During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast.

"El Niño" is an environmental condition often cited as a cause for the decline of West Coast salmonids (NMFS 1996b). El Niño is an unusual warming of the Pacific Ocean off South America and is caused by atmospheric changes in the tropical Pacific Ocean (Southern Oscillation-ENSO) resulting in reductions or reversals of the normal trade wind circulation patterns. The El Niño ocean conditions are characterized by anomalous warm sea surface temperatures and changes to coastal currents and upwelling patterns. Principal ecosystem alterations include decreased primary and secondary productivity in affected regions and changes in prey and predator species distributions. Cold-water species are displaced towards higher latitudes or move into deeper, cooler water, and their habitat niches occupied by species tolerant of warmer water that move upwards from the lower latitudes with the warm water tongue.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival in the ocean is driven largely by events occurring between ocean entry and recruitment to a sub-adult life stage.

10. Ecosystem Restoration

a. *California Bay-Delta Authority (CBDA)*

Two programs included under CBDA; the Ecosystem Restoration Program (ERP) and the EWA, were created to improve conditions for fish, including listed salmonids, in the Central Valley (CALFED 2000). Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids and emphasis has been placed in tributary drainages with high potential for steelhead and spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CBDA-ERP Program have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids. Similar habitat restoration is imminent adjacent to Suisun Marsh (*i.e.*, at the confluence of Montezuma Slough and the Sacramento River) as part of the Montezuma Wetlands project, which is intended to provide for commercial disposal of material dredged from San Francisco Bay in conjunction with tidal wetland restoration.

A sub-program of the ERP called the Environmental Water Program (EWP) has been established to support ERP projects through enhancement of instream flows that are biologically and ecologically significant in anadromous reaches of priority streams controlled by dams. This program is in the development stage and the benefits to listed salmonids are not yet clear. Clear

Creek is one of five priority watersheds in the Central Valley that has been targeted for action during Phase I of the EWP.

The EWA is designed to provide water at critical times to meet ESA requirements and incidental take limits without water supply impacts to other users, particularly South of Delta water users. In early 2001, the EWA released 290 thousand acre feet of water from San Luis Reservoir at key times to offset reductions in south Delta pumping implemented to protect winter-run Chinook salmon, delta smelt, and splittail. However, the benefit derived by this action to winter-run Chinook salmon in terms of number of fish saved was very small. The anticipated benefits to other Delta fisheries from the use of the EWA water are much higher than those benefits ascribed to listed salmonids by the EWA release. Under the long term operations of the CVP and SWP, EWA assets have declined to 48 thousand acre feet after carriage water costs. The RPA actions developed within the 2009 NMFS Operations BO are designed to minimize or remove the adverse impacts associated with many of the OCAP project related stressors. Within the Delta, stressors such as the Delta Cross Channel (DCC) gates and export operations have been modified to reduce the hydraulic changes created by the project operations. Earlier closures of the DCC gates prevent early emigrating listed salmonids from entering the Delta interior through the open DCC gates. Management of the Old and Middle River flows prevents an excessive amount of negative flow towards the export facilities from occurring in the channels of Old and Middle River. When flows are negative, water moves in the opposite direction than would occur naturally, drawing fish into the south Delta and towards the export facilities or delaying their migration through the system.

b. *Central Valley Project Improvement Act*

The CVPIA, implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the CVP. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward recovery of all anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the DOI's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for spring-run Chinook salmon and steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

c. *Iron Mountain Mine Remediation*

Environmental Protection Agency's Iron Mountain Mine remediation involves the removal of toxic metals in acidic mine drainage from the Spring Creek Watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain

Mine has shown measurable reductions since the early 1990s (see Reclamation 2004 Appendix J). Decreasing the heavy metal contaminants that enter the Sacramento River should increase the survival of salmonid eggs and juveniles. However, during periods of heavy rainfall upstream of the Iron Mountain Mine, Reclamation substantially increases Sacramento River flows in order to dilute heavy metal contaminants being spilled from the Spring Creek debris dam. This rapid change in flows can cause juvenile salmonids to become stranded or isolated in side channels below Keswick Dam.

d. *State Water Project Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement)*

The Four Pumps Agreement Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement inception in 1986. Four Pumps projects that benefit spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer creeks; enhanced law enforcement efforts from San Francisco Bay upstream to the Sacramento and San Joaquin rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead (see Reclamation 2004 Chapter 15).

e. *San Joaquin River Restoration Program (SJRRP)*

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and the CVP Friant Division Contractors. After more than 18 years of litigation of this lawsuit, known as *NRDC, et al. v. Kirk Rodgers, et al.*, a settlement was reached. On September 13, 2006, the Settling Parties, including NRDC, Friant Water Users Authority, and the U.S. Departments of the Interior and Commerce, filed a stipulation of the terms and conditions of the settlement, which was subsequently approved by the U.S. District Court, Eastern District of California, on October 23, 2006. The settlement establishes restoration and management goals. The Restoration Goal is to restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence with the Merced River, including naturally reproducing and self-sustaining of salmon and other fish. The Water Management Goal is to reduce or avoid water supply impacts to all of the Friant Division long-term contractors that may result from the Interim and Restoration Flows provided for in the Settlement. President Obama signed the San Joaquin River Restoration Settlement Act (Act) on March 30, 2009, which authorized implementation of the settlement, as part of the Omnibus Public Land Management Act of 2009. Pub. L. No. 111-11, 123 Stat.991.,

To achieve the Restoration Goal, the settlement calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of Chinook salmon, *O. tshawytscha* prior to December 31, 2012. Title X, section 10011(b) of the Act states that spring-run Chinook salmon shall be reintroduced in the San Joaquin River below Friant Dam pursuant to section 10(j) of the ESA, provided that a permit for the reintroduction may be issued pursuant

to section 10(a)(1)(A) of the ESA. In addition, Title X, section 10011(c)(2) of the Act states that the Secretary of Commerce shall issue a final rule pursuant to section 4(d) of the ESA governing the incidental take of reintroduced Central Valley spring-run Chinook salmon prior to the reintroduction. Furthermore, Title X, section 10011(c)(3) of the Act states that the rule issued under paragraph 2 shall provide that the reintroduction will not impose more than de minimus: water supply reductions, additional storage releases, or bypass flows on unwilling third parties due to such reintroduction.

11. Non-Native Invasive Species (NIS)

As currently seen in the San Francisco estuary, NIS can alter the natural food webs that existed prior to their introduction. Perhaps the most significant example is illustrated by the Asiatic freshwater clams *Corbicula fluminea* and *Potamocorbula amurensis*. The arrival of these clams in the estuary disrupted the normal benthic community structure and depressed phytoplankton levels in the estuary due to the highly efficient filter feeding of the introduced clams (Cohen and Moyle 2004). The decline in the levels of phytoplankton reduces the population levels of zooplankton that feed upon them, and hence reduces the forage base available to salmonids transiting the Delta and San Francisco estuary which feed either upon the zooplankton directly or their mature forms. This lack of forage base can adversely impact the health and physiological condition of these salmonids as they emigrate through the Delta region to the Pacific Ocean.

Attempts to control the NIS also can adversely impact the health and well-being of salmonids within the affected water systems. For example, the control programs for the invasive water hyacinth (*Eichhornia crassipes*) and Brazilian Elodea (*Egeria densa*) plants in the Delta must balance the toxicity of the herbicides applied to control the plants to the probability of exposure to listed salmonids during herbicide application. In addition, the control of the nuisance plants can have negative effects on certain physical parameters that must be accounted for in the treatment protocols, particularly the decrease in DO resulting from the decomposing vegetable matter left by plants that have died.

12. Summary

For Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, the construction of high dams for hydropower, flood control, and water supply resulted in the loss of vast amounts of upstream habitat (*i.e.*, approximately 80 percent, or a minimum linear estimate of over 1,000 stream miles), and often resulted in precipitous declines in affected salmonid populations. For example, the completion of Friant Dam in 1947 has been linked with the extirpation of spring-run Chinook salmon in the San Joaquin River upstream of the Merced River within just a few years. The reduced populations that remain below Central Valley dams are forced to spawn in lower elevation tailwater habitats of the mainstem rivers and tributaries that were previously not used for this purpose. This habitat is entirely dependent on managing reservoir releases to maintain cool water temperatures suitable for spawning, and/or rearing of salmonids. This requirement has been difficult to achieve in all water year types and for all life stages of affected salmonid species. Steelhead, in particular, seem to require the qualities of small tributary habitat similar to what they historically used for spawning; habitat that is largely unavailable to them under the current water

management scenario. All salmonid species considered in this consultation have been adversely affected by the production of hatchery fish associated with the mitigation for the habitat lost to dam construction (*e.g.*, from genetic impacts, increased competition, exposure to novel diseases, *etc.*).

Land-use activities such as road construction, urban development, logging, mining, agriculture, and recreation are pervasive and have significantly altered fish habitat quantity and quality for Chinook salmon and steelhead through alteration of streambank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWD; and removal of riparian vegetation resulting in increased streambank erosion. Human-induced habitat changes, such as: alteration of natural flow regimes; installation of bank revetment; and building structures such as dams, bridges, water diversions, piers, and wharves, often provide conditions that both disorient juvenile salmonids and attract predators. Harvest activities, ocean productivity, and drought conditions provide added stressors to listed salmonid populations. In contrast, various ecosystem restoration activities have contributed to improved conditions for listed salmonids (*e.g.*, various fish screens). However, some important restoration activities (*e.g.*, Battle Creek Restoration Project) have not yet been completed and benefits to listed salmonids from the EWA have been less than anticipated.

Similar to the listed salmonids, the Southern DPS of North American green sturgeon have been negatively impacted by hydroelectric and water storage operations in the Central Valley which ultimately affect the hydrology and accesibility of Central Valley rivers and streams to anadromous fish. Anthropogenic manipulations of the aquatic habitat, such as dredging, bank stabilization, and waste water discharges have also degraded the quality of the Central Valley's waterways for green sturgeon.

IV. ENVIRONMENTAL BASELINE

The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR §402.02).

