAF)
October	50	246
November	157	238
December	180	246
January	159	246
February	126	246
March	106	246
April	32	250
May	30	184
June	30	178
July	30	282
August	30	250
September	140	250

Source: Long-term CVP-OCAP, October 1992.

TABLE 4
BANKS PUMPING PLANT (SWP)
Predicted Monthly Operating Range

Month	Low (TAF)	High (TAF)
October	114	388
November	105	397
December	185	430
January	88	449
February	68	405
March	55	449
April	28	397
May	28	184
June	28	119
July	25	282
August	17	411
September	38	397

Source: Long-term CVP-OCAP, October 1992.

TABLE 5
CONTRA COSTA PUMPING PLANT (CCWD)
Predicted Monthly Operating Range

Month	Low (TAF)	High (TAF)
October	11	11
November	8	8
December	7	7
January	7	7
February	8	8
March	6	8
April	8	11
May	9	12
June	11	15
July	13	18
August	13	18
September	10	14

Source: Long-term CVP-OCAP, October 1992.

Suisun Marsh Salinity Control Gates

During formal consultation, NMFS requested clarification regarding the State's proposed operational plan for the Suisun Marsh Salinity Control Structure. The Delta portion of the biological assessment prepared by the California Department of Water Resources proposes operation of the structure only when needed from October 1 through May 31 to meet the channel water quality standards established by State Water Resources Control Board Decision 1485. This operational mode is consistent with that authorized by Army Corps of Engineers permit number 16223E58 (see CVP-OCAP pages 60-61).

However, the Department of Water Resources presently operates the structure at or near capacity from October 1 through May 31 regardless of water year type. To date, the objective of the State's operators is to provide the best water quality possible within Suisun Marsh pursuant to the Suisun Marsh Preservation Agreement. The State's operators are unaware of any criteria in which the structure is not to be operated during the control season (D. Russell, personal communication).

At a January 8, 1993, meeting attended by staff from NMFS, the Bureau, California Department of Water Resources, California Department of Fish and Game, FWS, the NMFS requested a written description of the proposed plan for the long-term operation of the structure. No written or oral response has been provided to NMFS.

III. LISTED SPECIES

The winter-run chinook salmon (Oncorhynchus tshawytscha) comprise a distinct population of chinook salmon in the Sacramento River. They are distinguishable from the other three Sacramento River chinook runs by the timing of their upstream migration and spawning season. Adult winter-run chinook salmon generally leave the ocean and migrate through the Sacramento-San Joaquin Delta to the upper Sacramento River from December through June. Their spawning season generally extends from mid-April to August.

NMFS listed the Sacramento River winter-run chinook salmon as "threatened" under emergency provisions contained in the Federal Endangered Species Act (ESA) in August 1989 and the species was formally listed as "threatened" in November 1990. On June 19, 1992, the NMFS proposed reclassification of the Sacramento winter-run chinook salmon to "endangered" (57 FR 27416). The State of California listed winter-run chinook salmon as "endangered" in 1989. On August 14, 1992, the NMFS proposed critical habitat for the winter-run chinook salmon from Keswick Dam at Sacramento River Mile 302 to the Golden Gate Bridge on San Francisco Bay (57 FR 36626).

Before construction of Shasta and Keswick Dams in 1945 and 1950, respectively, winter-run chinook salmon were reported to spawn in the upper reaches of the Little Sacramento, McCloud, and lower Pit Rivers (Moyle et al. 1989). Specific data relative to the historic run sizes of winter-run chinook salmon prior to 1967 is sparse and mostly anecdotal. Numerous fishery researchers have cited Slater (1963) to indicate that the winter-run chinook salmon population may have been fairly small and limited to the spring fed areas of the McCloud River before the construction of Shasta Dam.

However, recent California Department of Fish and Game research in State Archives has cited several fisheries chronicles that indicate the winter-run chinook salmon population may have been much larger than previously thought. According to these qualitative and anecdotal accounts, the winter-run chinook salmon reproduced in the McCloud, Pit and Little Sacramento Rivers and may have numbered over 200,000 (Rectenwald 1989). Construction of Shasta and Keswick Dams blocked access to all of the winter-run chinook salmon's historic spawning grounds. However, the subsequent operation of these dams created new spawning habitat downstream from Keswick dam due to the release of cold hypolimnetic water from reservoir storage into the mainstem of the Sacramento River. Since the winter-run chinook salmon's spawning habitat is now restricted primarily to the Sacramento River reach from Keswick dam down to the Red Bluff Diversion Dam, it is critical that the Bureau operate Shasta and Keswick Dams so that this spawning habitat is maintained on a long-term basis.

Adult Spawning Migration

Completion of the Red Bluff Diversion Dam in 1966 enabled accurate estimates of all salmon runs to the upper Sacramento River and documented the dramatic decline of the winter-run chinook salmon population. The estimated numbers of winter-run chinook salmon reaching the dam from 1967-1969 averaged 86,509. During 1989, 1990, 1991, and 1992 the spawning escapement of winter-run chinook salmon past the dam has been estimated at 547, 441, 191, and 1,180, respectively. NMFS believes these run sizes are dangerously low since it has been estimated that a run size of 400 to 1,000 fish is necessary to maintain genetic diversity in the winter-run population (52 FR 6041).

Since the construction of Shasta and Keswick Dams, winter-run chinook salmon spawning has primarily occurred between Red Bluff Diversion Dam and Keswick Dam. The first upstream migrants appear in the Sacramento-San Joaquin Delta during the early winter months (Skinner 1972). On the upper Sacramento River, the first upstream migrants appear during the month of December (Vogel and Marine 1991). Due to the lack of fish passage facilities at Keswick Dam, adult winter-run chinook salmon tend to migrate to and hold in deep pools between the two dams before

initiating spawning activities. The upstream migration typically peaks during the month of March, but may vary with river flow, water year type, and operation of the Red Bluff Diversion Dam.

Spawning and Incubation

The spawning period of winter-run chinook salmon generally extends from late April to mid-August with peak activity occurring in June (Vogel and Marine 1991). The eggs are fertilized and buried in nests of river gravels, referred to as redds, excavated by the female. The eggs incubate and hatch over a 2-month period. Spawning success is highly dependant on water temperature. Optimum temperatures for egg development are between 43°F and 56°F. Elevated temperatures can negatively impact spawning adults, egg maturation and viability, and pre-emergent fry. Mortality of eggs and pre-emergent fry commences at 57.5°F and reaches 100 percent at 62°F (Boles 1988).

Although temperatures between 56°F and 57.5°F may not directly cause mortality of eggs and larvae, this temperature range is thought to induce stress by reducing resistance to parasites, diseases, pollutants, and other environmental factors. Thus, sublethal temperatures may lead to delayed mortality. The California Department of Water Resources reports that chinook fry produced from eggs incubated at warmer temperatures, even though within the preferred temperature range of 53.6°F to 57.3°F selected by juveniles, may hatch sooner but are smaller than those produced at lower temperatures (Boles 1988). Other sources of mortality during the intragravel incubation period of chinook salmon include disease, redd dewatering, physical disturbance, and water-born containments.

Aerial surveys of winter-run chinook salmon redds have been conducted annually by the California Department of Fish and Game from 1987 to 1992. These surveys have shown that the majority of winter-run chinook salmon spawning in the upper Sacramento River occurs between the ACID dam (river mile 298) and the upper Anderson Bridge (river mile 284). During 1988, winter-run chinook salmon redds were observed as far downstream as Woodson Bridge (river mile 218).

Fry Emergence and Juvenile Emigration

Emergence of the winter-run chinook salmon fry from the gravel begins during late June and continues through September, but could occur as late as mid-October (Vogel and Marine 1991). Large numbers of fry redistribute themselves downstream almost immediately upon emergence during August and September. Juvenile chinook salmon capture data collected at Red Bluff Diversion Dam between 1978 and 1989 demonstrate most winter-run chinook salmon pass the dam between August and October (California Department of Fish and Game, unpublished data, 1991). Early emigrants from the

upper Sacramento River probably rear somewhere in the system between the Red Bluff Diversion Dam and the Sacramento-San Joaquin Delta since water temperatures in the Delta during the summer are not suitable for juvenile salmon (Johnson et al. 1992).

Although many winter-run chinook salmon fry emigrate almost immediately upon emergence, substantial numbers of juveniles rear in the upper Sacramento River for several months (Johnson et al. 1992). It is hypothesized that these juveniles are awaiting winter rains to begin their emigration. Observations by FWS and the California Department of Fish and Game suggest that storm events can generate en masse emigration pulses (California Department of Fish and Game and FWS, unpublished data). Thus, downstream migration past Red Bluff Diversion Dam may occur as early as late July or August, generally peaks in September, but can continue until mid-March in drier years (Vogel and Marine 1991).

The timing and dynamics of rearing and downstream migration are more ambiguous in the lower Sacramento River and Sacramento-San Joaquin Delta. A recent review of chinook salmon data from the San Francisco Bay Study (California Department of Fish and Game, Bay-Delta Division) and other Bay-Delta investigations was conducted by the California Department of Fish and Game for occurrence, distribution, and seasonality of winter-run chinook salmon (Perry 1992). Data spanning 30 years were analyzed using the most recent winter-run chinook salmon size criteria by Fisher (Johnson et al. 1992).

This review showed that winter-run chinook salmon were captured as early as September at Clarksburg in 1973 (Schaffter 1980; Stevens 1989) and as late as June at Carquinez Strait (Messersmith 1966). Brown and Greene (1992) report high winter-run chinook salmon catches in Montezuma Slough (western Delta) during a major flow event in late November of 1981. Mid-water trawl sampling by the California Department of Fish and Game identified winter-run chinook salmon juveniles in the northern Delta on November 9, 1992 (California Department of Fish and Game, unpublished data). Available information suggest the peak period of winter-run emigration through the Delta extends from late January through April, but early high flows in November or December may bring juveniles into lower Sacramento River and Delta much earlier (Brown and Greene 1992; Perry 1992; Stevens 1989).

Scale analysis performed by the California Department of Fish and Game provides some additional information regarding the freshwater and estuarine life history of winter-run chinook salmon. Back-calculated length at saltwater entry suggests the average size of a winter-run chinook salmon smolt is approximately 118 millimeters while fall-run size at saltwater

entry averages 85 millimeters (California Department of Fish and Game, unpublished data). In combination with growth data used to determine the spatial and temporal distribution of winter-run chinook salmon (Johnson et al. 1992), this back-calculated size at saltwater entry supports the January through April period of peak Delta emigration. This evidence suggests that winter-run chinook salmon are residing in fresh and estuarine waters for 5 to 9 months prior to actively emigrating as smolts to the ocean. This period of in-river and Delta residence exceeds that of fall-run chinook salmon by 2 to 4 months.

IV. ASSESSMENT OF IMPACTS

Shasta/Trinity Divisions

Shasta Reservoir Storage

The Bureau's proposed operation of Shasta Reservoir to meet the needs of the CVP is likely to result in low end-of-year storage levels in Shasta Lake and adversely affect winter-run chinook salmon. All of the Bureau's proposed operational cases predict Shasta operations combined with that of the Trinity River Division will be unable to meet a temperature criteria of 56°F at Bend Bridge through September. Bend Bridge is approximately 44.5 miles below Keswick Dam and encompasses 95+ percent of the winter-run chinook salmon spawning grounds when delay and blockage at Red Bluff Diversion Dam are minimized.

Without a minimum carryover level for Shasta Dam, it is likely that most operational cases will create unsuitable temperature conditions in portions of the winter-run chinook salmon spawning grounds. In drier years with low initial reservoir storage, the mortality of winter-run chinook salmon eggs and larvae may be severe. The extent of temperature-related mortality is dependant upon operational variables at Shasta Reservoir including the pattern of reservoir drawdown and the extent of the reservoir drawdown.

From 1987 to 1992, water stored in Shasta Reservoir was drawn down under the assumption that drought conditions might not persist. This resulted in reduced amounts of stored water available to meet the following year's needs. Low reservoir carryover storage during this period resulted in increased water temperatures within the spawning grounds and temperature-induced mortality of winter-run chinook salmon eggs and larvae has occurred. The lack of a minimum carryover level in the Bureau's proposed operational plan for Shasta Reservoir is likely to lead to similar low carryover storage conditions and adverse temperatures in future years.

Minimum Flows

Under most operational cases, the Bureau proposes a minimum release of 3,250 cfs from Keswick Dam in January and February and 3,000 cfs in March. This minimum release in itself is not expected to significantly impact winter-run chinook salmon. However, in combination with the proposed ramping schedule, flow reductions to 3,250 cfs and 3,000 cfs could strand juvenile winter-run chinook salmon in isolated pools, side channels, or completely dewatered fish in some areas. The proposed ramping schedule may strand winter-run chinook salmon juveniles during January, February, and March at flows of 3,000 cfs and 3,250 cfs.

Seasonal Fluctuations and Ramping of Streamflows

The biological assessment provided by the Bureau did not address potential effects on winter-run chinook salmon associated with the proposed flow reduction schedule (ramping). The Bureau proposes to reduce streamflows at Keswick Dam at no more than 15 percent in twelve-hour period (see CVP-OCAP pages 36-37).

This ramping rate has been shown to be inadequate for susceptible stranding areas such as side channels with shallow inverts and broad flat gradient near-shore areas. Large flow reductions and reductions which approach or meet minimum instream flows are likely to result in the greatest number of fish strandings. During flow reductions of up to 8,000 cfs for in-season adjustments at ACID dam, CVP operations have resulted in the stranding and loss of winter-run chinook salmon fry (CDFG 1990).

Independent of the ramping rate, large streamflow fluctuations during the incubation period may impact winter-run chinook salmon redds. Redds dewatered for an extended period will result in complete loss of eggs and larvae. Partially dewatered redds are adversely effected by reduced subsurface flow through the river substrate. Sufficient exchange of fresh water is needed to oxygenated the redds and carry away metabolic wastes.

Temperature

Fisheries experts have identified water temperature in the upper Sacramento River as a critical factor in the decline of winter-run chinook salmon. During most years, winter-run chinook salmon are not able to spawn successfully below Red Bluff Diversion Dam due to lethal temperatures (Hallock and Fisher 1985). In recent years, drought conditions have resulted in lethal temperatures above the dam as well.

Combs and Burrows (1957) reported that water temperatures between 43°F to 57.5°F are optimal for chinook egg development. Although, a literature review conducted by the California Department of Water Resources indicated that the optimum range of

temperature for development through the emerged fry stage may be bound by 56°F on the upper end (Seymour 1956 as cited by Boles 1988). Water temperature of 62°F is believed to produce 100 percent mortality.