A. Status of the Species and Critical Habitat in the Action Area

1. Status of the Species within the Action Area

The action area functions primarily as a migratory corridor for adult and juvenile Central Valley steelhead. All adult Central Valley steelhead originating in the San Joaquin River watershed will have to migrate through the action area in order to reach their spawning grounds and to return to the ocean following spawning. Likewise, all Central Valley steelhead smolts originating in the San Joaquin River watershed will also have to pass through the action area during their emigration to the ocean. The waterways in the action area also are expected to provide some

rearing benefit to emigrating steelhead smolts as they move through the action area. The action area also provides some use as a migratory corridor and rearing habitat for juvenile Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon, as well as Central Valley steelhead from the Sacramento River watershed, that are drawn into the Central and south Delta by the actions of the CVP and SWP water diversion facilities, and must therefore emigrate towards the ocean through the lower San Joaquin River system. The action area also functions as migratory, holding, and rearing habitat for adult and juvenile Southern DPS of North American green sturgeon.

a. *Sacramento River Winter-Run Chinook Salmon*

The temporal occurrence of Sacramento River winter-run Chinook salmon smolts and juveniles in the action area are best described by the salvage records of the CVP and SWP fish handling facilities. Based on salvage records covering the last 10 years at the CVP and SWP, Sacramento River winter-run Chinook salmon are typically present in the south Delta action area starting in December. Their presence peaks in March and then rapidly declines from April through June. Nearly 50 percent of the average annual salvage of Sacramento River winter-run Chinook salmon juveniles occurs in March (50.4 percent). Salvage in April accounts for only 2.8 percent of the average annual salvage and falls to less than 1 percent for May and June combined (Table 8). The presence of juvenile Sacramento River winter-run Chinook salmon in the south Delta is a function of river flows on the Sacramento River, where the fish are spawned, and the demands for water diverted by the SWP and CVP facilities. When conditions on the Sacramento River are conducive to stimulating outmigrations of juvenile Sacramento River winter-run Chinook salmon, the draw of the CVP and SWP pumping facilities pulls a portion of these emigrating fish through the waterways of the Central and southern Delta from one of the four access points originating on the Sacramento River (Georgiana Slough, the Delta Cross Channel, Three Mile Slough, and the San Joaquin River via Broad Slough). The combination of pumping rates and tidal flows moves these fish towards the southwestern corner of the Delta. When the combination of pumping rates and fish movements are high, significant numbers of juvenile Sacramento River winter-run Chinook salmon are drawn into the south Delta.

b. *Central Valley Spring-Run Chinook salmon*

Like the Sacramento River winter-run Chinook salmon, the presence of juvenile Central Valley spring-run Chinook salmon in the action area is under the influence of the CVP and SWP water diversions and the flows on the Sacramento River and its tributary watersheds. Currently, all known populations of Central Valley spring-run Chinook salmon inhabit the Sacramento River watershed. The San Joaquin River watershed populations have been extirpated, with the last known runs on the San Joaquin River being extirpated in the late 1940s and early 1950s by the construction of Friant Dam and the opening of the Kern-Friant irrigation canal.

Juvenile Central Valley spring-run Chinook salmon first begin to appear in the action area in January. A significant presence of fish does not occur until March (17.2 percent of average annual salvage) and peaks in April (65.9 percent of average annual salvage) (Table 8). By May, the salvage of Central Valley spring-run Chinook salmon juveniles declines sharply (15.5

percent of average annual salvage) and essentially ends by the end of June (1.2 percent of average annual salvage).

Table 8: Summary table of monthly Winter-run and Spring-run Chinook salmon loss and Combined total salvage and loss of Central Valley steelhead at the CVP and SWP fish collection facilities from water year 1999-2000 to water year 2008-2009. Data from CVO web site: (http://www.usbr.gov/mp/cvo/)

Fish Facility Salvage Records (Loss)

Winter Run (loss)

Year	October	November	Dec	Jan	Feb	March	April	May	June	July	August	September	Sum
2008-2009	0	0	8	55	210	1654	21	0	0	NA	NA	NA	1948
2007-2008	0	0	0	164	484	628	40	0	0	NA	NA	NA	1316
2006-2007	0	0	87	514	1678	2730	330	0	0	NA	NA	NA	5339
2005-2006	0	0	649	362	1016	1558	249	27	208	NA	NA	NA	4069
2004-2005	0	0	228	3097	1188	644	123	0	0	NA	NA	NA	5280
2003-2004	0	0	84	640	2812	4865	39	30	0	NA	NA	NA	8470
2002-2003	0	0	1261	1614	1464	2789	241	24	8	NA	NA	NA	7401
2001-2002	0	0	1326	478	222	1167	301	0	0	NA	NA	NA	3494
2000-2001	0	0	384	1302	6014	15379	259	0	0	NA	NA	NA	23338
1999-2000	0	0				1592	250	0	0	NA	NA	NA	1842
Sum	0	0	4027	8226	15088	33006	1853	81	216	0	0	0	62497
Avg	0	0	447	914	1676	3301	185	8	22	0	0	0	6553
%Wr/yr	0.000	0.000	6.828	13.947	25.581	50.364	2.828	0.124	0.330	0.000	0.000	0.000	

Spring-Run (loss)

Year	October	November	Dec	Jan	Feb	March	April	May	June	July	August	September	Sum
2008-2009	0	0	0	0	0	333	5912	2604	4	NA	NA	NA	8853
2007-2008	0	0	0	0	15	315	6918	4673	87	NA	NA	NA	12008
2006-2007	0	0	0	0	7	190	4700	365	0	NA	NA	NA	5262
2005-2006	0	0	0	0	104	1034	8315	3521	668	NA	NA	NA	13642
2004-2005	0	0	0	0	0	1856	10007	1761	639	NA	NA	NA	14263
2003-2004	0	0	0	25	50	4646	5901	960	0	NA	NA	NA	11582
2002-2003	0	0	0	46	57	11400	27977	2577	0	NA	NA	NA	42057
2001-2002	0	0	0	21	8	1245	10832	2465	19	NA	NA	NA	14590
2000-2001	0	0								NA	NA	NA	0
1999-2000										NA	NA	NA	0
Sum	0	0	0	92	241	21019	80562	18926	1417	0	0	0	122257
Avg	0	0	0	12	30	2627	10070	2366	177	0	0	0	15282
%SR/yr	0.000	0.000	0.000	0.075	0.197	17.192	65.896	15.481	1.159	0.000	0.000	0.000	

Steelhead (combined salvage and loss, clipped and non-clipped)

Year	October	November	Dec	Jan	Feb	March	April	May	June	July	August	September	Sum
2008-2009	0	0	0	40	571	1358	210	68	13	7	NA	NA	2267
2007-2008	0	0	0	624	4639	717	300	106	24	15	NA	NA	6425
2006-2007	0	0	10	81	1643	4784	2689	113	20	NA	NA	NA	9340
2005-2006	0	0	0	129	867	3942	337	324	619	NA	NA	NA	6218
2004-2005	0	20	70	120	1212	777	687	159	116	NA	NA	NA	3161
2003-2004	0	12	40	613	10598	4671	207	110	0	NA	NA	NA	16251
2002-2003	0	0	413	13627	3818	2357	823	203	61	NA	NA	NA	21302
2001-2002	0	0	3	1169	1559	2400	583	37	42	NA	NA	NA	5793
2000-2001	0	0	89	543	5332	5925	720	69	12	NA	NA	NA	12690
1999-2000	3	60				1243	426	87	48	NA	NA	NA	1867
Sum	3	92	625	16946	30239	28174	6982	1276	955	22	0	0	85314
Avg	0	9	69	1883	3360	2817	698	128	96	11	0	0	9071
SH%/yr	0.0	0.1	0.8	20.8	37.0	31.1	7.7	1.4	1.1	0.1	0.0	0.0	

c. *Central Valley Steelhead*

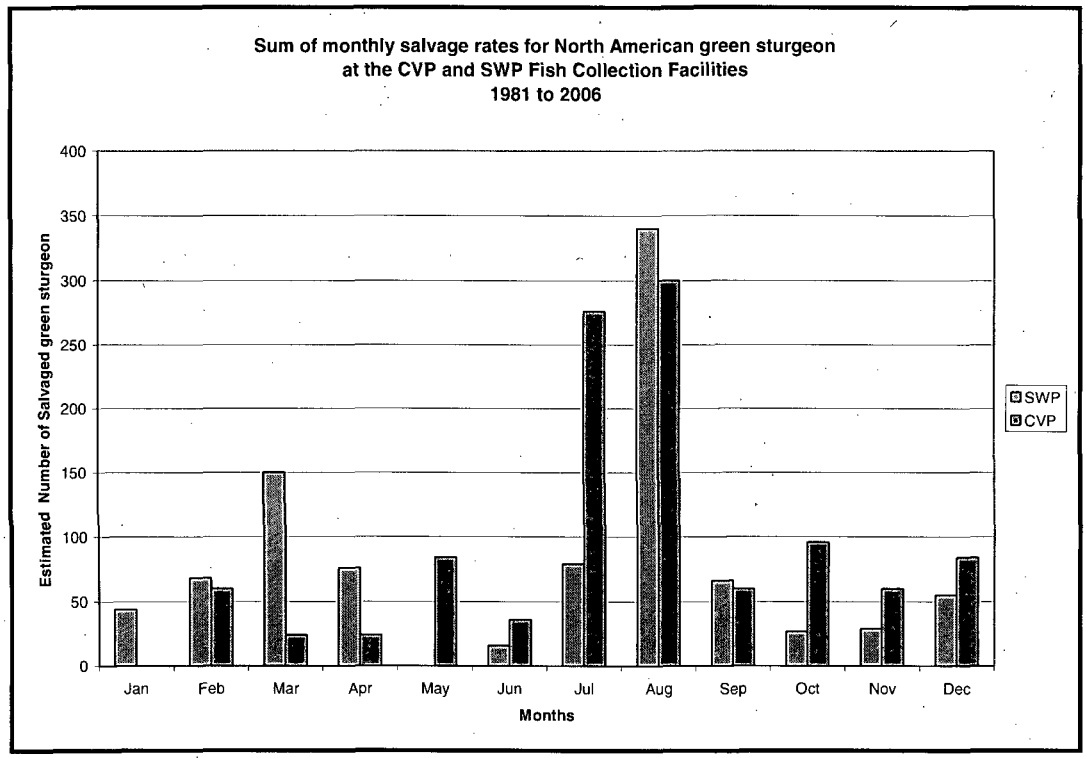
The Central Valley steelhead DPS occurs in both the Sacramento River and the San Joaquin River watersheds. However the spawning population of fish is much greater in the Sacramento River watershed and accounts for nearly all of the DPS' population. Like Sacramento River Chinook salmon, Sacramento River steelhead can be drawn into the south Delta by the actions of the CVP and SWP water diversion facilities. Small, remnant populations of Central Valley steelhead are known to occur on the Stanislaus River and the Tuolumne River and their presence

is assumed on the Merced River due to proximity, similar habitats, and historical presence. Central Valley steelhead smolts first start to appear in the action area in November based on the records from the CVP and SWP fish salvage facilities (Table 8). Their presence increases through December and January (21.6 percent of average annual salvage) and peaks in February (37.0 percent) and March (31.1 percent) before rapidly declining in April (7.7 percent). By June, the emigration has essentially ended, with only a small number of fish being salvaged through the summer at the CVP and SWP. Kodiak trawls conducted by the USFWS and CDFG on the mainstem of the San Joaquin River just above the Head of Old River (HOR) during the Vernalis Adaptive Management Plan (VAMP) experimental period routinely catch low numbers of outmigrating steelhead smolts from the San Joaquin Basin. Monitoring is less frequent prior to the VAMP, therefore emigrating steelhead smolts have a lower probability of being detected. The RST monitoring on the Stanislaus River at Caswell State Park and further upriver near the City of Oakdale indicate that smolt-sized fish start emigrating downriver in January and can continue through late May. Fry sized fish (30 to 50 mm) are captured at the Oakdale RST starting as early as April and continuing through June. Adult escapement numbers have been monitored for the past several years with the installation of an Alaskan style weir on the lower Stanislaus River between Ripon and Riverbank. Typically, very few adult *O. mykiss* have been observed moving upstream past the weir due to the removal of the structure at the end of December. However, in 2006 to 2007, the weir was left in through the winter and spring and seven adult steelhead were counted moving upstream. In the 2009-2010 period, 8 adult *O. mykiss* have moved upstream past the weir as of March 11, 2010. In 2008-2009, 15 adult *O. mykiss* moved upstream past the weir. The weir counts indicate that at least some *O. mykiss* adults are moving upstream from the lower Stanislaus River into upstream areas. These fish, due to their migratory behavior, timing of entrance, and typically larger size would be considered potential steelhead returning to the tributary.

d. *Southern DPS of North American Green Sturgeon*

Juvenile green sturgeons from the Southern DPS are routinely collected at the SWP and CVP salvage facilities throughout the year. However, numbers are considerably lower than for other species of fish monitored at the facilities. Based on the salvage records from 1981 through 2007, green sturgeon may be present during any month of the year, and have been particularly prevalent during July and August (Figure 6). The sizes of these fish are less than 1 meter and average 330 mm with a range of 136 mm to 774 mm. The size range indicates that these are sub-adult fish rather than adult or larval/juvenile fish. It is believed that these sub-adult fish utilize the Delta for rearing for up to a period of approximately 3 years. The proximity of the CVP and SWP facilities to the action area would indicate that sub-adult green sturgeons have a strong potential to be present within the action area.