Water temperature in the upper Sacramento River varies with location and distance downstream of Keswick Dam depending upon annual hydrologic conditions and operation of the Shasta and Trinity Divisions of the CVP. Water released from Keswick Dam generally warms as it travels downstream during the summer and early fall months. Water temperatures between Keswick Dam and Red Bluff Diversion Dam are primarily influenced by ambient air temperature, tributary inflows, volume of water released from Keswick Dam, total reservoir storage, the location of the reservoir thermocline, the ratio of Spring Creek Powerplant release to Shasta Dam release, and depth of release from both Shasta and Trinity Dams.

Winter-run chinook salmon temperature criteria. NMFS has determined that a daily average water temperature of less than or equal to 56°F is required between Keswick Dam and Bend Bridge from April 15 through September 30 to protect winter-run chinook salmon spawning and incubation. An October 1 through October 31 temperature criteria of less than or equal to 60°F in the Sacramento River from Keswick Dam to Bend Bridge has been determined for protection of late incubating larvae and newly emerged fry. This temperature criteria for winter-run chinook is based on observations of winter-run spatiotemporal spawning distributions, laboratory investigations of chinook salmon egg and larval temperature tolerances, and the geographic limit for effective temperature control by CVP operations. Bend Bridge is approximately 44.5 miles below Keswick Dam and this reach typically encompasses more than 95 percent of the winter-run chinook salmon spawning grounds when delay and blockage at Red Bluff Diversion Dam are minimized.

In dry water years, hydrologic conditions may limit the temperature control ability of Shasta and Trinity operations to a shorter period of time or a compliance point upstream of Bend Bridge. In such cases, the NMFS has determined the 56°F temperature compliance point should be moved upstream to Jelly's Ferry to provide 56°F temperature protection through September. Jelly's Ferry is located approximately 35.25 miles below Keswick Dam and this reach typically encompasses 85 to 90 percent of the winter-run chinook salmon redds if delay and blockage at Red Bluff Diversion Dam are minimized. Annual spawning area surveys by the California Department of Fish and Game indicate that under low streamflow conditions which typically occur in dry water years, winter-run chinook salmon spawning generally shifts further upstream. This tendency to spawn further upstream under dry conditions partially offsets the potential adverse impacts

associated with reducing the area of suitable temperature conditions for spawning and incubation.

The State Water Resources Control Board, U.S. Environmental Protection Agency, FWS, Bureau, California Department of Fish and Game and NMFS agree that a maximum temperature of 56°F is needed and scientifically justified for successful chinook salmon spawning and incubation. NMFS has judged the maintenance of a daily average water temperature of less than or equal to 56°F as acceptable in recognition that subsurface water temperatures in redds are generally cooler and experience less diurnal fluctuation than that of the water column above. In addition, diurnal exceedances of 56°F are not likely to be large or extend beyond a few hours if a daily average water temperature of less than or equal to 56°F is maintained.

Proposed Temperature Operation Plans. The Bureau proposes to provide for management of temperature conditions in the upper Sacramento River by scheduling both upper-level releases of warm water and lower-level releases of cold water from Shasta Dam. Upper-level bypass of warm water can be used to conserve cold water in the reservoir for use at a later time and has been used in the past, with limited success, to attract the winter-run chinook salmon adults into spawning areas further upstream.

All of the Bureau's proposed CVP operational plans fail to meet the Bend Bridge temperature criteria of 56°F through September. Less than half of the CVP operational plans are predicted to achieve the Jelly's Ferry temperature criteria through September. Appendix C of the "Long-term CVP-OCAP" report presents the temperature study results of the Bureau's proposed operational cases.

The temperature performance of the proposed CVP operational cases failed to meet the NMFS criteria because the Bureau adopted an inappropriate methodology to provide for the management of upper Sacramento River temperature conditions. The Bureau's analytical approach to temperature management began by utilizing the available water resources of an operational environment (initial reservoir storage and water year type) to set allocations to CVP contractors. The Bureau then modeled typical CVP operations, and finally Shasta Dam bypass and Trinity River exports were adjusted to optimize temperatures for winter-run chinook salmon survival as predicted by the temperature-mortality model described in the biological assessment (see pages 6-13 - 6-23).

Forecast, Temperature and Mortality Models. The results of the temperature-mortality model presented in the "Long-term CVP-OCAP" report and biological assessment predict winter-run chinook salmon egg and larval survival associated with each operational case will range from 78 to 99 percent (see CVP-OCAP pages 121-127; biological assessment pages 6-19 - 6-24). However, two of

twenty operational cases which are based on extreme critical hydrology were not evaluated and significantly higher levels of temperature-induced mortality would be anticipated in those instances.

NMFS predicts the temperature-induced mortality rates are likely to be higher under all proposed operational cases than the values presented in the "Long-term CVP-OCAP" report and biological assessment. Several factors contribute to an optimistic projection of estimated survival rates in the "Long-term CVP-OCAP" report and biological assessment. These factors are mainly related to the high level of uncertainty associated with several hydrological and biological assumptions used in the forecasts and models combined with the proposed operation of Red Bluff Diversion Dam.

Runoff Forecast. The Bureau proposes to announce water allocations to CVP contractions based on either the 50-percent exceedance runoff forecast or the 90-percent exceedance runoff forecast. By definition the 50-percent exceedance forecast has an equal chance of exceeding or falling short of the predicted runoff quantities. Because the accuracy of the runoff forecasts in any given year is highly dependant on the pattern of precipitation in that year, it is not a factor that can be well predicted. At the time water allocations are made, there is always an element of risk that Shasta Reservoir carryover levels will be less than forecasted. Lower reservoir carryover levels generally result in high water temperatures to the Sacramento River during the late summer and higher rates temperature-related mortality would be expected.

CVP Operations Model. The Bureau's operations model includes assumptions regarding Sacramento River accretion and depletion rates. Water accretions and depletions to the Sacramento River are primarily dependant upon precipitation and water diversion operations. During the irrigation season, CVP operations are adjusted to accommodate depletions due to water diversion operations.

The Bureau has developed estimates of summer depletion rates based on cropping patterns and land development in the region. However, the Bureau predicts monthly depletion estimates during the summer may frequently be in error by 20 percent or more (see CVP-OCAP page 100). During May 1992, Sacramento River depletions in excess of forecasted operations required the Bureau to release additional water from Shasta Reservoir. The resulting lower carryover levels during the summer of 1992 contributed to higher than predicted water temperature conditions during September and October.

Predictive Temperature Model. The Bureau's temperature predictive model uses average ambient air temperatures to produce average monthly water temperatures. In the event ambient air temperatures exceed average conditions, warming of Keswick Dam releases during passage downstream could be significantly underestimated. In addition, using average monthly water temperatures does not account for the trend or magnitude of temperature fluctuations over the course of a month and may underestimate the mortality of eggs and larvae.

Chinook Salmon Temperature-mortality Model. Although the model's biological assumptions regarding winter-run chinook salmon spawning distributions were developed in consultation with NMFS, FWS and the California Department of Fish and Game, the assumptions are subjective and actual conditions are expected to vary from year to year. If CVP operational decisions including water allocations are based on these hypothetical spawning distributions in February and it is determined in July that the actual winter-run chinook salmon spawning activity has deviated from the hypothesized distribution, temperature-related losses of eggs and larvae could be substantially higher than predicted by the model.

In addition, the survival model does not consider the effect of warm water on disease. An extremely common disease is Saprolegnia, a fungus that attacks and kills eggs. The fungus spreads among the eggs in the nest at a faster rate at higher temperatures due to the increased growth rate. As temperatures increase between the mid-50's to low-60's, the rate of fungus growth increases exponentially.

Operation of Red Bluff Diversion Dam. As stated above, the temperature-mortality model utilized hypothetical winter-run chinook salmon spatial and temporal spawning distributions. However, changes by the Bureau in the proposed operation of Red Bluff Diversion Dam were not considered in the development of the estimated relative spawning distributions. Intermittent gate closures are likely to result in additional delay and blockage of upstream migrant adults at the dam and shift the spawning distribution of winter-run chinook salmon further downstream. Thus, the estimated relative spawning distributions incorporated into the temperature-mortality model are inaccurate with this gate closure provision and the results of the temperature-mortality model presented in the "Long-term CVP-OCAP" report and biological assessment are invalid.

The temperature operation plans proposed by the Bureau offer no room for flexibility and are likely to result in adverse impacts. NMFS thinks temperature-related loss of eggs and larvae will often be higher than predicted by the Bureau's model and in some cases may be significantly higher. The proposed method for development of temperature operational plans is inappropriate for

planning purposes because the Bureau has relied exclusively on an assumed spawning distribution at the time an irretrievable commitment of water resources is made to CVP contractors. NMFS has evaluated the performance of CVP operational cases by the 56°F temperature criteria, because actual spatiotemporal spawning distributions are expected to vary and there is a need for additional flexibility.

When combined with the lack of a minimum carryover storage level in Shasta Reservoir, proposed CVP operational cases in years of critical and extremely critical hydrology could weaken the associated winter-run chinook salmon year class. For the most part, the winter-run chinook salmon population is comprised of three year-classes, each of which return to spawn as 3-year-old fish. With little overlap between year classes, the loss of a single year class would likely result in reduced spawning stock and low recruitment in three years, and so on. During prolonged periods of drought, a year class could be reduced to population levels that may not recover.

Spring Creek Debris Dam

Metal-laden acid mine discharge from the Spring Creek drainage is impounded behind the Spring Creek Debris Dam. The Bureau generally operates the dam to control the release of contaminated Spring Creek flows to match the Shasta and Whiskeytown Reservoir releases of clean water for dilution. The Bureau proposes to maintain the "interim release" criteria of the MOU during periods of control release, provided that such operation will not cause flooding or interfere unreasonably with other CVP requirements (see section on Spring Creek Debris Dam in Background: Operation Agreements, Constraints and Objectives).

The Bureau also proposes to continue the minimum schedule for monitoring copper and zinc concentrations which consists of weekly grab samples at the outlet of the dam and in the Sacramento River below Keswick Dam. The "interim" release criteria of the MOU does not meet the water quality standards of the Sacramento River Basin Plan objectives (Regional Water Quality Control Board).

During periods of high precipitation, runoff from the watershed may exceed the storage capacity of the reservoir resulting in an uncontrolled spill of metal-laden water. If the Bureau provides adequate dilution of metal concentrations in the Sacramento River below Keswick, the controlled release or spill from Spring Creek Debris Dam may not adversely effect winter-run chinook salmon. However, under the provisions of the MOU, the Bureau is not bound to meet this criteria if it interferes unreasonably with other CVP requirements. This provision allows the "interim" water quality standards for copper and zinc to be exceeded if CVP

operations are attempting to refill Shasta and Trinity Reservoirs during storm events.

In some cases, the Bureau has voluntarily released additional water from Shasta Lake and/or Spring Creek Powerplant to dilute spills, but no criteria has been established for making these releases. The proposed review of each spill on a case-by-case basis does not insure winter-run chinook salmon protection from high, and sometimes lethal, concentrations of heavy metals in the upper Sacramento River.

The greatest risk of acid mine drainage to winter-run chinook salmon is during the wet season (November to March). This is the period when uncontrolled spills from the dam are most likely to occur. Winter-run chinook salmon juveniles may be present in the upper river through March and adults are likely to be in the vicinity of Keswick Dam beginning in late December. Numerous fish kills attributed to sources in the Spring Creek drainage have been documented downstream of the confluence of Spring Creek with the Sacramento River (EPA 1991). An uncontrolled spill during the wet season may expose winter-run chinook salmon juveniles between Keswick Dam and Clear Creek to lethal metal concentrations. During the dry season, the proposed operation of the dam will likely greatly increase the duration of exposure of winter-run chinook salmon to chronic toxicity resulting from acid mine discharge. FWS found higher metal burdens in the livers of adult winter-run chinook salmon collected at Keswick Dam than fish collected at Red Bluff Diversion Dam (Schwarzbach draft report January 1993).

Pursuant to agreements with PG&E and the Western Area Power Administration, the Bureau may be called on at any time to operate full load at Spring Creek Powerplant. Although the duration of full load operation is likely to be short, the discharge of 4,400 cfs through the powerplant and down the Spring Creek Arm of Keswick Reservoir could potentially occur when the water elevation of Keswick Reservoir is below normal operating levels. Accumulated toxic metal-laden sediments in Keswick Reservoir could be mobilized and discharged into the Sacramento River below Keswick Dam. The potential for this combination of low Keswick Reservoir elevation and high Spring Creek Powerplant operation is rare, but could have catastrophic consequences during a sensitive life-stage of winter-run chinook salmon.

Anderson-Cottonwood Irrigation District

Typically, CVP operations require the reduction of Sacramento River flows for Anderson-Cottonwood Irrigation District (ACID) dam operations which in turn can adversely impact winter-run chinook salmon. Large fluctuations in upper Sacramento flows have dewatered chinook redds and stranded winter-run chinook salmon fry (CDFG 1990).

In years of full water deliveries, reduction in flows for in-season adjustments at ACID dam may impact winter-run chinook salmon redds. Redds constructed at streamflows of 10,000 cfs to 14,000 cfs could become dewatered at flows of 5,000 cfs. Redds dewatered for several days can result in high levels of mortality. Partially dewatered redds could also be impacted due to reduced subsurface flow through the substrate. Sufficient exchange of fresh water is needed to oxygenate the redds and remove metabolic wastes.

Flow reductions in the late summer and fall for ACID dam operations may strand winter-run chinook salmon fry. Winter-run chinook salmon fry prefer shallow nearshore areas with slow currents and good cover during the late summer and fall. To accommodate ACID dam operations, the Bureau's proposed ramp down schedule may result in leaving fry isolated in shallow pools and side channels or completely dewatered. If trapped in isolated pools, winter-run chinook salmon fry may be subjected to lethal water temperature conditions, avian predators, and other adverse conditions. Sudden increases in streamflow when ACID dam operations are completed are likely to repopulate shallow nearshore areas with winter-run chinook salmon fry where they will once again be susceptible to stranding when the next flow reductions take place.

Sacramento River Division

Red Bluff Diversion Dam

The operation of Red Bluff Diversion Dam concerns NMFS because it creates a serious impediment to upstream migrant salmon and losses of juvenile salmon due to predation can be severe. The proposed operation of Red Bluff Diversion Dam from May 1 to October 31 with the gates down is expected to significantly impact winter-run chinook salmon adults and juveniles. The proposed operation of the dam with the gates raised from November 1 through April 30 with provision in March and April for an intermittent closure up to two weeks is anticipated to adversely impact adults. The biological assessment provided by the Bureau did not evaluate the potential effects of the provision for intermittent gate closure during March and April.

Impacts to Upstream Migrants. Hallock et al. (1982) and Vogel et al. (1988) have shown that Red Bluff diversion Dam affects upstream salmon migration by delaying and blocking fish passage to the upper river. Vogel et al. (1988) reported that up to 44 percent of tagged winter-run chinook salmon adults were blocked by the dam. Delay or blockage of winter-run chinook salmon at the dam has serious consequences due to the predicted occurrence of lethal and sublethal temperature conditions above and below the dam during the spawning and incubation period.

The Bureau proposes to maintain the gates of the dam in the raised position from November 1 through the end of February. Based on the average run timing for winter-run chinook during the years of 1982 to 1986, it can be expected that approximately 30 percent of the spawning run will have passed the dam by March 1 (CDFG, unpublished data). Thus, winter-run chinook salmon upstream migrants from mid-December through February will encounter the dam gates out and essentially all adverse impacts associated with upstream passage will be eliminated.

From March 1 through April 30, approximately 53 percent of the spawning run destined for the upper Sacramento River (CDFG, unpublished data) may encounter the gates closed for 7 to 14 days at the discretion of the Bureau. The proposed intermittent gate closure will likely block upstream passage of winter-run chinook salmon for the duration of the closure and some fish may be delayed beyond the closure period. This action will result in additional temperature-induced mortality of winter-run chinook salmon eggs and larvae.

During May, June and July, the remaining 17 percent of the spawning run will encounter the gates in the lowered position (CDFG, unpublished data). The complete closure of the dam gates will delay and block winter-run chinook salmon spawners. This action will also result in additional temperature-induced mortality of winter-run chinook salmon eggs and larvae.

The provision for intermittent gate closures is likely to affect adversely the 53 percent of spawning run expected to reach Red Bluff during March and April. Lake Red Bluff behind the dam generally takes about 2 days to fill and provide gravity flow into the Tehama-Colusa Canal. The reverse process of raising the gates to drawdown Lake Red Bluff also requires about 2 days. During the fill and drawdown procedures, the dam's fish ladders become impassable due to the changing water surface elevation in Lake Red Bluff. Thus, no fish passage will be available for at least 4 days of the gate closure.

Even with the ladders in operation during the closure, it is likely many winter-run chinook salmon will not be able to find the ladder. Investigations by Vogel et al. (1988) determined that 3 to 9 days of complete blockage occurred between the time that the fish ladders became impassable and the time that salmon could pass beneath the dam gates. Vogel et al. (1988) also reports that salmon blocked by the dam spent an average of seven days below the dam before eventually dropping further back downstream. If this is an indication of an upper threshold beyond which most salmon cease their attempts to pass the dam, the proposed intermittent closure for 7 to 14 days could have significant delay and blockage effects extending far beyond the closure period.

Impacts to Spawning and Incubation. The provision for intermittent closure is likely to result in additional spawning activity below the dam where unsuitable temperature conditions are predicted to occur each year during the incubation period. In 1988, the lowering of the gates for approximately three weeks in February resulting in 26 percent of the winter-run chinook salmon population spawning below the dam. In contrast, reduced water deliveries in 1991 resulted in an uninterrupted period of raised gates from December 1 through May 2 and all winter-run chinook salmon redds were observed upstream of Cottonwood Creek, 28 miles below Keswick Dam (CDFG, unpublished data).

Due to the limited cold water resources of Shasta Lake, the reproductive success of winter-run chinook salmon spawning is directly related to the spawning distribution in the upper Sacramento River. Adults which are delayed by the proposed intermittent closure of the gates, but eventually pass the dam are likely to spawn further downstream where additional temperature-induced mortality of eggs and larvae is projected to occur. In addition, the physiological stress associated with delays and repeated attempts to get past the dam may contribute to reduced fecundity of spawners that do eventually pass upstream.

During May, June and July, the last 17 percent of the spawning run will encounter the gates in the lowered position (CDFG, unpublished data). Delay and blockage at the closed gates will result in additional winter-run chinook salmon spawning activity below the dam where unsuitable temperature conditions are likely to occur during the incubation period. Spawning activity above of the dam is likely to be distributed further downstream due to passage delays and result in additional temperature-induced mortality of winter-run chinook salmon eggs and larvae.

Impacts to juveniles. Red Bluff Diversion Dam impounds water in Lake Red Bluff for diversion into the Tehama-Colusa Canal. The headworks of the canal include new state-of-the-art fish screens which appear to be highly effective for the screening of juvenile chinook salmon. However, winter-run chinook salmon fry and juveniles which do not pass through the Tehama-Colusa fish bypass facility are adversely impacted by passage under the lowered gates of the diversion dam.

Studies by the California Department of Fish and Game indict that the survival of juvenile fall-run chinook salmon released downstream of the dam exhibited a 46 percent greater survival rate than those released upstream of the dam. The results suggests that juvenile salmon losses occur in the spring as well as in the winter, so it is likely that winter-run chinook salmon juveniles suffer mortality rates similar to fall-run chinook salmon (Hallock and Fisher, 1985). However, these studies were conducted prior to the 1990 installation of a new fish screen,

fish bypass system, and headworks deflector wall for the Tehama-Colusa Canal and initial studies suggest these measures have effectively reduced juvenile salmon entrainment losses to the canal (Johnson 1991).

Studies by the FWS determined that predation (primarily by squawfish) is a major cause of downstream migrant salmon mortality at the dam. Research indicates that squawfish and striped bass are likely to prey heavily upon disoriented winter-run chinook salmon fry and smolts as they pass under the gates and into the turbulent waters below the dam. Garcia (1989) observed significant numbers of squawfish directly below the dam during the late summer and early fall months when juvenile winter-run chinook salmon begin to migrant downstream past the dam. Vogel et al. (1988) reports losses due to predation range from 16 to 55 percent during passage under the gates at the Red Bluff Diversion Dam.

Passage through Lake Red Bluff can also delay downstream migrants and presumably increase the chances winter-run chinook salmon emigrants being preyed upon by birds and predatory fish. Vogel and Smith (1987) reported that radio-tagged juvenile steelhead and salmon were preyed upon by cormorants while moving through Lake Red Bluff; similar predation may occur on winter-run chinook salmon juveniles when the dam is in operation.

Downstream migrant salmon that encounter Red Bluff Diversion Dam in operation are thought to be diverted into the canal headworks in direct proportion to the amount of river flow that is diverted (Vogel et al. 1988). Newly-emerged winter-run chinook salmon emigrants that encounter the dam during the peak irrigation season (July and August) are more likely to encounter high diversion rates and, thus, more fish would be subject to passage through the Tehama-Colusa fish screen bypass system. As diversion rates decrease in September and October, more downstream migrant winter-run chinook salmon will pass under the dam gates.

It has been speculated that passage through the Tehama-Colusa fish bypass facility may be preferable to passage under the dam gates. Initial studies at the new "state-of-the-art" fish screen and bypass facilities suggest that the problem of entrainment of juvenile salmon has been greatly reduced by the new structures (Johnson 1991). Evaluation of impacts associated with predation and physical injury in the screen bypass system has yet to be completed.

Based upon the average timing of juvenile winter-run chinook salmon emigration at the dam, it is estimated that 68 percent of the winter-run chinook salmon year class may encounter the dam during its operation prior to November 1 (CDFG, unpublished data), but the numbers can range from 25 to 75 percent depending

on the water year type and streamflow conditions (Vogel and Marine 1991). All winter-run chinook salmon emigrants encountering the dam in operation will be subject to the adverse conditions associated with Lake Red Bluff, the Tehama-Colusa Canal and fish bypass system, and passage under the gates. It is estimated that virtually all of the year class will have passed the dam prior to proposed intermittent gate closure in March and April. Based on these estimates of winter-run chinook salmon emigration at Red Bluff, approximately 9 to 32 percent of the total year class may be lost at the dam prior the proposed November 1 raising of the gates.

Delta Division and State Water Project

The proposed operation of CVP and State Water Project facilities in the Sacramento-San Joaquin Delta is likely to adversely impact winter-run chinook salmon. Primarily, the proposed operation of the Delta Cross Channel combined with Delta water exports is likely to adversely impact winter-run chinook salmon. Juvenile winter-run chinook salmon may occur in the lower Sacramento River and Delta from September through May. Peak emigration of smolts usually occurs from January through March. Adult winter-run chinook salmon are thought to migrate upstream through the Delta from December through May.

Delta Cross Channel

The Bureau proposes to mitigate impacts to winter-run chinook salmon by operating the Cross Channel gates based upon observations and information from Delta fishery monitoring programs. As proposed, the gates of the Cross Channel will be closed during periods of "significant" emigration of winter-run chinook salmon juveniles. However, the Bureau has not provided a definition of "significant" which would trigger the closure. Proposed gate closures would be subject to interruption under conditions whereby control of Delta water quality conditions could not reasonably be achieved by other means.

Operation of the Cross Channel in this manner concerns NMFS due to the difficulties associated with monitoring for "significant" numbers of juvenile winter-run chinook salmon. Fisheries sampling gear available to biologists is extremely limited in large waterways such as the lower Sacramento River. Rotary and fyke traps are likely to be the best sampling tools, but they are size selective and can become inoperable when streamflow and debris loads are high.

In addition to the problems related to sampling large streams, winter-run chinook salmon are not abundant. Extremely low numbers of adults have returned to the upper Sacramento River in recent years and low escapement levels are expected for the near future. Without a definition of "significant", it is uncertain

whether this monitoring effort will be an effective technique for the management of gate operations.

At the Delta Cross Channel, an estimated 25 to 40 percent of the Sacramento River flow may enter the central Delta through the artificial channel when both gates are open (Brown and Greene 1992; Contra Costa Water District and USBR 1991). High percentages generally occur under low Sacramento River flow conditions. Investigations by Schaffter (1980) and Vogel et al. (1988) suggest an equivalent proportion of Sacramento River flow and winter-run chinook salmon juveniles are diverted into the central Delta at the Cross Channel. Schaffter (1980) found that the densities of salmon in the Sacramento River above the Cross Channel were similar to those in the Cross Channel. Vogel et al. (1988) found that the lateral distribution of juvenile salmon was relatively uniform across the Sacramento River channel as they approached Red Bluff Diversion Dam. Thus, the proposed operation of the gates at the Cross Channel could result in an estimated 25 to 40 percent of the total winter-run chinook salmon emigrant population diverted off the Sacramento River into the central Delta at the Cross Channel.

Once diverted through the Cross Channel, winter-run chinook salmon juveniles will be subject to adverse conditions that decrease their survival (USFWS 1987). It appears that lower survival rates in central and southern Delta waterways are a result of the longer migration route where fish are exposed to increased predation, higher water temperatures, unscreened agricultural diversions, poor water quality, reduced availability of food, entrainment at the CVP and State Water Project pumping plants, and a complex configuration of channels. In addition, upon reaching the mouth of the Mokelumne River on the lower San Joaquin River, juvenile winter-run chinook salmon will often be exposed to upstream (reverse) flows under proposed operation of the Delta water export facilities.

Reverse flow refers to the movement of the net flow in an easterly direction in the San Joaquin River channel and in a southerly direction in Old and Middle Rivers. The CVP and the State Water Project propose to export more water than the flow of the San Joaquin River at Vernalis. The balance of water proposed for export comes from the Sacramento River via the Cross Channel, Georgiana Slough, the Mokelumne River, and Lower Old and Middle Rivers. When water is exported by the CVP and State Water Project pumps, water is drawn from the San Joaquin River upstream into Old and Middle Rivers. Under most conditions, the magnitude of reverse flows in central and southern Delta waterways increases with pumping rates.

From 1984 to 1989, the FWS evaluated the effect of juvenile salmon passage in the Delta by mark and recapture studies. Their investigations revealed that salmon smolts released to the

Sacramento River below the open Cross Channel survived significantly better than those fish released above. Similar results using an index of survival based on recoveries of marked fish as adults have been found (USFWS 1992). These results are not surprising considering the habitat alterations created by the Delta Cross Channel and Delta pumping operations along their Sacramento River migration route.

Adult winter-run chinook salmon may be impacted by the proposed operation of the Cross Channel gates by straying and migration delay in central and southern Delta waterways. Orientation of upstream migrant chinook salmon depends primarily on olfactory perception of home-stream water. Thus, a "homing" or "parent" stream odor is required to assure the fish's return to the upstream spawning grounds. Adult winter-run chinook salmon bound for the upper Sacramento River can stray and be delayed by passage into the complex network of Delta waterways with the presence of Sacramento River water in central and southern Delta channels.

Georgiana Slough

Although not an operational feature of the water projects, the diversion of Sacramento River outflow through Georgiana Slough is partially a function of the operation of the Delta Cross Channel gates. Georgiana Slough is a natural waterway between the Sacramento River and the lower San Joaquin River. Under most Delta outflow conditions from 10 to 25 percent of Sacramento River flow passes through Georgiana Slough to the central Delta. Under moderate flow conditions of approximately 26,000 cfs in the Sacramento River, an estimated 16.5 percent of the river is diverted at Georgiana Slough (DWR, preliminary unpublished data). When the gates of the Delta Cross Channel are closed, a slightly higher percentage of Sacramento River flow is diverted at Georgiana Slough.

As in the case of the Delta Cross Channel, it is assumed that winter-run chinook salmon are diverted from the river in equal proportion to the flow and survival will be reduced during passage through central Delta waterways. However, Georgiana Slough does differ from the Delta Cross Channel in that 1) the slough is historically a natural migration corridor for emigrant Sacramento River salmon, 2) the capacity for diversion is considerably less than the Cross Channel especially under low flow conditions, and 3) there is no existing facility to regulate diversion rates. Thus, some winter-run chinook salmon will be diverted into the central Delta via this slough, but it is a smaller proportion than that diverted at the Delta Cross Channel.

It is likely that survival of winter-run chinook salmon juveniles is reduced by diversion from the Sacramento River at Georgiana Slough due to adverse conditions with central Delta waterways.

During 1992, the California Department of Water Resources proposed to mitigate the adverse impacts to winter-run chinook salmon by installation of a temporary barrier at the head of Georgiana Slough. The proposed project was designed to improve the survival of winter-run chinook salmon juveniles by guiding them down the Sacramento River toward the ocean from February 1 through March 31. On December 23, 1992, planning was halted for the 1993 installation of the barrier.