Figure 6:
Estimated number of North American green sturgeon (Southern DPS) salvaged monthly from the State Water Project and the Central Valley Project fish collection facilities.
Source: CDFG 2002, unpublished CDFG records.



2. Status of Critical Habitat Within the Action Area

The action area is predominately within the Middle San Joaquin – Lower Merced – Lower Stanislaus and the San Joaquin Delta hydrologic units (HU) (18040002 and 18040003, respectively) and is included in the critical habitat designated for Central Valley steelhead. The action area includes the portion of the San Joaquin River from the confluence of the Merced River upstream Mud Slough (north), which is not critical habitat for Central Valley steelhead. This opinion will focus on the mainstem San Joaquin River as well as those waterways in the southern portions of the Delta, which are expected to show expressions of water quality characteristics influenced by discharges originating in the GBP.

The San Joaquin Delta HU is in the southwestern portion of the Central Valley steelhead DPS range and includes portions of the south Delta channel complex. The San Joaquin Delta HU encompasses approximately 938 square miles, with 455 miles of stream channels (at 1:100,000 hydrography). The critical habitat analytical review team (CHART) identified approximately 276 miles of occupied riverine/estuarine habitat in this hydrologic subunit area (HSA) that contained one or more PCEs for the Central Valley steelhead DPS (NMFS 2005b). The PCEs of steelhead habitat within the action area include freshwater rearing habitat, freshwater migration

corridors, and estuarine areas. The essential features of these PCEs included the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, natural levels of predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by Central Valley steelhead juveniles and smolts and for adult upstream migration. No spawning of Central Valley steelhead occurs within the action area.

In regards to the designated critical habitat for the Southern DPS of green sturgeon, the action area includes PCEs concerned with: adequate food resources for all life stages utilizing the Delta, water flows sufficient to allow adults, subadults, and juveniles to orient to flows for migration and normal behavioral responses, water quality sufficient to allow normal physiological and behavioral responses, unobstructed migratory corridors for all life stages utilizing the Delta, a broad spectrum of water depths to satisfy the needs of the different life stages present in the estuary, and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment.

The general condition and function of freshwater rearing and migration habitats has already been described in the *Status of the Species and Critical Habitat* section of this biological opinion. The substantial degradation over time of several of the essential features of these PCEs has diminished the function and condition of the habitats in the action area. This area currently provides only rudimentary functions compared to its historical status. The channels of the Delta have been heavily riprapped with coarse rock slope protection on artificial levee banks and these channels have been straightened to facilitate water conveyance through the system. The extensive riprapping and levee construction has precluded river channel migrations and the formation of natural riverine/estuarine features in the Delta's channels. The natural floodplains have essentially been eliminated, and the once extensive wetlands and riparian zones have been cleared for farming. Little riparian vegetation remains in the Delta, limited mainly to tules growing along the foot of artificial levee banks. Numerous artificial channels also have been created to bring water to irrigated lands that historically did not have access to the river channels (*i.e.*, Victoria Canal, Grant Line Canal, Fabian and Bell Canal, Woodward Cut, *etc.*). These artificial channels have disturbed the natural flow of water through the Delta. As a byproduct of this intensive engineering of the Delta's hydrology, numerous irrigation diversions have been placed along the banks of the flood control levees to divert water from the area's waterways to the agricultural lands of the Delta's numerous "reclaimed" islands. Most of these diversions are not screened adequately to protect migrating fish from entrainment. Sections of the Delta have been routinely dredged by DWR to provide adequate intake depth for these agricultural water diversions, particularly in the south Delta. Likewise, the main channels of the San Joaquin River and the Sacramento River have been routinely dredged by the Corps to create an artificially deep channel to provide passage for ocean going commercial shipping to the Port of Stockton and the Port of Sacramento.

Water flow through the Delta is highly manipulated to serve human purposes. Rainfall and snowmelt is captured by reservoirs in the upper watersheds, from which its release is dictated primarily by downstream human needs. The SWP and CVP pumps draw water towards the

southwest corner of the Delta which creates a net upstream flow of water towards their intake points. Fish, and the forage base they depend upon for food, represented by free floating phytoplankton and zooplankton, as well as larval, juvenile, and adult forms, are drawn along with the current towards these diversion points. In addition to the altered flow patterns in the Delta, numerous discharges of treated wastewater from sanitation wastewater treatment plants (*e.g.*, Cities of Tracy, Stockton, Manteca, Lathrop, Modesto, Turlock, Riverbank, Oakdale, Ripon, Mountain House, and the Town of Discovery Bay) and the untreated discharge of numerous agricultural wasteways are emptied into the waters of the San Joaquin River and the channels of the Delta. This leads to cumulative additions to the system of thermal effluent loads as well as cumulative loads of potential contaminants (*i.e.*, selenium, boron, endocrine disruptors, pesticides, biostimulatory compounds, *etc.*).

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for San Joaquin River basin steelhead. This segment of the Central Valley steelhead DPS must pass through the San Joaquin Delta HSA to reach their upstream spawning and freshwater rearing areas on the tributary watersheds and to pass through the region again during the downstream migrations of both adult runbacks and juvenile smolts. Therefore, it is of critical importance to the long-term viability of the San Joaquin River basin portion of the Central Valley steelhead DPS to maintain a functional migratory corridor and freshwater rearing habitat through the action area and the San Joaquin Delta HSA.

B. Factors Affecting the Species and Habitat in the Action Area

The action area encompasses a small portion of the area utilized by the Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon ESUs, Central Valley steelhead DPS, and the Southern DPS of North American green sturgeon. Many of the range-wide factors affecting these species are discussed in the *Status of the Species and Critical Habitat* section of this biological opinion, and are considered the same in the action area. This section will focus on the specific factors in the action area that are most relevant to the proposed execution of the SLWD and PWD Interim Renewal Contracts.

The magnitude and duration of peak flows during the winter and spring, which affects listed salmonids in the action area, are reduced by water impoundment in upstream reservoirs. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (*i.e.*, levees) and low lying terraces under cultivation (*i.e.*, orchards and row crops) in the natural floodplain along the basin tributaries. Consequently, managed flows in the main stem of the river often truncate the peak of the flood hydrographs and extend the releases from basin reservoirs over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize sediments and create natural riverine morphological features within the action area. Furthermore, the unimpeded river flow in the San Joaquin River basin is severely reduced by the combined storage capacity of the different reservoirs located throughout the basin's watershed. Very little

of the natural hydrologic input to the basin is allowed to flow through the reservoirs to the valley floor sections of the tributaries leading to the Delta. Most is either stored or diverted for anthropogenic uses. Elevated flows on the valley floor are typically only seen in wet years or flood conditions, when the storage capacities of the numerous reservoirs are unable to contain all of the inflow from the watersheds above the reservoirs.

High water temperatures also limit habitat availability for listed salmonids in the San Joaquin River and the lower portions of the tributaries feeding into the mainstem of the river. High summer water temperatures in the lower San Joaquin River frequently exceed 72°F (CDEC database), and create a thermal barrier to the migration of adult and juvenile salmonids.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and shaded riverine aquatic (SRA) cover. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the cumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach (USFWS 2000). Armored embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat. Impacts at the reach level result primarily from halting erosion and controlling riparian vegetation. Reach-level impacts which cause significant impacts to fish are reductions in new habitats of various kinds, changes to sediment and organic material storage and transport, reductions of lower food-chain production, and reduction in LWD.

The use of rock armoring limits recruitment of LWD (*i.e.*, from non-riprapped areas), and greatly reduces, if not eliminates, the retention of LWD once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of LWD to become securely snagged and anchored by sediment. LWD tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place for extended periods to generate maximum values to fish and wildlife (USFWS 2000). Recruitment of LWD is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows (USFWS 2000). Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectedness of remaining near shore refuge areas.

PS and NPS of pollution resulting from agricultural discharge and urban and industrial development occur upstream of, and within the action area. The effects of these impacts are discussed in detail in the *Status of the Species and Critical Habitat* section. Environmental stresses as a result of low water quality can lower reproductive success and may account for low productivity rates in fish (*e.g.* green sturgeon, Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element (*i.e.*, heavy metals) concentrations may deleteriously affect early life-stage survival of fish in the Central Valley watersheds (USFWS 1995b). Other impacts to adult migration present in the action area, such as migration barriers, water conveyance factors, water quality, NIS, *etc.*, are discussed in the *Status of Species and Critical Habitat* section.

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. §1536). This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This biological opinion assesses the effects of the proposed action on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, the threatened Southern DPS of North American green sturgeon, and designated critical habitat for Central Valley steelhead and the Southern DPS of North American green sturgeon.

In the *Description of the Proposed Action* section of this biological opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this biological opinion, NMFS provided an overview of the threatened and endangered species and critical habitat that are likely to be adversely affected by the activity under consultation.

NMFS generally approaches the "jeopardy" and critical habitat modification analyses in a series of steps. First, NMFS evaluates the available evidence to identify direct and indirect physical, chemical, and biotic effects of the proposed action on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once NMFS has identified the effects of the action, the available evidence is evaluated to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; or decreasing the age at which individuals stop reproducing). The available evidence is then used to determine if these reductions, if there are any, could

reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

1. Information Available for the Assessment

To conduct the assessment, NMFS examined evidence from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents, including peer-reviewed scientific journals, primary reference materials, governmental and non-governmental reports, and scientific meetings as well as the supplemental material provided by BOR in response to questions asked by NMFS.

2. Assumptions Underlying This Assessment

In the absence of definitive data or conclusive evidence, NMFS must make a logical series of assumptions to overcome the limits of the available information. These assumptions will be made using sound, scientific reasoning that can be logically derived from the available information. The progression of the reasoning will be stated for each assumption, and supporting evidence cited.

B. Assessment

The proposed action is the execution of interim water service contracts for the continued delivery of the same quantities of CVP water to the same lands currently covered under the existing long-term water service contracts for the San Luis and Panoche Water Districts. The new interim contracts would extend these agreements for a period of up to 24 months. The proposed action does not require the construction of any new facilities, the installation of any new structures, or the modification of existing facilities, but operational aspects of these continued water deliveries may adversely affect several life stages of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon in the action area. Adverse effects to these species and their habitat may result from changes in water quality resulting from the discharge of subsurface agricultural drainage water originating from within the San Luis and Panoche water districts. The execution of the Interim Renewal Contracts includes continuing implementation of the Westside Regional Drainage Plan and participation in programs such as the Grasslands Bypass Project, with the overall objective of reducing the amount of selenium entering the waterways of the San Joaquin Valley over time and thereby minimizing the potential impacts to water quality associated with agricultural drainage discharges to the San Joaquin River.

1. Presence of Listed Salmonids and North American Green Sturgeon in the Action Area

Adult Sacramento winter-run and Central Valley spring-run Chinook salmon migrate through the Delta on their way to upstream spawning sites in the Sacramento River and its tributaries. Adult winter-run fish are most likely to be present in the action area, specifically in the Delta, between November and May while spring-run adults are most likely to occur from late January through May. Timing of juvenile emigration for both species through the action area on their way to the sea is highly variable depending on water flows and temperatures, but the highest occurrence of

rearing juveniles of both ESUs in the Delta generally occurs between November and May. Therefore both adult and juvenile winter and spring-run Chinook salmon pass through the action area and will be exposed to project related effects for a brief period during either their migration to upstream spawning sites or out to sea. The project related effects, namely selenium exposure originating from SLWD and PWD agricultural runoff, are present in the Delta where winter- and spring-run Chinook salmon are known to occur; however, the selenium levels in the areas where winter- and spring-run Chinook salmon are known to occur are diluted to levels of 0.4 ppb or less, according to the supplemental information provided by BOR. Due to the fact that adults migrating upstream do not forage, and the juveniles that enter the action area do not remain there for more than a short period of time and have likely been diverted off their typical migration route to sea, it is unlikely that project related effects will result in adverse effects to either of these ESUs.

An experimental population of Chinook salmon will be present in the upper reaches of the San Joaquin River no later than December 31, 2012, as part of the SJRRP. Pursuant to ESA section 10(j), with limited exceptions, each member of an experimental population shall be treated as a threatened species. The re-introduction of Chinook salmon and the specific processes therein are currently under development. It is reasonable to assume that reintroduced Chinook salmon juveniles will be present in the San Joaquin River and within the action area (*i.e.*, between Mud Slough and the confluence of the Merced River) potentially during the latter six months of this IRC. According to the San Joaquin River Restoration Act under the Omnibus Public Land Management Act of 2009, Title X, section 10011(c)(2), the Secretary of Commerce will issue a final rule pursuant to section 4(d) of the ESA governing the incidental take of reintroduced Central Valley spring-run Chinook salmon prior to the reintroduction. Furthermore, Title X, section 10011(c)(3) of the Act states that the rule issued under paragraph 2 shall provide that the reintroduction will not impose more than *de minimus*: water supply reductions, additional storage releases, or bypass flows on unwilling third parties due to such reintroduction.

Adult Central Valley steelhead begin to migrate into the region's watersheds (San Joaquin, Stanislaus, Tuolumne, and Merced rivers) during the period between September and the end of December, particularly when increased flows are being released from San Joaquin River reservoirs to enhance fall-run Chinook salmon spawning habitat in the San Joaquin River tributaries or when early winter rains cause increased flows in the system. The peak of juvenile Central Valley steelhead emigration from their tributaries in the San Joaquin Valley occurs during the period between February and May. There are, however, larger steelhead smolts that migrate at other times of the year, including the fall and early winter period (S.P. Cramer and Associates 2005), and thus may be exposed to the project related effects during their passage through the action area as well. Depending on Hills Ferry Barrier operations, it is reasonable to assume that Central Valley steelhead may have access to the San Joaquin River upstream of the confluence of the Merced River, as a result of the SJRRP, within the time period of this IRC.

Low numbers of North American green sturgeon are anticipated to be present in the action area throughout the year, and in the case of rearing juveniles they may be present for up to 3 or 4 years before emigrating to the ocean. Although information on the density of green sturgeon in the action area is not currently available, their infrequent occurrence in sampling studies

targeting other fish species indicates that they may be present throughout the year within the mainstem of the San Joaquin River and thus vulnerable to the adverse effects of the project.

2. Effects of the Action on Listed Species

The San Luis and Panoche Water Districts discharge subsurface drainwater into drainage district conveyance facilities owned and operated by the Charleston and Panoche Drainage Districts, respectively. Both drainage districts prohibit the discharge of surface return flows into their systems, but occasionally storm events generate substantial surface runoff from agricultural areas that will enter regional conveyances and eventually reach natural streams, including Mud Slough, the San Joaquin River, and the Delta. The RWQCB issued waste discharge requirements for the Grassland Bypass Project that conveys the subsurface drainage delivered by the Charleston and Panoche Drainage Districts into natural waterways, establishing a performance goal of 5 ppb monthly mean selenium for the San Joaquin River below the Merced River for critical, dry, and below normal water year types, and 5ppb 4-day average during normal and wet years. In addition, the RWQCB adopted Resolution Number R5-2010-0046 on October 5, 2010, which extended the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) upstream beyond the previous point on the San Joaquin River at the confluence with the Merced River. The resolution provides an interim performance measure of 15 ppb monthly average through December 31, 2015, for the San Joaquin River at the confluence of the Merced River upstream to Mud Slough (north). By December 31, 2019, the 5 ppb 4-day average must be met in Mud Slough (north) and the San Joaquin River above the confluence of the Merced River. The 5 ppb RWQCB performance criteria for selenium may exceed toxic effect levels for listed salmonids and sturgeon (Beckon 2008a, 2008b); therefore, listed species may also be negatively affected by the 15 ppb monthly average interim performance criteria.

Since its inception in 1996, the Grasslands Bypass Project has been successful in helping to achieve RWQCB goals of reducing selenium inputs to the San Joaquin River by consolidating, storing, reusing, and ultimately reducing subsurface drainage waters from the participating water districts. Nevertheless, selenium concentrations in the San Joaquin River and Delta continue to rise over time due to its prevalence in the soils derived from organic-rich shales throughout the semi-arid San Joaquin Valley, as well as the persistent and additive nature of this element once it enters the aquatic environment.

Selenium efficiently bioaccumulates through aquatic food webs, and strongly biomagnifies into many components of the food web including primary producers, invertebrates, bivalves, fish, and birds. Dietary uptake of selenium through lower trophic level prey species and progressive biomagnification through the food web is the primary pathway for the disproportionately large bioaccumulation of selenium to higher trophic level predator species. Selenium is an essential element necessary for the production and proper functioning of important enzymes, however it rapidly surpasses required concentrations becoming toxic and resulting in dysfunctional enzymes and disrupted proteins that can lead to reproductive failure and teratogenesis (*i.e.*, deformities in developing young), and in cases of extreme contamination can lead to death of adult organisms. Concentrations of selenium greater than 3 µg/g in the diet of fish result in deposition of elevated concentrations in developing eggs, particularly in the yolk, and dietary selenium concentrations

of 5 to 20 µg/g load eggs beyond the teratogenic threshold (Luoma and Presser 2000). In experiments conducted by Silvestre *et al.* (2010), larval green sturgeon were significantly more sensitive to temperature and selenium stress than white sturgeon. Different predator species have variable accumulation rates of dietary selenium, probably due to the types of prey they consume. Generally, benthic feeding fish have higher selenium concentrations than predators that feed from the water column. Of particular concern are benthic feeding predators that consume bivalves in their diet, especially the Asian clam *Potamocorbula amurensis*, an invasive species that has displaced several other resident species of bivalve in the Delta, and exhibits concentrations of selenium that regularly exceed the thresholds for chronic toxicity in the food of birds and fish (i.e., > 10 µg/g).

There is no information available on the concentration of selenium in listed salmonids and green sturgeon tissue in the action area, and no way of determining to what extent the drainwater contributed by the irrigation returns from the San Luis and Panoche Water Districts might contribute to those selenium levels. However, given the fact that the drainwater from these districts is known to contain elevated levels of selenium, and the listed species occur (and feed) in the area where this drainwater is discharged into critical habitat, NMFS must make the assumption that the continuation of this situation, made possible by the proposed execution of interim water service to the San Luis and Panoche Water Districts for a period of 24 months, will result in adverse effects on listed salmonids and green sturgeon. Given the data previously described on the general effects of elevated selenium levels on fish (Luoma and Presser 2000), NMFS concludes that the response of Central Valley steelhead and the southern DPS of North American green sturgeon to the effects of the proposed action are likely to include physiological stress to the extent that the normal behavior patterns (*e.g.*, feeding, sheltering and migration) of affected individuals may be disrupted. Overall, an increased availability of selenium in prey items is expected to affect reproductive success, juvenile survival, and behavioral responses that may lead to decreased swimming performance and increased predation rates for juveniles. Because sturgeon may spend a period of years in the action area rearing before migrating to the ocean, are demersal fish closely associated with the bottom substrate, feed by taste and feel with their barbels, and even shovel up sediment with their snouts when searching for food, it is likely that they would be subjected to a higher risk of exposure to the effects of increased selenium in their diet.

Implementing the RWQCB performance criteria of 5 ppb over a 4-day average on the San Joaquin River below the confluence with the Merced River is a good-faith effort to reduce selenium concentration in the San Joaquin Basin and Delta; however, it does not eliminate the potential for take to occur to listed species within the action area. The continued participation in the Grasslands Bypass Project and implementation of the strategies developed in the Westside Regional Drainage Plan minimize the amount of selenium entering the San Joaquin River as a result of agricultural drainage.

3. Impacts to Critical Habitat

There are no suitable spawning sites within the project's action area for Central Valley steelhead or the Southern DPS of North American green sturgeon and migration routes will not be obstructed by the proposed action. Therefore the PCEs of Central Valley steelhead designated

critical habitat that will be affected by the execution of the SLWD and PWD IRCs are freshwater rearing habitat, and water quality in estuarine areas along the migration routes and juvenile rearing sites in the Delta and lower San Joaquin River. The PCEs of critical habitat for the Southern DPS of North American green sturgeon that will be affected by the execution of the SLWD and PWD IRCs are freshwater food resources, water quality, and sediment quality of the freshwater riverine systems along the migration routes and juvenile rearing sites in the Delta and lower San Joaquin River. Any continued contributions of selenium from agricultural subsurface drainage and occasional storm flow runoff will be additive to the available load already present in the water, sediment, and prey items of the south Delta for both juvenile and adult steelhead and green sturgeon during the course of the two year period that the contracts would authorize continued water deliveries to the water districts.

Due to the relatively short time period (*i.e.*, two years) for which the IRCs would authorize continued deliveries of water to the San Luis and Panoche Water Districts, and the degree to which selenium contributions would be made from agricultural subsurface drainage and occasional storm flow runoff from these two districts relative to the contributions of other watersheds throughout the region, the above described impacts from the execution of the SLWD and PWD IRCs to food resources, water quality, and sediment quality are not expected to significantly impact or appreciably reduce the value of the designated critical habitat for the conservation of the listed species in the action area.