Tracy Pumping Plant (CVP) and Banks Pumping Plant (SWP)

The proposed operation of CVP and State Water Project Delta export facilities is likely to adversely effect winter-run chinook salmon. Investigations by the California Department of Fish and Game indicated direct losses of salmon juveniles result from severe predation in Clifton Court Forebay, predation in front of the screens and within the bypass systems, entrainment through the louver screens, mortality within the holding tanks, mortality during the truck hauling, and predation at the Delta release sites.

The CVP and State Water Project Delta pumping plants presently have maximum capacities of 4,600 cfs and 10,300 cfs, respectively. However, the State's existing Army Corps of Engineers permit restricts the State's level of pumping by limiting the monthly maximum average inflow into Clifton Court Forebay to 6,680 cfs. The forebay is a 31,000 acre-foot regulating reservoir at the pump intake to the California Aqueduct. The forebay is operated to minimize water level fluctuations at the intake by taking water through the gates at high tide and closing the gates at low tide. When the gates are opened at high tides, inflow can exceed 20,000 cfs for a short time and decreases as the water levels inside and outside the forebay reach equilibrium.

Both projects operate fish collection facilities within the intake channels of their canals using the same basic screen design, a louver system which resembles venetian blinds and acts as a behavioral barrier. Although the slots are wide enough for fish to enter, at the correct water velocities approximately 75 percent of the chinook salmon encountering the screens sense the turbulence and move along the screen face to enter the bypass system. The remaining 25 percent are lost to the pumping plant and canal. Bypassed fish are moved by pipe to a secondary screening system where they are concentrated further and diverted into holding tanks. A sample of the collected fish are identified and measured. This data is utilized for calculation of direct fish losses at the pumping facilities. Fish are kept in the holding tanks for eventually hauling by truck to release sites in the Delta.

The proposed operation of the gates at the entrance to Clifton Court Forebay in combination with reverse flow conditions are likely to result in high levels of juvenile winter-run chinook salmon mortality. Both rearing and emigrating juvenile winter-run chinook salmon may be carried from the central Delta and Chipps Island into the south Delta towards the pumping plants by reverse flow conditions. In the south Delta, these fish are exposed to a complex network of waterways and high rates of predation.

Once winter-run chinook salmon are drawn into waterways of the south Delta by reverse flows, the operation of the gates of the Clifton Court Forebay will subject these fish to inflows of 20,000 cfs with velocities of several feet per second. These conditions are likely to entrain large numbers of juvenile winter-run chinook salmon from south Delta waterways. Within Clifton Court Forebay, winter-run chinook salmon juveniles are subject to severe predation loss. In a series of investigations by the California Department of Fish and Game, predation loss rates of marked hatchery fall-run salmon released in Clifton Court Forebay during April, May and June ranged from 63 to 97 percent. The results of a December 1992 investigation concluded that salmon juveniles entrained into the forebay during the winter months experience a similar predation loss rate (P. Coulston, 1993).

Inside the fish screening facilities, salmon juveniles are lost to striped bass and other predators within the primary and secondary bypass channels. For evaluation and mitigation purposes, pre-screening loss rates of 75 percent for the State facility and 15 percent for the CVP facility have been established. The pre-screening loss rate for the State pumping facility is considerably higher than that of the Federal facility due to severe predation loss within Clifton Court Forebay. These estimates of loss rates were determined for chinook salmon in general and apply to winter-run chinook salmon.

Winter-run chinook salmon are likely to be adversely impacted by processing through the fish salvage facility. Losses will occur in the holding tanks, during collection from the holding tanks, transfer to tanker trucks, and hauling to release points. Predation losses at the salvage facilities' release sites are suspected, but actual rates of loss are unknown. Menchen (1980) reports that the survival of chinook salmon subjected to this salvage process is lower than unsalvaged fish after their release into the Delta.

The adverse effects of reverse flows on salmon have been discussed above in relation to the proposed operation of the Delta Cross Channel and Georgiana Slough, but these irregular freshwater flow patterns are actually a creation of CVP and State Water Project pumping operations. Within Delta consumptive use

by local agricultural diversions may contribute to reverse flows during the irrigation season, but their diversion rates are minimal during the period of juvenile winter-run chinook salmon occurrence in the Delta. Reverse flows from October through March are primarily generated by CVP and State water export operations. Proposed water export rates and schedules under many of the proposed CVP operational plans are likely to create reverse flows in the presence of juvenile winter-run chinook salmon for brief and extended periods of time.

Research has shown that the timing of winter-run chinook salmon occurrence in the lower river and Delta can span from late September through June. In any one year, the actual arrival and residence time in the Delta is strongly influenced by the water year type and, specifically, the pattern of high streamflows in the Sacramento River.

The California Department of Water Resources assisted the Bureau in evaluating the effects of proposed Delta operations by preparing the Delta portion of the biological assessment (DWR 1992). This document underestimates the potential adverse impact of Delta pumping operations on juvenile winter-run chinook salmon by assuming 1) winter-run chinook salmon smolts will move through the estuary in a relatively short period of time, and 2) chinook salmon in the Delta rely on guidance cues other than freshwater net flow to find their way to the ocean. Both of these assumptions may exemplify Delta passage of hatchery released fall-run chinook salmon smolts, but are not representative of the life history strategy of winter-run chinook salmon in the lower Sacramento River and Delta.

Because winter-run chinook salmon juveniles move into the lower Sacramento River and Delta during periods of high streamflow, they could arrive at any time from October through March. The peak abundance of smolts in the Delta generally occurs during the January through April period, but more intensive sampling efforts during November and December in 1992 identified juvenile pre-smolts in the northern Delta during the late fall. Although the data are limited, it appears that some portion of the winter-run chinook salmon year class rear in the lower Sacramento River and northern Delta during the months of October through February.

Analysis of adult winter-run chinook salmon scales indicates that most juveniles enter saltwater at a length of 118 millimeters (CDFG, unpublished data). Thus, the majority of winter-run chinook salmon juveniles are pre-smolts during the late fall and early winter months. They will undergo smoltification from January through April and are not likely to actively emigrate to the ocean until this time. Fall-run, in contrast, enter saltwater at a much smaller size, approximately 85 millimeters (CDFG, unpublished data).

Sampling by FWS during 1992 indicated that the majority of the 1991 winter-run year class did not move out of the upper and middle reaches of the Sacramento River until rainfall during February and March increased streamflows. It has been hypothesized that under low and clear streamflow conditions, most juvenile winter-run chinook salmon will continue to reside in the upper and middle Sacramento River through March. Fisheries monitoring in the river detected downstream movement of juveniles with high flows in February and March in 1992. Concurrently, the Delta pumping facilities increased their operations to full capacity to capture freshwater flowing into the Delta. As streamflows decreased and winter-run chinook salmon arrived in the Delta, maximum export operations continued at the CVP and State Water Project facilities. High pumping rates combined with high reverse flow conditions in the lower San Joaquin River channel resulted in drawing large numbers of winter-run chinook salmon to the pumping plants and substantial losses.

However, in most years, high streamflow conditions will occur during the late fall and early winter period. As the fish migrate downstream for rearing in the lower Sacramento River and northern Delta, some unknown portion of the winter-run chinook salmon year class become susceptible to diversion into the central Delta through the open Delta Cross Channel gates and Georgiana Slough. Once in central Delta waterways, reverse flow conditions created by Delta water export operations will adversely impact winter-run chinook salmon. In years where high stream flows move large numbers of juveniles downstream during the early fall, more winter-run chinook salmon may be exposed to the adverse effects associated with reverse flows over an extended period of time.

Contra Costa Canal

The CVP's Contra Costa Canal diverts approximately 120,000 acre-feet per year from Rock Slough in the Delta. Proposed diversion rates vary from about 150 cfs to 255 cfs. This diversion is not screened and there are no data to determine if winter-run chinook salmon juveniles enter the canal. Although Rock Slough is relatively far from the main migration route of Sacramento River chinook salmon, the creation of reverse flow conditions by operation of the Tracy and Banks pumping plants may bring some winter-run chinook salmon juveniles in the vicinity of Rock Slough. Thus, some winter-run chinook salmon could potentially be entrained by the operation of the Contra Costa Canal.

Suisun Marsh Salinity Control Gates

The Suisun Marsh Salinity Control Gates operate from October through May as tidal pumps by closing on flood tides and opening on ebb tides. The California Department of Water Resources has proposed to operate the control gates at or near "full bore"

during the period of winter-run chinook salmon emigration and adult upstream migration. During "full bore" operation, the gates open and close twice each tidal day to divert the maximum quantity of water from the Sacramento River at Collinsville into the eastern end of Montezuma Slough. "Partial" operation of the gates differs in that the gates are not fully closed and a 5 foot gap will remain open along the bottom of the channel. The full depth of the gate is approximately 15 feet. The proposed operation of the control gates will result in a net flow through the gates of about 1,800 cfs when averaged over one tidal day.

With the diversion of Sacramento River flow, an equivalent proportion of the winter-run chinook salmon emigrants may also be diverted into Montezuma Slough. However, sampling by mid-water trawl during April of 1992 indicated that only 0.2 to 1.5 percent of marked salmon were diverted into Montezuma Slough. Additional sampling has been proposed to better quantify rates of chinook salmon diversion into the slough during the operation of the control structure.

Winter-run chinook salmon have been identified in Montezuma Slough and the results of fisheries investigations demonstrate that juvenile chinook salmon use Montezuma Slough as a migratory corridor (Spaar 1988). Juvenile winter-run chinook salmon diverted into the slough may be adversely impacted by a longer emigration pathway, elevated water temperatures, increased levels of predation, and exposure to more than 60 unscreened diversions. The upstream migration of adult winter-run chinook salmon may be impacted by delay or blockage at the structure.

Potential impacts on winter-run chinook salmon juveniles and adults are inferred from the results of the California Department of Fish and Game's predator sampling program. Between 1987 and 1992, variable mesh gill nets were deployed weekly from April through June to determine the presence of predators within one kilometer of the salinity control structure. Results indicate the presence of striped bass near the structure has increased 3 to 4 times above that which existed prior to installation and operation of the facility. Stomach content analysis has identified juvenile chinook salmon in the stomachs of striped bass (Raquel 1992).

Observations of adult chinook salmon during CDFG's predator sampling program suggest adult winter-run chinook salmon may be delayed by operation of the structure. The pre-project catch data for adult chinook salmon and field observations of salmon hitting the gill nets indicated that salmon were beginning to migrate past the proposed structure site in the first part of May and continue through June. When the control structure became operational and the stop-logs were in place preventing natural flow conditions, no salmon were caught or observed hitting the gill nets on either side of the structure. Once the radial gates

and stop-logs were lifted, allowing natural flow conditions to reoccur, salmon were caught and observed hitting the nets on both sides of the structure (Raquel 1992). Both adult spring-run chinook salmon and winter-run chinook salmon are present in the Delta during the annual CDFG predator sampling program.

The general consensus of salmon biologists familiar with Montezuma Slough is that survival of juvenile chinook salmon is greater in the mainstem Sacramento and Suisun Bay when compared to passage through the slough. The fact that Montezuma Slough is a longer migration pathway with 60 unscreened water intakes and good predator habitat, suggests that winter-run chinook salmon juveniles will be lost at a higher rate during passage through the slough. The screened water intake at the Roaring River Distribution System may also entrain juvenile winter-run chinook salmon due to recurrent scouring problems under the screens.

Under some operational scenarios, the operation of the salinity control structure indirectly impacts winter-run chinook salmon by requiring the release of an additional 300 cfs from Oroville Reservoir. Tidal pumping by the control structure typically requires 300 cfs replacement from upstream reservoirs to maintain the Decision 1485 water quality standard in the Sacramento River at Chipps Island (D. Russell, personal communication). If the additional operation of the control structure is not required for meeting Decision 1485 water quality standards in the Suisun Marsh, water savings from non-operation of the structure could potentially be transferred or loaned via the Cooperative Operations Agreement to Shasta Lake for carryover and temperature control.

Lower Sacramento and Delta Monitoring Programs

The Bureau and DWR are proposing to monitor the downstream movement of juvenile salmon to characterize the timing of the winter-run downstream migration timing to the Sacramento-San Joaquin Delta. Ultimately this information may be used in real-time management of CVP/DWR facilities to increase the operational flexibility of the projects while minimizing the loss of winter-run chinook salmon. The primary component of this sampling program will be the expansion of existing FWS and CDFG monitoring programs. Fish are to be collected by a variety of sampling devices including trawling, beach seine, rotary trap, and pushnet. Captured fish may be removed from the river and anesthetized. Data on the number of salmon captured, lengths, and general fish condition are to be recorded and the fish returned alive to the river at the site of collection. With low water temperatures during the sampling period, incidental mortality of collected fish is expected to be between 1 and 5 percent of total captures or between 60 and 300 juveniles.

In late January 1993, Coleman National Fish Hatchery released approximately 27,000 juvenile winter-run chinook salmon in the upper Sacramento River near Anderson. All hatchery-released winter-run chinook salmon have been tagged with an implanted coded wire tag (CWT) and marked with an adipose fin clip prior to release. NMFS and the FWS considered methods of marking these fish to distinguish them from other hatchery releases. If distinguishable, they would provide a means to verify the size criteria established by the CDFG for determining whether juvenile fish captured at the delta salvage facilities are winter-run chinook. However, the additional handling necessary for placing a distinguishable mark was estimated to result in a mortality of about 600 fish. This exceeded the number of marked fish expected to be recaptured in the monitoring program and at the pumps. Therefore, the most conservative method of acquiring information to verify winter-run size criteria and movement patterns is to sacrifice tagged fish in the winter-run size range so the tags can be recovered and read. This will likely result in a loss of less than 450 juveniles from the hatchery release. This level of additional take is not likely to be detrimental.

V. CONCLUSION

Based on an assessment of the impacts, NMFS concludes the proposed long-term operation of the CVP by the Bureau is likely to jeopardize the continued existence of Sacramento River winter-run chinook salmon.

The proposed long-term operation of the CVP will substantially impact winter-run chinook salmon throughout the Sacramento River system. Losses of winter-run chinook salmon are anticipated to result from exposure to lethal temperatures in the upper Sacramento River, stranding of juvenile fish from changes in streamflow, dewatering of redds from changes in streamflow, blockage and delay of adult upstream migrates at the Red Bluff Diversion Dam, predation of juveniles at the Red Bluff Diversion Dam, diversion of juveniles at the Delta Cross Channel, creation of reverse flow conditions by pumping plants in the south Delta, and losses associated with the Delta fish collection facilities.