VI. CUMULATIVE EFFECTS

For purposes of the ESA, cumulative effects are defined as the effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultations pursuant to section 7 of the ESA.

A. Agricultural Practices

Agricultural practices in and upstream of the San Joaquin River may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the San Joaquin River. Agricultural practices in the Delta may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Delta. Unscreened agricultural diversions throughout the Delta entrain fish including juvenile salmonids. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the San Joaquin River and Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

B. Increased Urbanization

The Delta, East Bay, and Sacramento regions, which include portions of Contra Costa, Alameda, Sacramento, San Joaquin, Solano, Stanislaus, and Yolo counties, are expected to increase in population by nearly 3 million people by the year 2020. Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. For example, the General Plans for the cities of Stockton, Brentwood, Lathrop, Tracy and Manteca and their surrounding communities anticipate rapid growth for several decades to come. City of Manteca (2007) anticipated 21 percent annual growth through 2010 reaching a population of approximately 70,000 people. City of Lathrop (2007) expects to double its population by 2012, from 14,600 to approximately 30,000 residents. The anticipated growth will occur along both the I-5 and US-99 transit corridors in the east and Highway 205/120 in the south and west. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased wave action and propeller wash in San Joaquin River due to increased recreational boating activity. This potentially will degrade riparian and wetland habitat by eroding channel banks, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids. Increased recreational boat operation on the San Joaquin River is anticipated to result in more contamination from the operation of engines on powered craft entering the river and its tributaries. In addition to recreational boating, commercial vessel traffic is expected to increase with the redevelopment plans of the Port of Stockton. Portions of this redevelopment plan have already been analyzed by NMFS for the West Complex (formerly Rough and Ready Island) but the redevelopment of the East Complex, which currently does not have a Federal action associated with it, will also increase vessel traffic as the Port becomes more modernized. Commercial vessel traffic is expected to create substantial entrainment of aquatic organisms through ship propellers as the vessels transit the shipping channel from Suisun Bay to the Port and back again. In addition, the hydrodynamics of the vessel traffic in the confines of the channel will create sediment re-suspension, and localized zones of high turbulence and shear forces. These physical effects are expected to adversely affect aquatic organisms, including both listed salmonids and North American green sturgeon resulting in death or injury.

C. Global Climate Change

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change [IPCC] 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic

changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting salmonid PCEs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the Central Valley has been modeled to have an increase of between 2°C and 7°C by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheenen *et al.* 2004, Dettinger 2005), with a drier hydrology predominated by precipitation rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This should truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.* Sacramento River winter-run Chinook salmon and Central Valley steelhead) that must hold below the dam over the summer and fall periods.

Within the context of the brief period over which the proposed project is scheduled to be operated, however, the near term effects of global climate change are unlikely to result in any perceptible declines to the overall health or distributions of the listed populations of anadromous fish within the action area that are the subject of this consultation.

VII. INTEGRATION AND SYNTHESIS

This section integrates the current conditions described in the environmental baseline with the effects of the proposed action and the cumulative effects of future actions. The purpose of this synthesis is to develop an understanding of the likely short-term and long-term responses of listed species and critical habitat to the proposed project.

The San Joaquin River basin historically contained numerous independent populations of Central Valley steelhead and spring-run Chinook salmon (Lindley *et al.* 2006a, 2007). Southern DPS green sturgeon were also potentially present in these watersheds prior to anthropogenic changes. The suitability of these watersheds to support these runs of fish changed with the onset of human activities in the region. Human intervention in the region initially captured mountain runoff in foothill reservoirs which supplied water to farms and urban areas. As demand grew, these reservoirs were enlarged or additional dams were constructed higher in the watershed to capture a larger fraction of the annual runoff. San Joaquin Valley agriculture created ever greater demands on the water captured by these reservoirs, diminishing the flow of water remaining in the region's rivers, and negatively impacting regional populations of salmonids (and likely green sturgeon, too). Reclamation actions eliminated vast stretches of riparian habitat and seasonal floodplains from the San Joaquin River watershed and Delta through the construction of levees and the armoring of banks with rock riprap for flood control. Construction of extensive water conveyance systems and water diversions altered the flow characteristics of the Delta region. These anthropogenic actions resulted in substantial degradation of the functional characteristics of the aquatic habitat in the watershed upon which the region's salmonids (and potentially green sturgeon) depended on to maintain healthy populations.

Both adult and juvenile winter and spring-run Chinook salmon pass through the action area and will be exposed to project-related effects for a brief period during either their migration to upstream spawning sites or out to sea. However, selenium levels are expected to remain at low concentrations and may decrease for the duration of the proposed action in the areas that winter- and spring-run Chinook salmon are known to occur. Due to the fact that adults migrating upstream do not forage, and the juveniles that enter the action area do not remain there for more than a short period of time and have likely been diverted off their typical migration route to sea, it is unlikely that project related effects will result in adverse effects to either of these ESUs.

Presently, populations of Central Valley spring-run Chinook salmon have been functionally extirpated from the San Joaquin River basin. Populations of Central Valley steelhead in the San Joaquin River basin have been substantially diminished to only a few remnant populations in the lower reaches of the Stanislaus, Tuolumne, and Merced Rivers below the first foothill dams. Southern DPS of green sturgeon have not been documented utilizing the San Joaquin River as a spawning river in recorded history but human alterations, which have been ongoing for over 100 years in the watershed, may have extirpated these populations before accurate records were maintained. However, fish survey records indicate that juvenile and sub-adult green sturgeon make use of the lower San Joaquin River for rearing purposes during the first several years of their life. Since the viability of small remnant populations of Central Valley steelhead in the San Joaquin River basin is especially tenuous and such populations are susceptible to temporally

rapid decreases in abundance and possess a greater risk of extinction relative to larger populations (Pimm *et al.* 1988, Berger 1990, Primack 2004), activities that reduce quality and quantity of habitats, or that preclude formation of independent population units (see the representation and redundancy rule cited by Lindley *et al.* 2007), are expected to reduce the viability of the overall DPS if individual populations within the larger metapopulation become extinct (McElhany *et al.* 2000). Therefore, if activities have significant impacts on steelhead populations or destroy necessary habitat, including designated critical habitat, within these San Joaquin populations, they could have significant implications for the DPS as a whole.

Central Valley Steelhead

Estimates of adult escapement of steelhead to these watersheds are typically only a few dozen per year. This is reflected by the low number of smolts captured by monitoring activities throughout the year in different tributaries (*i.e.*, rotary screw traps on the Stanislaus, Tuolumne, Merced, and Calaveras rivers, and the Mossdale trawls on the San Joaquin River below the confluence of these three east side tributaries) in which only a few dozen smolts to several hundred smolts are collected each year (Marston 2004, S.P. Cramer and Associates 2005). These capture numbers have been extrapolated to estimate an annual population of only a few thousand juvenile steelhead smolts basin-wide in the San Joaquin River region. The Stanislaus River weir, which is used to count adult steelhead passing through the counting chamber or dead carcasses floating back onto the weir, has only recorded a few adult fish each year it has been in use. This is indicative of the low escapement numbers for adult steelhead in this watershed (S.P. Cramer and Associates 2005). The other San Joaquin tributaries are thought to have similar or even lower numbers based on the superiority of the Stanislaus River in terms of habitat and water quality for Central Valley steelhead.

While the geographic isolation of the San Joaquin Basin populations helps to support the viability of the overall DPS, the extremely low juvenile production from the San Joaquin Basin, when compared to the Sacramento Basin, provides a very small contribution to the overall survival of the DPS. It is also likely that these small San Joaquin populations receive significant supplementation from the larger Sacramento River populations through straying by the overwhelmingly dominant Sacramento Basin populations, so that the loss of a few steelhead from the San Joaquin watershed is not expected to reduce the likelihood of survival and recovery of the Central Valley steelhead DPS overall.

Southern DPS of North American Green Sturgeon

Little is known about the migratory habits and patterns of adult and juvenile green sturgeon in the San Joaquin watershed. The basic pattern described for adult green sturgeon migrations into the Delta region from the San Francisco Bay estuary is that fish enter the Delta region starting in late winter or early spring and migrate upstream towards the stretch of the Sacramento River between Red Bluff and Keswick Dam. After spawning, adults return downstream and re-enter the Delta towards late summer and fall (based on behavior of sturgeon in the Klamath and Rogue River systems). Juvenile and larval green sturgeon begin to show up in rotary screw trap catches along the Sacramento River starting in summer (Beamesderfer *et al.* 2004) and could be expected to reach the Delta by fall. The extent and duration of these fish entering and remaining

in the San Joaquin River within the action area is unclear, but because of the habitat similarities and lack of barriers between the action area and documented sturgeon habitat in the Delta, NMFS believes that green sturgeon, including sub-adults, could be found at low densities during any month of the year within the action area. Both adult and juvenile green sturgeon feed on benthic invertebrates and would therefore have an increased potential to be adversely affected by exposure to increasing concentrations of dietary selenium in their prey base through a portion of their rearing habitat for a period of up to 3 years. However, because the Southern DPS of North American green sturgeon are only known to spawn in the Sacramento River, a small proportion of the overall DPS are expected to occur in the San Joaquin River drainage and be exposed to the adverse effects of the project.

Designated Critical Habitat

The evidence presented in the Environmental Baseline section indicates that past and present activities within the San Joaquin River basin and waters of the south Delta have caused significant habitat loss, degradation, and fragmentation. This has significantly reduced the quality and quantity of the remaining freshwater rearing sites and the migratory corridors within the lower valley floor reaches of the San Joaquin River and the south Delta for the populations of Central Valley steelhead and the Southern DPS of North American green sturgeon that utilize this area. Alterations in the geometry of the south Delta channels, removal of riparian vegetation and shallow water habitat, construction of armored levees for flood protection, changes in river flow created by demands of water diverters, and the influx of contaminants from agricultural and urban dischargers have also substantially reduced the functionality of the region's waterways. Additional losses of freshwater spawning sites, rearing sites, and migratory corridors have occurred upstream of the action area in the tributaries of the San Joaquin and Sacramento River basins, but are outside of the action area of this consultation.

Summary

In general, indirect, project-related, adverse effects to steelhead and green sturgeon in the San Joaquin River and southern Delta will be in the form of degraded sediment and water quality, as well as by contribution to the amount of selenium available to these species through prey items found in the action area. In this area, adult and juvenile steelhead are primarily expected to begin entering the action area during late November and December, when cool and rainy weather is likely to promote upstream migration by adults, and downstream emigrating by juveniles through the action area in March and April. As a result, the exposure time of Central Valley steelhead to project related effects are expected to be limited to a period of weeks to months as they pass through the Delta on their way to upstream spawning locations and as juveniles emigrating to the ocean. Green sturgeon presence within the action area is considered to be year-round, with juveniles entering the Delta during the late summer and fall and potentially rearing there for several months to years before migrating to the ocean.