Operation of the Shasta and Trinity Divisions of the CVP are predicted to frequently create lethal temperature conditions during the winter-run chinook salmon spawning and incubation period. Depending upon the actual spawning distribution, loss of spawn to lethal temperatures is likely to exceed the Bureau's projections. In years of low storage and extremely critical hydrology, loss of eggs and larvae could reduce the population size significantly and result in reduced recruitment in future years. Stranding of juvenile fish and dewatering of redds may occur during the reduction of streamflows at Keswick Dam.

At the Red Bluff Diversion Dam, 17 percent of the winter-run chinook salmon upstream migrant adults will be subject to blockage and delay by the operation of the dam's gates and a portion of an additional 53 percent may encounter the gates closed for 7 to 14 days during March and April. Little to no upstream fish passage is expected during the intermittent closure period. Loss of winter-run chinook salmon eggs and larvae to lethal temperatures is exacerbated by delay and blockage of upstream migrants at the dam. Prior to November 1, an estimated 20 to 75 percent of the year class will pass downstream and be subject to high predation rates during passage under the lowered gates of the dam.

At the Delta Cross Channel, significant numbers of downstream migrant winter-run chinook salmon juveniles will be diverted from the Sacramento River into the central Delta. Once in the central Sacramento-San Joaquin Delta, the survival of winter-run chinook salmon is severely reduced by a number of adverse conditions including predation, unscreened diversions, elevated water temperatures and poor water quality.

The Tracy and Banks pumping plants are expected to create reverse flow conditions and draw rearing and emigrating juvenile winter-run chinook salmon towards the export facilities. Juveniles entrained into the State's pumping facility will experience predation loss rates of approximately 75 percent in Clifton Court Forebay. At the Tracy facility predation loss is projected to be approximately 15 percent. Additional mortality within the fish collection facilities includes screening, handling, and trucking losses.

VI. REASONABLE AND PRUDENT ALTERNATIVE

NMFS is providing the following reasonable and prudent alternative which can be implemented by the Bureau to avoid jeopardy to the Sacramento River winter-run chinook salmon as a result of the proposed long-term operation of the Central Valley Project. This alternative was identified during formal consultation with the Bureau, and in coordination with the California Department of Water Resources, FWS, the California Department of Fish and Game, and the State Water Resources Control Board. This reasonable and prudent alternative includes only actions which were identified during formal consultation and can be implemented in a manner consistent with the intended purpose of the proposed action. If the Bureau implements this reasonable and prudent alternative, NMFS has concluded that the long-term operation of the Central Valley Project is not likely to jeopardize the continued existence of winter-run chinook salmon.

Shasta/Trinity Divisions

1. **The Bureau must make its February 15 forecast of deliverable water based on a estimates of precipitation and runoff at least as conservatively as 90 percent probability of exceedance. Subsequent updates of water delivery commitments must be based on at least as conservatively as a 90 percent probability of exceedance forecast.**

The use of this more conservative forecasting approach will substantially reduce the risk of adverse temperature conditions occurring in spawning and incubation habitat of the winter-run chinook salmon.

2. **The Bureau must maintain a minimum end-of-water-year (September 30) carryover storage in Shasta Reservoir of 1.9 million acre-feet.**

A carryover storage of 1.9 million acre-feet in Shasta Reservoir has been judged by the NMFS and the California Department of Fish and Game to be attainable in all but critical and extremely critical water year types (90 percent probability of exceedance). The methodology used for determination of minimum carryover storage needs was an empirical, exploratory type of analysis, based on historic operations, hydrology, and observed and simulated temperatures. This minimum carryover storage level is directed at protecting the critical winter-run chinook salmon spawning reach in a manner consistent with the intended purpose of the Bureau's proposed action.

The NMFS recognizes that it may not be possible to maintain a minimum carryover storage of 1.9 million acre-feet in the driest 10 percent of water year types. If the 90 percent probability of

exceedance runoff forecast projects critical or extremely critical hydrological conditions and the CVP operations forecast projects carryover storage levels in Shasta may drop below 1.9 million acre-feet at the end-of-water-year, the Bureau must reinitiate consultation with NMFS prior to the first water allocations announcement.

The maintenance of 1.9 million acre-feet carryover in Shasta Reservoir will reduce the occurrence of CVP operational cases with low initial reservoir storage conditions to less than 10 percent of water years. This level of carryover storage in Shasta Reservoir improves the Bureau's ability to provide suitable temperature conditions in the upper Sacramento River during the winter-run chinook salmon spawning and incubation period. In combination with the proposed release of cold hypolimnetic water from the low level outlets of Shasta Dam and modification of CVP operations, a minimum carryover storage level in Shasta Reservoir will significantly improve temperature protection in the upper Sacramento River during the winter-run chinook salmon spawning and incubation period.

3. **The Bureau must maintain a minimum flow of 3,250 cfs from Keswick Dam to the Sacramento River from October 1 through March 31.**

This minimum instream flow is required to provide for safe rearing and downstream passage of winter-run chinook salmon, and to protect against the stranding of juvenile winter-run chinook salmon. NMFS will consider variation from this requirement on a case by case basis when flood conditions threaten human health and safety. In these circumstances NMFS will consider how well accretions from tributary streams will preclude strandings of juvenile fish under the reduced flows.

4. **When reductions in releases through Keswick Dam to the Sacramento River are required from July 1 through March 31, the Bureau must reduce flows at night (from sunset to sunrise) as follows:**

   a. For reduction of Keswick Dam releases down to a level of 6,000 cfs, flows must not be decreased more than 15 percent each night. Flows must not be decreased more than 2.5 percent in a one-hour period.

   b. For reduction of Keswick Dam releases to levels between 5,999 cfs and 4,000 cfs, flows must not be decreased by more than 200 cfs each night. Flows must not be decreased more than 100 cfs in a one-hour period.

c. For reduction of Keswick Dam releases to levels between 3,999 cfs and 3,250 cfs, flows must not be decreased by more than 100 cfs each night.

During the fall of 1992, these ramping conditions effectively eliminated the adverse effects of flow reductions on juvenile winter-run chinook salmon. NMFS will consider variation from this requirement on a case by case basis when flood conditions threaten human health and safety. In these circumstances, NMFS will consider how well accretions from tributary streams will preclude strandings of juvenile fish under accelerated reductions in flows.

5. The Bureau must maintain daily average water temperature in the Sacramento River at no more than 56°F within the winter-run chinook salmon spawning grounds below Keswick Dam as follows:

   a. Not in excess of 56°F at Bend Bridge from April 15 through September 30, and not in excess of 60°F at Bend Bridge from October 1 through October 31 for operational environments W-HI, W-HM, W-LM, W-LO, A-HI, A-HM, A-LM, A-LO, and D-HI.

   b. Not in excess of 56°F at Bend Bridge from April 15 through August 31, not in excess of 56°F at Jelly's Ferry from September 1 through September 30, and not in excess of 60°F at Jelly's Ferry from October 1 through October 31 for operational environment D-HM.

   c. Not in excess of 56°F at Jelly's Ferry from April 15 through September 30, and not in excess of 60°F at Jelly's Ferry from October 1 through October 31 for operational environments D-LM, D-LO, C-HI, C-HM, C-LM, and E-HI.

   d. The Bureau must reinitiate consultation 14 days prior to the first announcement of water delivery allocations for operational environments C-LO, E-HM, E-LM, and E-LO.

   The February 90-percent exceedance forecast of runoff, or an exceedance forecast at least as conservative, must be used to determine the operational environment and associated temperature compliance points. Any modifications to the February water allocation must comply with the above requirements.

Winter-run chinook eggs and pre-emergent fry require water temperatures at or below 56°F for survival during their spawning and incubation period. Additional modeling efforts by the Bureau in coordination with NMFS and California Department of Fish and

Game demonstrated that operational plans can be modified to extend 56°F temperature protection as far downstream as Bend Bridge in 9 operational cases, to Bend Bridge and Jelly's Ferry in one operational case, and to Jelly's Ferry in 6 operational cases. Under 4 operational cases of critical and extremely critical hydrology, the Bureau must reinitiate consultation. Table 1 summarizes the upper Sacramento River temperature control capability of CVP operational cases under the Bureau's proposed action and the NMFS reasonable and prudent alternative.

The Bureau does not currently have the ability to precisely predict daily average temperature conditions and physical constraints result in lag times of several days between an operational change and its intended effect at a downstream temperature control sight. Therefore, NMFS will not consider reinitiation of consultation necessary if the temperature target is exceeded by 0.5°F or less provided the Bureau has promptly implemented measures to reduce the temperature to the target and the exceedance lasts no more that 3 days. If the Bureau were to operate in a manner to eliminate the possibility of exceeding a maximum of 56°F at the target sight, it would risk depleting the cold water reserve and loss of temperature control late in the spawning season.

Sacramento River Division

6. **Pursuant to the following schedule, the gates of Red Bluff Diversion Dam must remain in the raised position to provide unimpeded upstream and downstream passage for winter-run chinook salmon:**

   a. **The gates of Red Bluff Diversion Dam must remain in the raised position through at least April 30, 1993.**

   b. **The gates of Red Bluff Diversion Dam must be raised on November 1, 1993 and remain in the raised position through at least April 30, 1994.**

   c. **On September 15 of each year commencing in 1994, the gates of Red Bluff Diversion Dam must be raised and remain in the raised position from September 15 through at least May 14.**

   NMFS will review proposals for intermittent gate closures of up to 10 days one time per year on a case-by-case basis.

The operation of the gates at Red Bluff Diversion Dam has been shown to adversely affect the upstream passage of winter-run chinook salmon by delay and blockage of the adult spawning run to the upper Sacramento River. By leaving the dam gates out for 2 weeks beyond the proposed closure date of May 1, an additional 7 percent of adult spawning run will be provided unimpeded passage

at the dam. As a result, winter-run chinook salmon spawning activity should shift further upstream where suitable temperature conditions are more likely to occur during the spawning and incubation period.

For winter-run chinook salmon fry and juveniles, the raising of the gates at the Red Bluff Diversion Dam on September 15 will reduce predation losses associated with the operation of the dam. The NMFS estimates approximately 5 to 21 percent of the total winter-run chinook salmon emigrant population may be lost at the dam between September 15 and October 31 due to passage under the lowered gates. By raising the gates on September 15 instead of November 1, these losses will be eliminated.

The extended period of raised gates at Red Bluff Diversion Dam is not scheduled to commence until September 15, 1994 to permit completion of the Bureau's proposed pilot pumping plant. Three state-of-the-art low speed pumps are scheduled for completion in 1994. The project has been carefully designed and planned to allow the Bureau to meet irrigation demands in the Tehama-Colusa Service Area while raising the gates of the dam from mid-September through mid-May (USBR 1992). The pilot pumping plant will allow an initial maximum pumping capacity of 382 cfs from the river when combined with the existing 125 cfs pumping facility.

Delta Division and State Water Project

7. **The Bureau must maintain the Delta Cross Channel Gates in the closed position from February 1 through April 30 to reduce the diversion of juvenile winter-run chinook salmon emigrants into the Delta.**

Studies by the FWS have indicated that the diversion of juvenile chinook salmon into the central portion of the Sacramento-San Joaquin Delta via the Cross Channel and Georgiana Slough has a significant adverse impact on their survival. Full closure of gates at the Cross Channel during the peak emigration period for winter-run chinook salmon will reduce the percentage of the population diverted off the mainstem Sacramento River into the central Delta. Under low and moderate streamflow conditions, the Cross Channel diverts the majority of Sacramento River flow and, presumably fish, into the central Delta. This action will improve the overall survival of the winter-run chinook salmon emigrant population by reducing the number of fish exposed to adverse conditions in the central Delta. Fisheries sampling in the Delta indicates that February through April is the primary period of winter-run chinook salmon emigration through the Delta.

At Georgiana Slough, some fish will continue to be diverted into the central Delta, but it is probably a substantially smaller proportion of the population than would be diverted by the open

Delta Cross Channel. Georgiana Slough is a natural ungated channel with limited hydraulic capacity for diversion. Due to the limited capacity of the channel, the proportion of Sacramento River discharge passing through Georgiana Slough has been estimated to range from 14 to 25 percent. The California Department of Water Resources is presently evaluating physical means in which to close the mouth of the slough. To provide protection for winter-run chinook salmon diverted off the river at Georgiana Slough, the NMFS offers alternative operational plans for the Delta pumping facilities (see paragraphs 9 and 10 below).

8. **Based on the observations of a real-time monitoring program in the lower Sacramento River, the Bureau must operate the gates of the Delta Cross Channel during the period of October 1 through January 31 to minimize the diversion of juvenile winter-run chinook salmon into the central Delta. The Bureau must develop the real-time monitoring program and fisheries criteria for gate closures and openings in coordination with the NMFS, FWS, California Department of Fish and Game, and the California Department of Water Resources by August 1, 1993. The Bureau must ensure that continuous real-time monitoring is conducted between October 1 and January 31 of each year commencing in 1993.**

During 1992, the results of the Bureau's fisheries monitoring program in the lower Sacramento River and Delta indicated some juvenile winter-run chinook emigrated downstream to the Delta during the fall and early winter months. Storm events during late October and November probably initiated this downstream movement of pre-smolts. The extent and duration of this movement by winter-run chinook salmon juveniles are unknown, but appears to be associated with increases in streamflow and turbidity. In future years, an unknown proportion of the winter-run chinook salmon emigrant population will emigrate to the Delta during the fall and early winter.

Although it is somewhat experimental, the results of an intensive sampling effort at one or two locations on the lower Sacramento River will likely provide an index of juvenile winter-run chinook salmon movement towards the Delta Cross Channel. Due to presumed periodic nature of winter-run chinook salmon emigration during the fall and early winter, full closure of the Cross Channel gates from October 1 through January 31 may not be required. The monitoring program offered here is to accommodate Delta water export operations and provide intermittent protection for winter-run chinook salmon juveniles during periods of active downstream migration in fall and early winter months.

The sensitivity of the sampling gear to detect winter-run chinook salmon is unknown. However, the consensus of the resource agency biologists is that an intensive sampling effort will likely

provide adequate information to manage operation of the gates for the protection of winter-run chinook salmon during the period of October through January. From February through April, full gate closure at the Cross Channel is deemed necessary, because fish facilities salvage records and past fisheries investigations clearly indicate that peak emigration of winter-run chinook salmon occurs this period.