A. Effects of the Proposed Action on Listed Species

As a result of the proposed SLWD and PWD IRC executions, adverse impacts to the Southern DPS of North American green sturgeon and Central Valley steelhead stemming from the contamination of rearing and migrating habitat and food resources are expected to occur. These impacts may cause physiological stress to the extent that the normal behavior patterns (*e.g.*, feeding, sheltering and migration) of affected individuals may be disrupted. Overall, the changes in water quality associated with this project are expected to adversely affect listed species primarily by low-level alteration of habitat conditions, which may contribute to an increased availability of selenium in prey items potentially affecting reproductive success, juvenile survival, and behavioral responses that may lead to decreased swimming performance and increased predation rates for juveniles. Because sturgeon may spend a period of years in the action area rearing before migrating to the ocean, are demersal fish closely associated with the bottom substrate, feed by taste and feel with their barbels, and even shovel up sediment with their snouts when searching for food, it is likely that they would be subjected to a higher risk of exposure to the effects of increased selenium in their diet expected to be produced by the proposed project. Potential impacts are expected to be minimized by meeting Regional Water Quality Control Board water quality objectives for agricultural subsurface drainage entering the San Joaquin River and continuing to participate in the Grasslands Bypass Project and implementing the strategies developed in the Westside Regional Drainage Plan for reducing the amount of selenium entering the San Joaquin River as a result of agricultural drainage.

B. Effects of the Proposed Action on Listed Species Likelihood of Survival and Recovery

1. Central Valley Steelhead

NMFS anticipates that the proposed project will result in the exposure of adult and juvenile Central Valley steelhead to increased levels of selenium in the waters and prey items of the south Delta where they migrate and rear. Exposure to this contaminant is expected to adversely affect a small number of individuals for a relatively short duration of time because the fish do not spend more than a few weeks to months in the action area during their life time. Adverse effects directly attributable to the proposed action are expected to be minor because contributions of drainage from these water districts meet RWQCB standards, and because the interim renewal contracts authorize these continued discharges from the SLWD and PWD for a period of not more than 24 months. It should be noted that RWQCB standards may not provide adequate protection to migrating steelhead if they will have access above the confluence of the Merced River and below Mud Slough (north). Currently the Hills Ferry Barrier is operated by the California Department of Fish and Game to keep fall-run Chinook salmon out of this reach; therefore, it also functions to exclude most of the migrating adult steelhead. The recently adopted interim performance measure (15ppb monthly average through December 31, 2015) for the section of the San Joaquin River between the confluence of the Merced River and Mud Slough (north) is above toxicity thresholds for steelhead. Small numbers of direct mortality of juvenile or adult fish may occur in this section of the San Joaquin River if individuals remain in that reach of the river for a long time period. The elevated stress levels may degrade the fish's health and the reproductive potential of adults, and increase the potential of juveniles to be preyed upon by striped bass or other large predators due to impaired behavioral and

physiological responses. Individuals that appear different in their behavior attract predators, and thus experience higher mortality due to predator attraction. Even so, given the uncertain nature of the actual effects of the proposed project on steelhead in the action area, it is expected that these short-term effects, when considered in the context of the current baseline and likely future cumulative effects, would not appreciably reduce the likelihood of survival and recovery of the Central Valley steelhead DPS throughout its range.

2. Southern DPS of North American Green Sturgeon

Due to the lack of general abundance of information regarding the Southern DPS of North American green sturgeon, a variety of estimates must be utilized to determine the range of potential effects resulting from the take of green sturgeon due to the proposed action. Compared to the estimated population sizes suggested by the CDFG tagging efforts (CDFG 2002), juvenile and sub-adult captures passing Red Bluff Diversion Dam, and past IEP sampling efforts, the low level of take estimated from the proposed project would impact a small proportion of the adult and sub-adult North American green sturgeon DPS in the Sacramento River watershed. Ratios of tagged white to green sturgeon in San Pablo Bay have generated population estimates averaging 12,499 sub-adult and adult green sturgeon. Captures of juvenile and sub-adult green sturgeon passing Red Bluff Diversion Dam have exceeded 2,000 individuals in some years. Execution of the proposed SLWD and PWD IRCs would only authorize continued discharges of agricultural subsurface drainage to the San Joaquin River for a period of 24 months. Incidental take of both adult and juvenile North American green sturgeon is expected to represent a small proportion of the standing population and is not expected to appreciably reduce the likelihood of survival and recovery of the Southern DPS of North American green sturgeon.

C. Effects of the Proposed Action on Critical Habitat

The PCEs of designated Central Valley steelhead critical habitat that will be adversely affected by the proposed action include the food resources, water quality, and sediment quality of freshwater rearing sites for juveniles and freshwater migration corridors for both juveniles and adults.

The PCEs of proposed critical habitat for the Southern DPS of North American green sturgeon that will be adversely affected by the proposed action include the food resources, water quality, and sediment quality of freshwater riverine systems where juveniles rear for a period of up to 3 years, and through which both adults and juveniles migrate.

These effects to the PCEs of critical habitat may result in increased exposure of listed fish to selenium concentrations in the south Delta where they spend a portion of their life rearing and feeding before entering the ocean. However, NMFS expects that nearly all of the adverse effects to critical habitat from this project will be minimal in scope while RWQCB standards on the San Joaquin River downstream from the confluence of the Merced River are being met, when combined with the observed levels of dilution downstream of tributary inputs. In addition, there is a declining trend of selenium loading to the system in the future, including the time period of these Interim Renewal Contracts. Furthermore, due to the minimal amounts of agricultural subsurface drainage originating from the San Luis and Panoche water district lands, and the

limited period of 24 months that those discharges would be permitted, the adverse effects that are anticipated to result from the proposed project are not of the type, duration, or magnitude that would be expected to adversely affect critical habitat to the extent that it could lead to an appreciable reduction in the function and value of the affected habitat for the conservation of these species.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon, the environmental baseline, the effects of the proposed execution of the San Luis Water District and Panoche Water District Interim Renewal Contracts, and the cumulative effects, it is NMFS' biological opinion that the implementation of the SLWD and PWD IRCs, as proposed, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead or the Southern DPS of North American green sturgeon, nor will it result in the destruction or adverse modification of designated critical habitat for Central Valley steelhead or the Southern DPS of North American green sturgeon.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by BOR so that they become binding conditions of any contracts or permits, as appropriate, for the exemption in section 7(o)(2) to apply. BOR has a continuing duty to regulate the activity covered by this incidental take statement. If BOR (1) fails to assume and implement the terms and conditions or (2) fails to require the San Luis and Panoche Water Districts to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, BOR and/or the San Luis and Panoche Water Districts must report the

progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

While some measures described below are expected and intended to avoid, minimize, or monitor the take of North American green sturgeon, the prohibitions against taking of endangered species in section 9 of the ESA do not automatically apply to threatened species such as the recently listed southern DPS of North American green sturgeon. However, on June 2, 2010, a final rule pursuant to ESA section 4(d) was published (75 FR 30714) which defines and dictates the prohibitions against taking this threatened DPS. Therefore, NMFS advises BOR to implement the following reasonable and prudent measures for North American green sturgeon. Because the final 4(d) rule has been adopted, these measures, with their implementing terms and conditions, will be nondiscretionary for North American green sturgeon.

A. Amount or Extent of Take

NMFS anticipates incidental take of Central Valley steelhead and North American green sturgeon in the San Joaquin River and south Delta as a result of increased selenium contamination in those waters through which they migrate and where juveniles of the species rear. Specifically, NMFS anticipates that juvenile and adult steelhead and green sturgeon may be adversely affected by increasing exposure to elevated levels of selenium which may impair the reproductive success, growth, and survival of these species in the wild.

NMFS cannot, using the best available information, specifically quantify the anticipated amount of incidental take of individual Central Valley steelhead and North American green sturgeon because of the variability and uncertainty associated with the response of listed species to the effects of the project, the varying population size of each species, annual variations in the timing of spawning and migration, and individual habitat use within the project area. However, it is possible to designate ecological surrogates for the extent of take anticipated to be caused by the project, and to monitor those surrogates to determine the level of take that is occurring. The most appropriate ecological surrogates for the extent of take caused by the project are the measured concentrations of selenium in Mud Slough and the San Joaquin River, and the continued participation by the San Luis and Panoche water districts in the Grasslands Bypass Project.

1. Ecological Surrogates

- The analysis of the effects of the proposed project anticipates that measured selenium concentrations in Mud Slough and the San Joaquin River will continue to meet the RWQCB waste discharge requirements for the Grasslands Bypass Project identified in the *Effects of the Action* section, and that occurrences exceeding those thresholds will be limited to the influence of overland flow resulting from major storm events. NOTE: the RWQCB interim criteria of a 15 ppb monthly average for selenium from Mud Slough (north) downstream to the confluence of the Merced River is not protective of listed anadromous species that may be present within that area.

- The analysis of the effects of the proposed project anticipates that the San Luis and Panoche water districts will continue to participate in the Grasslands Bypass Project throughout the life of the contracts, thereby minimizing the volume and concentrations of selenium introduced into the habitat of listed species as a result of agricultural discharges from their districts.

If the specific parameters of these ecological surrogates are not met, the proposed project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the project.

B. Effect of the Take

In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

C. Reasonable and Prudent Measures

NMFS has determined that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the incidental take of listed anadromous fish. These reasonable and prudent measures also would minimize adverse effects on designated critical habitat.

1. Measures shall be taken to minimize the amount of agricultural subsurface drainage discharged to the San Joaquin River from the San Luis and Panoche water districts.

2. Measures shall be taken to ensure the continued participation in the Grasslands Bypass Project for the duration of the Interim Renewal Project.

3. Measures shall be taken to protect Central Valley steelhead from high selenium pulses in the San Joaquin River above the confluence with the Merced River through the operation of the Hills Ferry Barrier.

4. Measures shall be taken to assess and monitor the concentrations of selenium within the waters, sediments, vegetation, and invertebrates of the San Joaquin River as well as in the mouths of Salt Slough and Mud Slough (north) to assess the selenium contributions from each pathway.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, BOR must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary and must be incorporated as binding conditions of any contracts or permits between BOR and the San Luis and Panoche water districts.

1. Measures shall be taken to minimize the amount of agricultural subsurface drainage discharged to the San Joaquin River from the San Luis and Panoche water districts.

    a. BOR shall require the water districts' continued participation in the Westside Regional Drainage Plan, which employs actions leading to zero discharge of subsurface drainage water beyond the boundaries of regional drainage management facilities, including but not limited to:

        i. Recirculating tailwater on-farm;

        ii. Employing micro irrigation and drip irrigation systems to the maximum extent practical;

        iii. Lining district water delivery facilities to the maximum extent practical;

        iv. Applying collected subsurface drainage water to salt tolerant crops and other drainwater displacement projects (such as road wetting for dust control); and

        v. Converting any remaining furrow and flood agricultural practices to contoured row agriculture employing micro, drip, or overhead sprinkler irrigation wherever feasible.

2. BOR shall require the San Luis and Panoche water districts' continuing participation in the Grasslands Bypass Project.

3. BOR shall coordinate with the California Department of Fish and Game and create an action plan to protect Central Valley steelhead from high selenium pulses in the San Joaquin River above the confluence with the Merced River through the operation of the Hills Ferry Barrier.