9. **Based on the 14-day running average of QWEST in cfs, the Bureau and the California Department of Water Resources must operate the Delta water export facilities to achieve no reverse flows in the western Delta from February 1 through April 30. The 7-day running average, if negative, must be within 1,000 cfs of the applicable 14-day running average during this period.**

Elimination of reverse flow conditions in the western Delta from February through April is anticipated to reduce loss of winter-run chinook salmon juveniles in the Delta. CVP and State Water Project pump rates will decrease under low streamflow conditions, Delta outflows will increase, and the Delta survival of winter-run chinook salmon is predicted to increase by 100 to 200 percent, as measured by chinook salmon smolt survival models of the California Department of Water Resources and FWS.

QWEST is a calculated estimate generated by the California Department of Water Resource's DAYFLOW model that represents the net flow from the central Delta to the western Delta.

10. **Based on the 14-day running average of QWEST in cfs, the Bureau and the California Department of Water Resources must operate the Delta water export facilities to achieve flows in the western Delta greater than negative 2,000 cfs from November 1 through January 31. The 7-day running average, if negative, must be within 1,000 cfs of the applicable 14-day running average during this period.**

Maintenance of lower reverse flow conditions in the western Delta will reduce loss of juvenile winter-run chinook salmon pre-smolts from October through January. An unknown, and likely variable, portion of the juvenile winter-run chinook salmon population rears in the northern and central Delta during the fall and early winter months. Flows greater than -2,000 cfs are less likely to draw winter-run chinook salmon juveniles towards the Delta pumping plants. Losses to predation and entrainment during the early winter are likely to be reduced by this action.

11. Continue and expand monitoring of winter-run chinook salmon in the lower Sacramento River and Sacramento-San Joaquin

Delta to establish their presence, residence time, and serve as a basis for the real-time management of Delta Cross Channel gate operations.

The Bureau must develop a real-time monitoring program including sampling locations, sampling equipment, sampling frequency and the fisheries criteria for gate closures and openings. The Bureau must ensure that continuous real-time monitoring is conducted upstream of the Cross Channel gates between October 1 and January 31 of each year commencing in 1993 to serve as a basis for operation of the Delta Cross Channel gates. Additional monitoring must be conducted throughout the lower Sacramento River and Delta between September 1 and May 31 of each year commencing in 1993 to provide information regarding the presence and residence time of winter-run chinook salmon juveniles in the lower river and Delta. The results of the program must be reported to NMFS in accordance with the reporting schedule in term and condition No. 13 of the incidental take statement.

This monitoring program should involve sampling of juvenile winter-run chinook salmon by electrofishing, seining, fyke-netting, push netting, trawling, and rotary trapping at various sites on the Sacramento River from River Mile (RM) 202 to RM 0 at Chipps Island and within the waterways of the central and southern Delta. All juvenile salmon should be counted, measured, and examined in the field for biological data on growth, smoltification, and fish health. Immediately after all data are collected, all live fish must be returned to the Sacramento River or Delta. All mortalities must be minimized and reported to the Southwest Regional Director of NMFS. All dead winter-run chinook salmon must be placed in plastic bags, promptly frozen, and retained by the Bureau. Each sample must be carefully and completely labeled with the following information: (1) sampling location, (2) sampling gear, (3) date and time, and (4) fork length in millimeters.

In 1993, the Bureau must conduct a research study as part of this program to verify juvenile growth rates and the CDFG size criteria used to identify juvenile winter-run chinook salmon. This study must involve sacrificing a limited number of coded-wire tagged (CWT) juvenile winter-run chinook salmon (not to exceed 150 individuals) that were released from the Coleman National Fish Hatchery and that are collected during the monitoring program. Each sacrificed fish must be measured, placed in a separate whirl-pak bag, and promptly frozen for eventual CWT removal. Each sample must be carefully and completely labeled in the manner described above for other mortalities.

All CWT's must be promptly recovered from fish within the winter-run chinook salmon size range and a log must be maintained to record the size of each tag (full CWT or half CWT) as it is

recovered. In the event CWT readings can not be performed promptly, all half CWT fish must be considered winter-run chinook salmon until actual tag readings can be performed. All carcasses containing half CWTs must be promptly frozen and retained by the Bureau.

All monitoring programs that involve the intentional taking of winter-run chinook salmon must be conducted by a person or entity that has been authorized by the National Marine Fisheries Service to conduct these activities (i.e., scientific research permit or cooperative agreement).

12. **The Bureau in coordination with the Contra Costa Water District must develop and implement a program to monitor entrainment loss of winter-run chinook salmon juveniles at the Rock Slough intake of the Contra Costa Canal.**

The Bureau and Contra Costa Water District must develop a real-time monitoring program including sampling locations, sampling equipment, and sampling frequency. The Bureau must ensure continuous real-time monitoring in the Contra Costa Canal between October 1 and May 31 is performed for 3 years commencing in 1993.

All juvenile chinook salmon that fall within the daily size criteria developed by the California Department of Fish and Game (attachment 1) must be classified as winter-run chinook salmon. All salmon must be counted, measured, and examined in the field for biological data on growth, smoltification, and fish health. Immediately after all data are collected, all live fish are to be returned to the Sacramento River or Delta outside the influence of the canal intake.

All juvenile mortalities must be minimized during the monitoring program and must be reported to the Regional Director of NMFS, Southwest Region. All dead winter-run chinook salmon must be placed in plastic bags and promptly frozen. Frozen samples must be retained by the Bureau. Each sample must be carefully and completely labeled with the following information: (1) sampling location, (2) sampling gear, (3) date and time, and (4) fork length in millimeters.

A proposed monitoring and evaluation program must be submitted to NMFS for review and approval prior to June 1, 1993. Sampling at the Rock Slough intake must be initiated during the fall of 1993. Monitoring program results must be provided to NMFS in accordance with the reporting schedule outlined in term and condition # 13 of the incidental take statement.

All monitoring programs that involve the intentional taking of winter-run chinook salmon must be conducted by a person or entity that has been authorized by the National Marine Fisheries Service

to conduct these activities (i.e., scientific research permit or cooperative agreement).

13. The Bureau and Department of Water Resources in cooperation with the California Department of Water Resources must monitor the extent of incidental take associated with the operation of the Tracy and Byron pumping facilities.

The Bureau and the Department of Water Resources must conduct a monitoring program to determine the extent of incidental taking of winter-run chinook salmon associated with operation of the Tracy and Byron pumping facilities.

Through May 31, 1993, the following monitoring procedures and data analysis must be performed using personnel experienced in salmon biology:

a. For a minimum period of 10 minutes within each 2 hour interval throughout the day and night (minimum of 120 minutes per day) all salmon are to be measured (fork length to the nearest millimeter), examined for the presence or absence of the adipose fin, and enumerated.

b. For the period from January 15 through May 31 of 1993 only, a maximum of 150 CWT juvenile winter-run chinook salmon may be taken and sacrificed during the fish counts described above at Tracy and Skinner Fish Collection Facilities combined. CWT winter-run chinook salmon juveniles will have originated from Coleman National Fish Hatchery and will be distinguishable by an adipose fin clip. Each fish sacrificed must be measured, placed in a separate whirl-pak bag, and promptly frozen for transportation to the Stockton office of FWS for CWT recovery. Each sample must be carefully and completely labeled with the following information: (i) sampling location, (ii) date and time, and (iii) fork length in millimeters.

All CWTs from winter-run-size chinook salmon must be promptly recovered and read. A CWT recovery log must be maintained to record the size of each tag (full CWT or half CWT) as it is removed from each fish carcass. In the event CWT readings can not be performed promptly, all half CWT fish shall be considered winter-run chinook salmon until actual tag readings can be performed. Daily and weekly reports must make note if the classification is based solely on CWT size. All carcasses containing half CWTs shall be placed in whirl-pak bags, labeled in the manner described above, and promptly frozen. Frozen samples shall be retained until specific instructions are provided by NMFS.

The Bureau and the California Department of Water Resources are responsible for ensuring the 150 CWT fish limit is not

exceeded. NMFS and FWS will assist in the establishment of a random or stratified sampling scheme when the two facilities combined have collected a total of 100 CWT fish.

c. With the exception of the CWT fish collected during 1993, all fish are to be processed alive through the established fish salvage process after data has been collected. All mortalities of winter-run-size chinook salmon must be minimized and reported to the Regional Director of NMFS, Southwest Region. All winter-run chinook salmon mortalities shall be placed in whirl-pak bags, labeled in the manner described above, and promptly frozen. Frozen samples shall be retained until specific instructions are provided by NMFS.

d. Loss estimates are to be determined as follows:

All juvenile chinook salmon that fall within the daily size criteria developed by the California Department of Fish and Game (attachment 1) are to be classified as winter-run chinook salmon.

Winter-run chinook salmon salvage estimates are to be calculated by the following formula:

EXP-WR-TTL = (TTL-WR X TTL-PUMP)/LGT-CNT

EXP-WR-TTL = expanded winter-run chinook salmon salvage
TTL-WR = total winter-run chinook salmon count
TTL-PUMP = total pumping period in minutes
LGT-CNT = length of sampling period in minutes

Winter-run chinook salmon loss estimates are to calculated by the following formula for the Skinner Fish Collection Facility:

TTL-WR-LOSS = ((EXP-WR-TTL/0.75)/0.25) - (EXP-WR-TTL X 0.99)

TTL-WR-LOSS = total winter-run chinook salmon loss
EXP-WR-TTL = expanded winter-run chinook salmon salvage

0.75 = average SWP and CVP screen efficiency
0.25 = Skinner pre-screening loss of 75%
0.99 = Handling and trucking loss of 1%

Winter-run chinook salmon loss estimates are to be calculated by the following formula for the Tracy Fish Collection Facility:

TTL-WR-LOSS = (EXP-WR-TTL/0.75)/0.85) - (EXP-WR-TTL X 0.99)

TTL-WR-LOSS = total winter-run chinook salmon loss
EXP-WR-TTL = expanded winter-run chinook salmon salvage

0.75 = average SWP and CVP screen efficiency
0.85 = Tracy pre-screening loss of 15%
0.99 = Handling and trucking loss of 1%

From October 1, 1992 through May 31, 1993, The Bureau and Department of Water Resources must calculate estimates of winter-run chinook salmon loss (incidental take) on a real-time basis using the methodology described above.

Monitoring program results must be provided to the Regional Director of the NMFS, Southwest Region in accordance with the reporting schedule outlined in term and condition No.13 of the incidental take statement. This monitoring and reporting program will be used by NMFS to monitor the rate of incidental taking and cumulative incidental take, and to determine if there is a need to reinitiate formal consultation.

All monitoring programs that involve the intentional taking of winter-run chinook salmon must be conducted by a person or entity that has been authorized by the National Marine Fisheries Service to conduct these activities (i.e., scientific research permit or cooperative agreement).

VII. REINITIATION OF CONSULTATION

Reinitiation of formal consultation is required if there is discretionary Federal involvement or control over the action and if (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

If CVP operations are modified from those proposed in the CVP-OCAP as modified by the reasonable and prudent alternatives contained in this biological opinion, the Bureau must notify promptly the Regional Director of the NMFS Southwest Region.

VIII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. These "conservation recommendations" include discretionary measures that the Bureau can take to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat or regarding the development of information. In addition to the actions developed in the reasonable and prudent alternative, and the terms and conditions of the Incidental Take Statement, the NMFS provides the following conservation recommendations that would reduce or avoid adverse impacts on the Sacramento River winter-run chinook salmon.

1. Continue implementation of the Shasta temperature control device.

2. Continue implementation of the temperature control facilities and operational modifications at Whiskeytown Lake.

3. Modify the scheduling of Trinity River exports to the Sacramento Basin when effective for Sacramento River temperature control.

4. Improve sampling and analytical methodology for estimating total winter-run chinook salmon salvage numbers at Delta Fish Collection Facilities. Revised sampling methodology and salvage estimations should be designed for small sample sizes which may not be normally distributed.

5. Continue to refine and improve the upper Sacramento River predictive temperature model with the objective of developing a daily predictive model.

6. Provide funding to the U.S. Fish and Wildlife Service to fully evaluate the newly installed Red Bluff Diversion Dam downstream migrant fish protection facilities under the full range of operating conditions.

TABLE 6
PREDICTED TEMPERATURE CONTROL CAPABILITY
OF CVP OPERATIONAL CASES
During the Winter-run Chinook Salmon
Spawning and Incubation Period

	Proposed Action		Reasonable & Prudent Alternative		
Operational Environment	56°F @ Bend Bridge	56°F @ Jelly's Ferry	56°F @ Bend Bridge	56°F @ Jelly's Ferry	Reinitiation of Consultation
W-HI	No	Yes	Yes	Yes	
W-HM	No	Yes	Yes	Yes	
W-LM	no	Yes	Yes	Yes	
W-LO	No	Yes	Yes	Yes	
A-HI	No	Yes	Yes	Yes	
A-HM	No	Yes	Yes	Yes	
A-LM	No	Yes	Yes	Yes	
A-LO	No	Yes	Yes	Yes	
D-HI	No	No	Yes	Yes	
D-HM	No	No	No	Yes	
D-LM	No	No	No	Yes	
D-LO	No	No	No	Yes	
C-HI	No	Yes	No	Yes	
C-HM	No	No	No	Yes	
C-LM	No	No	No	Yes	
C-LO	No	No	No	No	Yes
E-HI	No	No	No	Yes	
E-HM	No	No	No	No	Yes
E-LM	No	No	No	No	Yes
E-LO	No	No	No	No	Yes

IX. INCIDENTAL TAKE STATEMENT

Section 7(b)(4) of the Endangered Species Act (ESA) requires that when a proposed agency action is found to be in compliance with section 7(a)(2), the National Marine Fisheries Service will issue a statement that specifies the impact of any incidental taking, provide reasonable and prudent measures necessary to minimize impact and include terms and conditions that must be followed. Only incidental taking by the Federal agency that complies with the specified terms and conditions is authorized. Also, if the biological opinion concludes that the activity will likely jeopardize the continued existence of the species, the incidental take is authorized only if the reasonable and prudent alternative included in the opinion is implemented by the Federal agency.

This incidental take statement is applicable to all activities conducted by the Bureau in the long-term operation of the Central Valley Project and all related activities of the California Department of Water Resources and Contra Costa Water District conducted in cooperation with the Bureau. Unless modified, this incidental take statement does not apply to individuals, irrigation districts, and other persons engaged in specific diversion activities.