4. Measures shall be taken to assess and monitor the concentrations of selenium within the waters, sediments, vegetation, and invertebrates of the San Joaquin River, and at the mouths of Salt Slough and Mud Slough (north) to assess the contributions of selenium from each pathway.

    a. BOR shall design and initiate a plan for sampling the selenium concentrations in the waters, sediment, vegetation, and invertebrates of the San Joaquin River below the confluence with Mud Slough and above the confluence with the Merced River to adequately provide baseline conditions to be included in the next biological assessment prior to initiating consultation for future long-term contracts.

b. BOR shall design and initiate a plan for sampling the selenium concentrations in the waters, sediment, vegetation, and invertebrates of the San Joaquin River above the confluence with Salt Slough to adequately provide baseline conditions to be included in the next biological assessment prior to initiating consultation for future long-term contracts.

c. BOR shall provide an annual report to NMFS summarizing the sampling of selenium concentrations in the waters, sediments, vegetation, and invertebrates of the San Joaquin River as well as in Mud Slough (north).

Updates and reports required by these terms and conditions are due to NMFS no later than June 1, 2012, (covering the March 1, 2011, through February 28, 2012, period) and June 3, 2013, (covering the March 1, 2011, through February 28, 2013, period). These updates and reports shall be submitted to:

Supervisor
Sacramento Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento CA 95814
FAX: (916) 930-3629
Phone: (916) 930-3600

X. 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. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat or regarding the development of pertinent information.

1. BOR should support and promote aquatic and riparian habitat restoration within the Delta region, and encourage practices that avoid or minimize negative impacts to salmon, steelhead, and green sturgeon.

2. BOR should support anadromous salmonid monitoring programs throughout the Sacramento-San Joaquin Delta to improve the understanding of migration and habitat utilization by salmonids and green sturgeon in this region.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the actions outlined in the request for consultation received from the BOR for the San Luis Water District and Panoche Water District Interim Renewal Contracts. As provided for in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in any incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered, (3) the agency 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 is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XII. LITERATURE CITED

Adams, P.B., C.B. Grimes, J.E. Hightower, S.T. Lindley, and M.L. Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*. National Marine Fisheries Service. 58 pages.

Adams ,P.B., C. B. Grimes, J.E. Hightower, S.T. Lindley, M.L. Moser, M.J. Parsley. 2007. Population status of North American green sturgeon *Acipenser medirostris*. Environmental Biology of Fish. 79(3-4): 339-356.

Alderdice, D.F., and F.P.J. Velsen. 1978. Relation between temperature and incubation time for eggs of Chinook salmon (*Oncorhynchus tshawytscha*). Journal of the Fisheries Research Board of Canada 35(1):69-75.

Allen, M.A., and T.J. Hassler. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates. (Pacific Southwest), Chinook salmon. U.S. Fish and Wildlife Report 82 (11.49). April 1986.

Allen, P. J. and J. J. Cech Jr. 2007. Age/size effects on juvenile green sturgeon, *Acipenser medirostris*, oxygen consumption, growth, and osmoregulation in saline environments. Environmental Biology of Fishes 79:211-229.

Allen, P. J., B. Hodge, I. Werner, and J. J. Cech. 2006. Effects of ontogeny, season, and temperature on the swimming performance of juvenile green sturgeon (*Acipenser medirostris*). Canadian Journal of Fisheries and Aquatic Sciences 63:1360-1369.

Artyukhin, E.N., P. Vecsei, and D.L. Peterson. 2007. Morphology and ecology of Pacific sturgeons. Environmental Biology of Fish. 79:369-381.

Ayers and Associates. 2001. Two-dimensional modeling and analysis of spawning bed mobilization, lower American River. Prepared for the U.S. Army Corps of Engineers, Sacramento District Office.

Bailey E.D. 1954. Time pattern of 1953–54 migration of salmon and steelhead into the upper Sacramento River. California Department of Fish and Game. Unpublished report.

Bain, M.B., and N.J. Stevenson, editors. 1999. Aquatic habitat assessment: common methods. American Fisheries Society, Bethesda, Maryland.

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. U.S. Fish and Wildlife Service, Biological Report 82 (11.60). 21 pages.

Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller, and D. Demko. 2004. Historical and current information on green sturgeon occurrence in the Sacramento and San Joaquin Rivers and tributaries. Prepared for State Water Contractors by S.P. Cramer and Associates, Inc., Gresham, Oregon. 46 pages.

Beamesderfer, R.C.P., M.L. Simpson, and G.J. Kopp. 2007. Use of life history information in a population model for Sacramento green sturgeon. Environmental Biology of Fishes. 79 (3-4): 315-337.

Beckon, W. and T.C. Maurer. 2008 Potential effects of selenium contamination of federally-listed species resulting from delivery of federal water to the San Luis Unit. U.S. Fish and Wildlife Service report to the U.S. Bureau of Reclamation Under Agreement #05AA210003. March 2008.

Beckon, W. 2008. Toxicity of selenium to salmonids. Presented at CalFed Science Conference, Sacramento, CA, October 24, 2008.

Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria (third edition). U.S. Army Corps of Engineers, Portland, OR.

Benson, R.L., S. Turo, and B.W. McCovey Jr. 2007. Migration and movement patterns of green sturgeon (*Acipenser medirostris*) in the Klamath and Trinity rivers, California, USA. Environmental Biology of Fishes 79:269-279.

Berger, J. 1990. Persistence of different-sized populations: an empirical assessment of rapid extinctions in big horn sheep. Conservation Biology. 4: 91-98.

Bilby, R.E. 1984. Removal of woody debris may affect stream channel stability. Journal of Forestry 82:609-613.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of anadromous salmonids. *In* W.R. Meehan (editor), Influences of forest and rangeland management on salmonid fishes and their habitats, pages 83-138. American Fisheries Society Special Publication 19. American Fisheries Society, Bethesda, MD.

Boles, G. 1988. Water temperature effects on Chinook salmon (*Oncorhynchus tshawytscha*) with emphasis on the Sacramento River: a literature review. Report to the California Department of Water Resources, Northern District, 43 pages.

Boreman, J. 1997. Sensitivity of North American sturgeons and paddlefish to fishing mortality. Environmental Biology of Fishes. 48:399-405.

Brandes, P.L., and J.S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento-San Joaquin Estuary. *In*: Brown, R.L., editor. Contributions to the biology of Central Valley salmonids. Volume 2. California Department of Fish and Game Fish Bulletin 179:39-136.

Brett, J.R. 1952. Temperature tolerance of young Pacific salmon, genus *Oncorhynchus*. Journal of the Fisheries Research Board of Canada 9:265-323.

Brown, K. 2007. Evidence of spawning by green sturgeon, *Acipenser medirostris,* in the upper Sacramento River, California. Environmental Biology of Fishes 79:297-303.

Busby, P.J., T.C. Wainright, G.J. Bryant, L. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon and California. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-27, 261 pages.

CALFED. 2000. Ecosystem Restoration Program Plan, Volume II. Technical Appendix to draft PEIS/EIR. July 2000.

CALFED Science Program. 2001. Science in action: scrutinizing the Delta Cross Channel. CALFED Bay-Delta Program. June 2001. Available online at: http://science.calwater.ca.gov/library.shtml.

California Data Exchange Center. Found at: http://cdec.water.ca.gov/wquality

California Department of Fish and Game. 1995. Adult steelhead counts in Mill and Deer Creeks, Tehama County, October 1993-June 1994. Inland Fisheries Administrative Report Number 95-3.

California Department of Fish and Game. 1998. Report to the Fish and Game Commission. A status review of the spring-run Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River Drainage. Candidate species status report 98-01. Sacramento, 394 pages.

California Department of Fish and Game. 2002. California Department of Fish and Game comments to NMFS regarding green sturgeon listing. 79 pages plus appendices.

California Department of Fish and Game. 2004. Sacramento River winter-run Chinook salmon 2002-2003 biennial report. Prepared for the California Fish and Game Commission. Habitat Conservation Division, Native Anadromous Fish and Watershed Branch. Sacramento, 22 pages.

California Department of Fish and Game. 2007. GrandTab spreadsheet of adult Chinook salmon escapement in the Central Valley. February.

California Department of Fish and Game. 2008a. GrandTab spreadsheet of adult Chinook salmon escapement in the Central Valley.

California Department of Fish and Game. 2008b. Preliminary Data Report: 2007 Sturgeon Fishing Report Card. September 2008.

California Department of Fish and Game. 2010. GrandTab spreadsheet of adult Chinook salmon escapement for 2009 in the Central Valley. March.

California Department of Fish and Game. 2011. GrandTab spreadsheet of adult Chinook salmon escapement in the Central Valley. February1, 2011.

California Department of Fish and Game freshwater fishing regulations 2010-2011. Found at: http://www.dfg.ca.gov/regulations/

California Department of Water Resources. 2002. Suisun Marsh Salinity Control Gates salmon passage evaluation report. Environmental Services Office, Sacramento, 19 pages.

California Department of Water Resources. 2009. Quantification of pre-screen loss of juvenile steelhead within Clifton Court Forebay. Prepared by K.W. Clark, M.D. Bowen, R.B. Mayfield, K.P. Zehfuss, J.D. Taplin, and C.H. Hanson for the Fishery Improvement Section, Bay Delta Office. xvii + 119 pages.

California Regional Water Quality Control Board-Central Valley Region. 1998. Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins, fourth edition. Available: http://www.swrcb.ca.gov/~CRWQCB5/home.html

California Regional Water Quality Control Board-Central Valley Region. 2001. Draft staff report on recommended changes to California's Clean Water Act, section 303(d) list. Available at: http://www.swrcb.ca.gov/CRWQCB5/tmdl/

California Regional Water Quality Control Board Central Valley Region. 2010. Resolution R5-2010-0046, Amending the Water Quality Control Plan for the Sacramento River and San Joaquin Basins for the Control of Selenium in the Lower San Joaquin River Basin. Available at: http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2010/rs2010_0046.pdf

California Resources Agency. 1989. Upper Sacramento River fisheries and riparian management plan. Prepared by an Advisory Council established by SB1086, authored by State Senator Jim Nielson. 157 pages.

Calkins, R.D., W.F. Durand, and W.H. Rich. 1940. Report of the Board of Consultants on the fish problem of the upper Sacramento River. Stanford University, Stanford, CA, 34 pages.

Chambers, J. 1956. Fish passage development and evaluation program. Progress Report No. 5. U.S. Army Corps of Engineers, North Pacific Division, Portland, OR.

City of Lathrop. 2007. City demographics accessed via the internet. Available online at: www.ci.lathrop.ca.us/cdd/demographics.

City of Manteca. 2007. City demographics accessed via the internet. Available online at: www.ci.manteca.ca.us/cdd/demographics.

Clark, G. H. 1929. Sacramento-San Joaquin salmon (*Oncorhynchus tshawytscha*) fishery of California. California Fish and Game Bulletin. 17:73.

Cohen, A.N., and P.B. Moyle. 2004. Summary of data and analyses indicating that exotic species have impaired the beneficial uses of certain California waters: a report submitted to the State Water Resources Control Board on June 14, 2004. 25 pages.

Conomos, T.J., R.E. Smith, and J.W. Gartner. 1985. Environmental settings of San Francisco Bay. Hydrobiologia 129: 1-12.