As described in the biological opinion, the proposed long-term operation of the Central Valley Project (CVP) and the State Water Project, as modified by the reasonable and prudent alternative, is expected to result in the incidental take of winter-run chinook salmon and modification of its spawning and rearing habitat. However, the magnitude of winter-run chinook salmon take associated with the long-term operation of CVP and State Water Project cannot be easily quantified, because of variability and uncertainty in the winter-run chinook salmon population size; the adult spawning run size; the spatial and temporal distribution of spawners in the upper Sacramento River; the timing of the downstream and upstream migrations; and actual water supply/runoff conditions. Therefore, NMFS estimates and authorizes a level of take associated with proposed operations, as modified by the reasonable and prudent alternative, in terms of habitat loss and percent of the run subjected to adverse conditions.

As described in the reasonable and prudent alternative of the biological opinion (see section on Shasta/Trinity Divisions in the reasonable and prudent alternative), the Bureau's model predicts suitable temperature conditions will occur in 90 to 100 percent of the winter-run chinook salmon spawning grounds during the critical spawning and incubation period. Thus, the temperature-related mortality of winter-run chinook salmon eggs and larvae associated with CVP operations should not exceed 0 to 5 percent.

The biological opinion describes estimated levels of incidental take associated with the operation of the Red Bluff Diversion Dam (see section on Sacramento River Division in assessment of impacts). In 1993 and 1994, dam operations will subject an estimated 17 percent of the upstream migrant winter-run chinook salmon adults to delay and potential blockage. However, beginning in 1995 with completion of the pilot pumping plant, an estimated 10 percent of the upstream migrant adults will be subject to delay and potential blockage by closure of the gates on May 15.

Based on the average timing of juvenile emigrants, dam operations during 1993 will likely result in the loss of 9 to 32 percent of the winter-run chinook salmon year class prior to the raising of the gates on November 1. Beginning in mid-September of 1994 with the raising of the gates, an estimated 3.5 to 12 percent of the total emigrant population is projected to be lost due to predation at the dam prior to the raising of gates. With the screening of the 125 cfs pumps (term and condition No.7 below), NMFS anticipates that approximately 0.25 percent of the winter-run chinook salmon year class will be lost at the Tehama-Colusa Fish Screen facility and the screened 125 cfs pumps.

A general description of the incidental take associated with operation of the Delta Cross Channel is described in the biological opinion (see section on Delta Cross Channel in biological assessment). Operation of the Cross Channel as modified by the reasonable and prudent alternative will divert an unknown proportion of the total emigrant population from the Sacramento River into the central Delta. In most years, the majority of winter-run chinook salmon juveniles are not likely to be diverted from their Sacramento River migration corridor by the Cross Channel with intermittent closures from October through January and a complete closure from February through April. However, the survival of those winter-run chinook salmon juveniles that are diverted into the central Delta will be reduced by high rates of predation, elevated temperatures, unscreened diversions, poor water quality, reverse flow conditions, and entrainment at the Delta pumping facilities.

Calculated estimations of winter-run chinook salmon loss are to be performed on a real-time basis to monitor the level of take associated with the operation of the Tracy, Banks and Contra Costa pumping facilities. Incidental take associated with the operation of the Delta pumping facilities is described in the biological opinion (see section on Tracy Pumping Plant and Banks Pumping Plant in assessment of impacts). The total level of anticipated take at the Delta pumping facilities must not exceed 1 percent of the estimated number of winter-run chinook salmon entering the Delta for the current year.

Takings of winter-run chinook salmon that exceed the levels that are estimated or projected in this incidental take statement are not authorized, and if reached or exceeded, the Bureau must reinitiate consultation.

The following reasonable and prudent measures include terms and conditions that must be complied with to monitor and/or minimize the incidental take of winter-run chinook salmon from the proposed long-term operation of the Central Valley Project as modified by the reasonable and prudent alternative.

Shasta and Trinity Divisions

1. **Continue and expand temperature monitoring in the upper Sacramento River.**

The Bureau must utilize an automatic temperature recording device in the Sacramento River at Jelly's Ferry (river mile 266) to monitor temperature conditions and compliance with the reasonable and prudent alternative. The device must be capable of recording water temperature at 1 or 2 hour intervals on a 24-hour basis. Water temperature data must be provided to NMFS in accordance with the reporting schedule outlined in term and condition No. 15. The device must be in operation by June 1, 1993.

2. **The Bureau must provide NMFS the opportunity to review and approve the proposed operations forecast prior to the first water allocations announcement each year and all subsequent updates to ensure they are consistent with the reasonable and prudent alternatives.**

The Bureau must provide to the Regional Director of NMFS Southwest Region the results of the February 90-percent exceedance forecasts of runoff and CVP operations, and the results of the predictive upper Sacramento River temperature model at least 7 days prior to the first water allocations announcement of the current year and all subsequent updates.

3. **The Bureau must operate the Spring Creek Debris Dam and Shasta Dam season to minimize chronic exposure of metal concentrations on adult and juvenile winter-run chinook salmon and eliminate potential scouring of toxic metal-laden sediments in Keswick Reservoir.**

The Bureau must utilize a real-time flow monitoring device at the weir below the dam to provide an accurate measurement of Spring Creek Debris Dam outflow. The device must be in operation as soon as possible.

The Bureau must utilize analytical instruments capable of detecting copper and zinc at concentrations equal to that specified by the Sacramento River Basin Plan. The analytical

methodology shall be consistent with the U. S. Environmental Protection Agency quality assurances and quality control guidelines.

The Bureau must increase the sampling frequency of copper and zinc concentrations in the dam outflow at the weir and in the Sacramento River below Keswick Dam during and immediately following all major storm events, or when malfunctions at the upstream treatment facilities cause metal concentrations to change. Water quality data must be provided to NMFS in accordance with the reporting schedule outlined in term and condition No. 13.

During the dry season, the Bureau must utilize the results of the real-time flow monitoring device and analytical tests outlined above to reduce metal concentrations in the Sacramento River to levels as low as the Spring Creek Debris Dam evacuation period will allow. At this time, the Bureau must target the metal concentration levels specified by the Sacramento River Basin Plan. An exception to this measure would be required during extremely critical water years when Keswick Dam releases are too low under this schedule to accommodate full evacuation of Spring Creek Debris Dam.

The Bureau must maintain Keswick Reservoir at or above the normal operating level during all operation of the Spring Creek Powerplant to prevent the scouring of toxic metal-laden sediments in Keswick Reservoir.

4. **The Bureau must prevent the entrapment of winter-run chinook salmon adults within the stilling basin of Keswick Dam.**

The Bureau must develop plans for the structural modification of the stilling basin at Keswick Dam that will allow free passage of adult salmon from the basin back to the river. Plans must be submitted to NMFS for review and approval no later than June 1, 1993. Structural modifications must be completed prior to December 31, 1993.

5. **During the ramping down of Keswick Dam releases, the Bureau must ensure fisheries monitoring is conducted in nearshore areas along upper Sacramento River between streamflows of 4,000 and 3,250 cfs.**

The Bureau must provide resources to monitor and prevent the stranding of juvenile winter-run chinook salmon during streamflow reductions between 4,000 cfs and 3,250 cfs at Keswick Dam.

Sacramento River Division

6. **The Bureau must develop and implement a program to evaluate potential adverse effects on juvenile salmon associated with air entrainment in the fish bypass system of the Tehama-Colusa Fish Facilities. If necessary, corrective measures must be developed and implemented by the Bureau.**

The Bureau must ensure a program of evaluation of the fish bypass system at the Tehama-Colusa Fish Facilities is funded and implemented. If air entrainment problems are identified, the Bureau must develop corrective measures. The proposed evaluation program must be submitted for review and approval by the NMFS prior to June 1, 1993.

7. **The Bureau must prevent entrainment of winter-run chinook salmon fry and juveniles at the intakes of the existing 125 cfs pumps at Red Bluff Diversion Dam.**

The Bureau's existing pumping capacity of 125 cfs from the river into the Tehama-Colusa Canal at Red Bluff Diversion Dam must be screened with state-of-the-art positive-barrier screens. The fish screen design must meet NMFS' fish screening criteria for anadromous salmonids. Screen design and specifications shall be submitted to NMFS' Southwest Region for review and approval prior to June 1, 1993. The screens must be operated and maintained by the Bureau whenever these pumps are in operation commencing October 1, 1993.

8. **The Bureau must prevent winter-run chinook salmon fry and juveniles from stranding within East Sand Slough of Lake Red Bluff during lake drawdown periods.**

The Bureau must develop plans for modification of the bottom of Lake Red Bluff or other methods that will prevent winter-run chinook salmon fry and juveniles from becoming stranded in isolated pools during lake drawdown periods. Plans must be submitted to NMFS for review and approval no later than June 1, 1993.

Delta Division and State Water Project

9. **The DWR and the Bureau are authorized to take up to 1% of the estimated number of out migrating smolt winter-run incidental to the operation of the Delta pumping facilities at Byron and Tracy.**

During the period from October 1, through May 31, of each year, calculated estimates of winter-run chinook salmon loss mut be performed by the Bureau and DWR on a real-time basis. The total level of incidental take at the Delta pumping facilities for this period must not exceed 1 percent of the estimated number of

winter-run chinook salmon entering the Delta. NMFS and CDFG estimate that approximately 270,000 will enter the delta during the 1992-93 outmigration. Therefore, the total combined incidental take limit for the Delta pumping facilities covered in this biological opinion must not exceed an estimated loss of 2,700 juvenile winter-run chinook salmon.

Commencing in September of 1993, NMFS will develop an estimate of the number of winter-run chinook salmon fry and juveniles that will enter the Delta during the following fall, winter, and spring months of each year. This estimate will be used to determine the incidental take limit for that year.

NMFS expects the Bureau and the DWR to monitor the loss of juvenile winter-run chinook salmon at the Delta facilities as described in the reasonable and prudent alternative and to use that information to determine whether the estimated level of loss is likely to exceed the allowable level. If either agency or the NMFS determines the rate of loss is sufficiently high that the estimated loss will likely exceed authorized levels, consultation should be reinitiated to explore additional measures that could be implemented to reduce the rate of take and ensure the authorized level of take is not exceeded.

10. **The California Department of Water Resources in coordination the Bureau must develop and implement a program of chinook salmon investigations at the Suisun Marsh Salinity Control Structure and within Montezuma Slough. Chinook salmon investigations must be designed to address the diversion rate of juveniles into the slough, predation at the control structure, survival during passage through Montezuma Slough, and passage of upstream migrant adults at the control structure.**

The California Department of Water Resources in coordination the Bureau must develop and implement a program of chinook salmon investigations designed to evaluate the effects of the operation of the Suisun Marsh Salinity Control Structure on winter-run chinook salmon. The investigations must assess the diversion rate of chinook salmon juveniles into the slough, predation at the control structure, survival of chinook salmon juveniles during passage through Montezuma Slough, and passage of upstream migrant adult chinook at the control structure. The proposed evaluation program must be submitted to NMFS for review and approval prior to October 1, 1993. Investigations shall be initiated during the spring of 1994.

11. **The Bureau and California Department of Water Resources must ensure that the fish collection facilities are fully staffed for monitoring incidental take and the screens fully operated whenever the Tracy and Banks pumping plants are in operation from October 1 through May 31.**

The Bureau and the California Department of Water Resources shall at no time allow unscreened water to pass through the Tracy or Skinner Fish Collection Facilities from October 1 through May 31. If either fish screening facility is not fully operational due to maintenance or equipment failure, the operation of the associated pumping plant must simultaneously be discontinued until the screening facility returns to full operation.

The Bureau and the California Department of Water Resources are required also to ensure the fish collection facilities are adequately staffed to perform the necessary sampling and monitoring of incidental take outlined in term and condition No. 15 from October 1 through May 31.

General

12. **The Bureau in coordination with the California Department of Water Resources must develop and implement a demonstration screening program designed to promote the advancement of state-of-the-art positive-barrier screening technology at small unscreened diversions along the Sacramento River and within Delta waterways.**

Entrainment of winter-run chinook salmon juveniles through hundreds of small unscreened diversions along the Sacramento River and within the Delta is suspected to be a significant cumulative impact. By providing funds and other assistance to a select number of small individual diverters, the demonstration screening program will encourage Sacramento River water users to minimize impacts to fisheries resources while maintaining their water diversions. This program will offer diverters an opportunity to examine appropriate and affordable technology for compliance with the incidental take restrictions of the ESA.

Provided the following evaluation procedures and remedial actions are implemented, the Bureau (Mid-Pacific Regional Office, 2800 Cottage Way, Sacramento, California 95825-1898), or their designated representative, is authorized to take up to 500 juvenile Sacramento River winter-run chinook salmon (Oncorhynchus tshawytscha) during the implementation of the demonstration screening program. Take of juvenile winter-run chinook salmon is authorized during the evaluation of newly installed screens provided the demonstration screening program is in strict conformance with the following:

a. The demonstration screening program shall be limited to diversions equal to or less than 40 cfs.

b. Evaluation programs for all demonstration screening sites must be developed and implemented.

c. Proposed evaluation programs must be submitted to the NMFS for review and approval for each site at least 45 days prior to implementation.

d. All evaluation programs must be performed by entities approved by NMFS.

e. All salmon are to be counted, measured, and examined in the field for biological data on growth, smoltification, and fish health. Immediately after all data are collected, all live fish are to be returned to the Sacramento River or Delta.

All mortalities must be minimized and reported to the Regional Director of NMFS, Southwest Region. All winter-run chinook salmon mortalities must be placed in whirl-pak bags, labeled in the manner described above (see term and condition No. 9 above), and promptly frozen. Frozen samples must be retained until specific instructions are provided by NMFS.

f. The Bureau or California Department of Water Resources must ensure that evaluation programs are fully funded for the duration of the evaluation period.

f. Sacramento River and Delta sites must be limited to use of state-of-the-art positive-barrier screens during the period July 1 through March 30 for sites above Princeton (river mile 160) and to the period of September 1 through May 31 for sites downstream of Princeton along the Sacramento River and in the Delta.

g. The Bureau or California Department of Water Resources must remedy any problem or shortfall identified by NMFS or the Bureau at any intake during the evaluation program in a manner approved by NMFS.

h. All screening designs must meet NMFS' fish screening criteria for anadromous salmonids. Screen design and specifications shall be submitted to the NMFS for review and approval at least 45 days prior to screen deployment.

i. The Bureau or California Department of Water Resources must ensure that all screens are properly operated and maintained.

j. The Bureau or California Department of Water Resources must ensure that all data are compiled and an annual report submitted to NMFS by (inset date) of each year.

Once a participant from the demonstration screening program has been released, this authorization for incidental take ceases to

apply to that participant. Therefore, it will be an individual participant's responsibility to obtain authorization for any subsequent incidental take.

13. **The Bureau in coordination with the California Department of Water Resources must submit daily, weekly, and annual reports to NMFS regarding operation of project facilities, temperature and hydrological conditions, and the results of monitoring programs.**

The Bureau must ensure the following information is provided to the NMFS in accordance with the reporting schedules outlined below. Daily reports are to be made available to the NMFS via the California Data Exchange Center database. Data must be compiled into summary reports and bulletins on the California Data Exchange Center (CDEC) database. All CDEC information must be accessible by personal computer with a modem and a telephone line in accordance with applicable reporting frequency. Weekly summaries and annual reports may be FAXed or mailed to Director Southwest Region, NMFS.

Shasta, Trinity and Sacramento River Diversions (reporting period must be year-round).

FOLLOWING INFORMATION TO BE PROVIDED BY:
DAILY REPORTS on CDEC each weekday within 24 hours;
WEEKLY SUMMARY transmittal to NMFS by mail or fax within 4 days of ending date;
ANNUAL REPORT to be submitted by December 31 of each year;

1) Actual Sacramento River average daily water temperatures (F°) at the following locations:

Keswick Dam
Clear Creek
Cottonwood Creek (as measured at Ball's Ferry)
Jelly's Ferry
Bend Bridge
Red Bluff Diversion Dam

2) Average daily release in cfs from:

Shasta Dam outlet 742
Shasta Dam outlet 815
Shasta Dam outlet 942
Spring Creek Powerhouse
Keswick Dam

3) Average daily outflow of the Spring Creek Debris as measured by the real-time flow monitoring device installed at the weir.

4) Average daily pumping rate at Red Bluff Diversion Dam in cfs.

5) Average daily diversion flows from Black Butte Reservoir to the Tehama-Colusa Canal in cfs.

FOLLOWING INFORMATION TO BE PROVIDED WHEN AVAILABLE:

6) Reservoir profile data

Shasta Reservoir
Clair Engle Reservoir
Whiskeytown Reservoir

FOLLOWING INFORMATION TO BE PROVIDED WEEKLY within 72 hours:

7) Copper and zinc concentrations at the Spring Creek Debris Dam outflow weir and in the Sacramento River below Keswick Dam.

Delta Division (reporting period from October 1 through May 31).

FOLLOWING INFORMATION TO BE PROVIDED BY:
DAILY REPORTS on CDEC each weekday within 24 hours;
WEEKLY SUMMARY transmittal to NMFS by mail or fax within 4 days of ending date;
ANNUAL REPORT to be submitted by September 30 of each year;

8) Average daily pump rates at Tracy Pumping Plant in cfs;

9) Average daily pump rate at Banks Pumping Plant in cfs:

10) Average daily Delta outflow index (cfs) and 7-day average;

11) San Joaquin River net flow at Bradford Island in cfs as calculated by QWEST and 7-day average (QWEST calculated estimated from DAYFLOW of the net flow from the central Delta to the western Delta; sum of lower San Joaquin, False River and Dutch Slough, without Threemile Slough);

12) Average daily Sacramento River flow at Freeport in cfs and 7-day average;

13) Average daily San Joaquin River flow at Vernalis in cfs and 7-day average;

14) Operation of the Suisun Marsh Salinity Control Structure.

FOLLOWING INFORMATION TO BE PROVIDED BY:

DAILY REPORTS on CDEC each weekday within 72 hours of collection;
WEEKLY SUMMARY transmittal to NMFS by mail or fax within 4 days of ending date;
ANNUAL REPORT to be submitted by September 30 of each year;

15) Skinner and Tracy Fish Collection Facilities (to be reported separately):

i. Daily total of winter-run-size chinook salmon observed (adipose clipped and non-clipped);

ii. Daily expanded salvage number of winter-run-size chinook salmon (adipose clipped and non-clipped);

iii. Daily loss estimate of winter-run-size chinook salmon (adipose clipped and non-clipped);

iv. Cumulative total of all the above for the month to date and year to date (year = reporting period of October 1 to May 31).

FOLLOWING INFORMATION TO BE PROVIDED BY:
WEEKLY SUMMARY transmittal to NMFS by mail or fax within 4 days of ending date;
ANNUAL REPORT to be submitted by September 30 of each year;

16) Winter-run chinook salmon monitoring program for the lower Sacramento River and Delta:

i. Daily total of winter-run-size chinook salmon captured by sampling location and by gear type (adipose-clipped and non-clipped);

ii. Totals of winter-run-size chinook salmon captures by sampling location (reach or area) and by gear type for the month to date.

17) Coded Wire Tag recovery program (reporting period from January 15 through May 31, 1993 only):

i. Date of collection and fork lengths of individual winter-run chinook salmon CWT recoveries at the Tracy Fish Collection Facility, Skinner Fish Collection Facility, and in the winter-run chinook salmon monitoring program .

ii. Total number of winter-run chinook salmon collected at Tracy and Skinner Fish Collection Facilities to date, and the total number collected in the winter-run chinook salmon monitoring program to date.

iii. For non-winter-run chinook salmon CWT recoveries, which fall within the winter-run chinook salmon size criteria, date of collection and fork lengths of individual chinook CWT recoveries at the Tracy Fish Collection Facility, Skinner Fish Collection Facility, and in the winter-run chinook salmon monitoring program.

iv. Total number of non-winter-run chinook salmon, which fall within the winter-run chinook salmon size criteria, collected at Tracy and Skinner Fish Collection Facilities to date, and the total number collected in the winter-run chinook salmon monitoring program to date.

18) Contra Costa Canal winter-run chinook salmon monitoring program:

i. Daily total of winter-run-size chinook salmon observed (adipose clipped and non-clipped);

ii. Cumulative total of winter-run-size chinook salmon observed for the month to date and year to date (year = reporting period of October 1 to May 31).

iii. All juvenile chinook salmon that fall within the daily size criteria developed by the California Department of Fish and Game (attachment 1) are to be classified as winter-run chinook salmon.

14. The Bureau must establish a working operations and management group that includes the NMFS to address the implementation of the reasonable and prudent alternative.

A working group consisting of representatives from the Bureau, NMFS, FWS, and State agencies including the Department of Water Resources and the Department of Fish and Game must be established to assist in the implementation of the reasonable and prudent alternative.

15. The Bureau in coordination with the Department of Water Resources must develop new sampling and analytical methodologies for estimating winter-run chinook salmon salvage and loss numbers at the fish collection facilities that is acceptable to NMFS.

Current methods for estimating the salvage and loss of juvenile winter-run chinook salmon at the fish collection facilities need to be reevaluated and new and improved methods need to be developed.

16. The Bureau must develop in consultation with NMFS a winter-run chinook population model that can be used to evaluate the long-term effects of CVP operations plans on the winter-run chinook salmon survival and recovery.

NMFS believes it is essential to develop a management tool, based on population modeling, that is capable of evaluating the long-term cumulative effects of CVP operations, as well as alternative operational strategies, on the survival and recovery of winter-run chinook salmon.

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ATTACHMENT 1

WINTER-RUN CHINOOK SALMON
ESTIMATED DAILY FORK LENGTHS (mm)

MONTH	DAY	WINTER-RUN LATE[1]	WINTER-RUN EARLY[2]
July	1	-	33
July	2	-	33
July	3	-	34
July	4	-	34
July	5	-	34
July	6	-	34
July	7	-	34
July	8	-	35
July	9	-	35
July	10	-	35
July	11	-	35
July	12	-	36
July	13	-	36
July	14	-	36
July	15	-	36
July	16	-	37
July	17	-	37
July	18	-	37
July	19	-	37
July	20	-	38
July	21	-	38
July	22	-	38
July	23	-	38
July	24	-	39
July	25	-	39
July	26	-	39
July	27	-	39
July	28	-	40
July	29	-	40
July	30	-	40
July	31	-	40
August	1	-	41
August	2	-	41
August	3	-	41
August	4	-	41
August	5	-	42
August	6	-	42
August	7	-	42
August	8	-	43
August	9	-	43
August	10	-	43
August	11	-	43
August	12	-	44
August	13	-	44
August	14	-	44
August	15	-	45

MONTH	DAY	WINTER-RUN LATE[1]	WINTER-RUN EARLY[2]
August	16	-	45
August	17	-	45
August	18	-	45
August	19	-	46
August	20	-	46
August	21	-	46
August	22	-	47
August	23	-	47
August	24	-	47
August	25	-	48
August	26	-	48
August	27	-	48
August	28	-	49
August	29	-	49
August	30	-	49
August	31	-	50
September	1	-	50
September	2	-	50
September	3	-	50
September	4	-	51
September	5	-	51
September	6	-	51
September	7	-	52
September	8	-	52
September	9	-	53
September	10	-	53
September	11	-	53
September	12	-	54
September	13	-	54
September	14	-	54
September	15	-	55
September	16	-	55
September	17	-	55
September	18	-	56
September	19	-	56
September	20	-	56
September	21	-	57
September	22	-	57
September	23	-	58
September	24	-	58
September	25	-	58
September	26	-	59
September	27	-	59
September	28	-	59
September	29	-	60
September	30	-	60

MONTH	DAY	WINTER-RUN LATE[1]	WINTER-RUN EARLY[2]
October	1	-	61
October	2	-	61
October	3	-	61
October	4	-	62
October	5	-	62
October	6	-	63
October	7	-	63
October	8	-	64
October	9	-	64
October	10	-	64
October	11	-	65
October	12	-	65
October	13	-	66
October	14	-	66
October	15	-	67
October	16	33	67
October	17	33	67
October	18	34	68
October	19	34	68
October	20	34	69
October	21	34	69
October	22	34	70
October	23	35	70
October	24	35	71
October	25	35	71
October	26	35	72
October	27	36	72
October	28	36	72
October	29	36	73
October	30	36	73
October	31	37	74
November	1	37	74
November	2	37	75
November	3	37	75
November	4	38	76
November	5	38	76
November	6	38	77
November	7	38	77
November	8	39	78
November	9	39	78
November	10	39	79
November	11	39	79
November	12	40	80
November	13	40	80
November	14	40	81
November	15	40	82
November	16	41	82
November	17	41	83
November	18	41	83
November	19	41	84
November	20	42	84
November	21	42	85
November	22	42	85
November	23	43	86
November	24	43	87
November	25	43	87
November	26	43	88
November	27	44	88
November	28	44	89
November	29	44	89
November	30	45	90
December	1	45	91
December	2	45	91
December	3	45	92
December	4	46	92
December	5	46	93
December	6	46	94
December	7	47	94
December	8	47	95
December	9	47	95
December	10	48	96
December	11	48	97
December	12	48	97
December	13	49	98
December	14	49	99
December	15	49	99
December	16	50	100
December	17	50	101
December	18	50	101
December	19	50	102
December	20	51	103
December	21	51	103
December	22	51	104
December	23	52	105
December	24	52	105
December	25	53	106
December	26	53	107
December	27	53	107
December	28	54	108
December	29	54	109
December	30	54	110
December	31	55	110
January	1	55	111
January	2	55	112
January	3	56	112
January	4	56	113
January	5	56	114
January	6	57	115

MONTH	DAY	WINTER-RUN LATE[1]	WINTER-RUN EARLY[2]
January	7	57	115
January	8	58	116
January	9	58	117
January	10	58	118
January	11	59	119
January	12	59	119
January	13	59	120
January	14	60	121
January	15	60	122
January	16	61	123
January	17	61	123
January	18	61	124
January	19	62	125
January	20	62	126
January	21	63	127
January	22	63	127
January	23	64	128
January	24	64	129
January	25	64	130
January	26	65	131
January	27	65	132
January	28	66	133
January	29	66	133
January	30	67	134
January	31	67	135
February	1	67	136
February	2	68	137
February	3	68	138
February	4	69	139
February	5	69	140
February	6	70	141
February	7	70	142
February	8	71	143
February	9	71	143
February	10	72	144
February	11	72	145
February	12	72	146
February	13	73	147
February	14	73	148
February	15	74	149
February	16	74	150
February	17	75	151
February	18	75	152
February	19	76	153
February	20	76	154
February	21	77	155
February	22	77	156
February	23	78	157
February	24	78	158

MONTH	DAY	WINTER-RUN LATE[1]	WINTER-RUN EARLY[2]
February	25	79	159
February	26	79	160
February	27	80	161
February	28	80	163
March	1	81	164
March	2	82	165
March	3	82	166
March	4	83	167
March	5	83	168
March	6	84	169
March	7	84	170
March	8	85	171
March	9	85	172
March	10	86	174
March	11	87	175
March	12	87	176
March	13	88	177
March	14	88	178
March	15	89	179
March	16	89	18
March	17	90	18
March	18	91	18
March	19	91	18
March	20	92	18
March	21	92	18
March	22	93	18
March	23	94	18
March	24	94	19
March	25	95	19
March	26	95	19
March	27	96	19
March	28	97	19
March	29	97	19
March	30	98	19
March	31	99	19
April	1	99	20
April	2	100	20
April	3	101	20
April	4	101	20
April	5	102	20
April	6	103	20
April	7	103	20
April	8	104	2
April	9	105	2
April	10	105	2
April	11	106	2
April	12	107	2
April	13	107	2
April	14	108	2

MONTH	DAY	WINTER-RUN LATE[1]	WINTER-RUN EARLY[2]
April	15	109	220
April	16	110	221
April	17	110	223
April	18	111	224
April	19	112	226
April	20	112	227
April	21	113	229
April	22	114	230
April	23	115	232
April	24	115	233
April	25	116	235
April	26	117	236
April	27	118	238
April	28	119	239
April	29	119	241
April	30	120	243
May	1	121	244
May	2	122	246
May	3	123	247
May	4	123	249
May	5	124	251
May	6	125	252
May	7	126	254
May	8	127	256
May	9	127	257
May	10	128	259
May	11	129	261
May	12	130	262
May	13	131	264
May	14	132	266
May	15	133	268
May	16	133	269
May	17	134	270
May	18	135	270
May	19	136	270
May	20	137	270
May	21	138	270
May	22	139	270
May	23	140	270
May	24	141	270
May	25	142	270
May	26	143	270
May	27	143	270
May	28	144	270
May	29	145	270
May	30	146	270
May	31	147	270

[1] LATE refers to the mean fork length (mm) of the progeny of late spawning winter-run chinook salmon.

[2] EARLY refers to the mean fork length (mm) of the progeny of early spawning winter-run chinook salmon.

SOURCE: California Department of Fish and Game, unpublished data; revised by California Department of Water Resources, memorandum from Shelia Greene to Randy Brown dated May 8, 1992.