Cordone, A.J., and D.W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game 47:89-228.

Daughton, C.G. 2003. Cradle-to-cradle stewardship of drugs for minimizing their environmental disposition while promoting human health. I. Rationale for and avenue toward a green pharmacy. Environmental Health Perspectives 111:757-774.

Decato, R.J. 1978. Evaluation of the Glenn-Colusa Irrigation District fish screen. California Department of Fish and Game, Anadromous Fisheries Branch Administrative Report No. 78-20.

Deng, X., J.P. Van Eenennaam, and S.I. Doroshov. 2002. Comparison of early life stages and growth of green sturgeon and white sturgeon. Pages 237-248 *in* W. Van Winkle, P.J. Anders, D.H. Secor, and D.A. Dixon, editors. Biology, management, and protection of North American sturgeon. American Fisheries Society, Symposium 28, Bethesda, Maryland.

Dettinger, M.D. 2005. From climate-change sphaghetti to climate-change distributions for 21st century California. San Francisco Estuary and Watershed Science 3(1), Article 4 (14 pages) Available at: http://repositories.cdlib.org/jmie/sfews/vol3/art4.

Dettinger, M.D., D.R. Cayan, M.K. Meyer, and A.E. Jeton. 2004. Simulated hydrological responses to climate variations and changes in the Merced, Carson, and American River basins, Sierra Nevada, California, 1900-2099. Climatic Change 62:283-317.

Dettman, D.H., D.W. Kelley, and W.T. Mitchell. 1987. The influence of flow on Central Valley salmon. Prepared for the California Department of Water Resources. Revised July 1987. (Available from D.W. Kelley and Associates, 8955 Langs Hill Rd., P.O. Box 634, Newcastle, CA 95658).

Dolloff, C.A. 1993. Predation by river otters (*Lutra Canadensis*) on juvenile coho salmon (*Oncorhynchus kisutch*) and Dolly Varden (*Salvelinus malma*) in southeast Alaska. Canadian Journal of Fisheries and Aquatic Sciences 50: 312-315.

Dubrovsky, N.M., C.R. Kratzer, L.R. Brown, J.M. Gronberg, and K.R. Burow. 2000. Water quality in the San Joaquin-Tulare basins, California, 1992-95. U.S. Geological Survey Circular 1159.

Dubrovsky, N.M., D.L. Knifong, P.D. Dileanis, L.R. Brown, J.T. May, V. Connor, and C.N. Alpers. 1998. Water quality in the Sacramento River basin. U.S. Geological Survey Circular 1215.

Dunford, W.E. 1975. Space and food utilization by salmonids in marsh habitats in the Fraser River Estuary. M.S. Thesis. University of British Colombia, Vancouver, B.C., 81 pages.

Edwards, G.W., K.A.F. Urquhart, and T.L. Tillman. 1996. Adult salmon migration monitoring, Suisun Marsh Salinity Control Gates, September-November 1994. Technical Report 50. Interagency Ecological Program for the San Francisco Bay/Delta Estuary, 27 pages.

Emmett, R.L., S.A. Hinton, S.L. Stone, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in West Coast estuaries, Volume II: Species life history summaries. ELMR Report No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD. 329 pp.

Erickson, D.L., J.A. North, J.E. Hightower, J. Weber, L. Lauck. 2002. Movement and habitat use of green sturgeon *Acipenser medirostris* in the Rogue River, Oregon, USA. Journal of Applied Ichthyology 18:565-569.

Erickson, D.L. and J.E. Hightower. 2007. Oceanic distribution and behavior of green sturgeon. American Fisheries Symposium 56: 197-211.

Fisher, F.W. 1994. Past and present status of Central Valley Chinook salmon. Conservation Biology 8:870-873.

Fry, D.H. 1961. King salmon spawning stocks of the California Central Valley, 1940-1959. California Fish and Game 47:55-71.

Gadomski, D.M. and M.J. Parsely. 2005. Effects of turbidity, light level, and cover on predation of white sturgeon larvae by prickly sculpins. Transactions of the American Fisheries Society 134:369-374.

Gaines, P.D. and C.D. Martin. 2002. Abundance and seasonal, spatial and diel distribution patterns of juvenile salmonid passing the Red Bluff Diversion Dam, Sacramento River. Red Bluff Research Pumping Plant Report Series, Volume 14. U.S. Fish and Wildlife Service, Red Bluff, California.

Gaines, P.D. and W.R. Poytress. 2004. Brood-year 2003 winter Chinook juvenile production indices with comparisons to adult escapement. Report of U.S. Fish and Wildlife Service to California Bay-Delta Authority, San Francisco, CA.

Garcia, A. 1989. The impacts of squawfish predation on juvenile Chinook salmon at Red Bluff Diversion Dam and other locations in the Sacramento River. U.S. Fish and Wildlife Service Report No. AFF/FAO-89-05.

Garland, R.D., K.F. Tiffan, D.W. Rondorf, and L.O. Clark. 2002. Comparison of subyearling fall Chinook salmon's use of riprap revetments and unaltered habitats in Lake Wallula of the Columbia River. North American Journal of Fisheries Management 22:1283-1289.

Gingras, M. 1997. Mark/recapture experiments at Clifton Court Forebay to estimate pre-screen loss of juvenile fishes: 1976-1993. Interagency Ecological Program Technical Report No. 55.

Goals Project. 1999. Baylands ecosystem habitat goals: A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco. San Francisco Bay Regional Water Quality Control Board, Oakland, CA.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESU of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-66, 598 pages.

Goyer, R.A. 1996. Toxic effects of metals. *In* C.D. Klassen (editor), Casarett & Doull's toxicology: the basic science of poisons, fifth edition, pages 691-736. McGraw Hill. New York, NY.

Hallock, R.J. D.H. Fry, and D.A. LaFaunce. 1957. The use of wire fyke traps to estimate the runs of adult salmon and steelhead in the Sacramento River. California Fish and Game. Volume 43, No. 4, pages 271-298.

Hallock, R.J., and F.W. Fisher. 1985. Status of winter-run Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento River. Report to the California Department of Fish and Game, Anadromous Fisheries Branch, Sacramento, CA.

Hallock, R.J., R.F. Elwell, and D.H. Fry, Jr. 1970. Migrations of adult king salmon, *Oncorhynchus tshawytscha*, in the San Joaquin Delta. California Fish and Game 151. Sacramento. 92 p.

Hallock, R.J., W.F. Van Woert, and L. Shapovalov. 1961. An evaluation of stocking hatchery reared steelhead rainbow (*Salmo gairdnerii gairdnerii*) in the Sacramento River system. California Department of Fish and Game Bulletin No. 114.

Hare, S.R., N.J. Mantua, and R.C. Frances. 1999. Inverse production regimes: Alaska and west coast Pacific salmon. Fisheries 24(1):6-14.

Hayhoe, K.D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences of the United States of America. 101(34)12422-12427.

Healey, M.C. 1980. Utilization of the Nanaimo River estuary by juvenile Chinook salmon *(Oncorhynchus tshawytscha)*. Fishery Bulletin 77:653-668.

Healey, M.C. 1982. Juvenile Pacific salmon in estuaries: the life support system. *In* V.S. Kennedy (editor), Estuarine Comparisons, pages 315-341. Academic Press. New York, N.Y.

Healey, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). In: Groot, C., Margolis L., editors. Pacific salmon life-histories. Vancouver: UBC Press. Pages 313-393.

Herren, J.R. and S.S. Kawasaki. 2001. Inventory of water diversions in four geographic areas in California's Central Valley. Pages 343-355. *In:* Contributions to the Biology of Central Valley Salmonids. R.L. Brown, editor. Volume. 2. California Fish and Game. Fish Bulletin 179.

Heublein, J.C., J.T. Kelly, and A.P. Klimley. 2006. Spawning migration and habitat of green sturgeon, *Acipenser medirostris*, in the Sacramento River. Presentation at the CALFED Science Conference, Sacramento California. October 23, 2006.

Heublein, J.C. 2006. Migration of green sturgeon *Acipenser medirostris* in the Sacramento River. Master of Science Thesis. California State University, San Francisco. October 2006. 63 pages. [from Delta section.

Heublin, J.C., J.T. Kelly, C.E. Crocker, A.P. Klimley, and S.T. Lindley. 2009. Migration of green sturgeon, *Acipenser medirostris*, in the Sacramento River. Environmental Biology of Fish 84:245-258.

Huang, B., and Z. Liu. 2000. Temperature Trend of the Last 40 Years in the Upper Pacific Ocean. Journal of Climate 4:3738–3750.

Hughes, N.F. 2004. The wave-drag hypothesis: an explanation for sized-based lateral segregation during the upstream migration of salmonids. Canadian Journal of Fisheries and Aquatic Sciences 61:103-109.

Ingersoll, C.G. 1995. Sediment tests. *In* G.M. Rand (editor), Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition, pages 231-255. Taylor and Francis, Bristol, Pennsylvania.

Interagency Ecological Program Steelhead Project Work Team. 1999. Monitoring, Assessment, and Research on Central Valley Steelhead: Status of Knowledge, Review Existing Programs, and Assessment Needs. In Comprehensive Monitoring, Assessment, and Research Program Plan, Technical Appendix VII-11.

Intergovernmental Panel on Climate Change (IPCC) 2001 Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 881 pages.

Israel, J. 2006a. North American green sturgeon population characterization and abundance of the southern DPS. Presentation to NMFS on April 4, 2006.

Israel, J. 2006b. Determining spawning population estimates for green sturgeon with microsatellite DNA. Presentation at the 2006 CALFED Science Conference. Sacramento, California. October 23, 2006.

Jones & Stokes Associates, Inc. 2002. Foundation runs report for restoration action gaming trials. Prepared for Friant Water Users Authority and Natural Resource Defense Council.

Keefer, M.L., C.A. Perry, M.A. Jepson, and L.C. Stuehrenberg. 2004. Upstream migration rates of radio-tagged adult Chinook salmon in riverine habitats of the Columbia River basin. Journal of Fish Biology 65:1126-1141.

Keller, E.A., and F.J. Swanson. 1979. Effects of large organic material on channel form and fluvial processes. Earth Surface Processes 4:361-380.

Kelley, J.T., A.P. Klimley, and C.E. Crocker. 2007. Movements of green sturgeon, *Acipenser medirostris*, in the San Francisco Bay Estuary, CA. Environmental Biology of Fishes 79(3-4): 281-295.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento-San Joaquin estuary, California. *In* V.S. Kennedy (editor), Estuarine comparisons, pages 393-411. Academic Press, New York, NY.

Klimley, A.P. 2002. Biological assessment of green sturgeon in the Sacramento-San Joaquin watershed. A proposal to the California Bay-Delta Authority.

Kynard, B., E. Parker, and T. Parker. 2005. Behavior of early life intervals of Klamath River green sturgeon, *Acipenser medirostris*, with note on body color. Environmental Biology of Fishes 72:85-97.

Levings, C.D. 1982. Short term use of low-tide refugia in a sand flat by juvenile chinook, (*Oncorhynchus tshawytscha*), Fraser River estuary. Canadian Technical Reports of Fisheries and Aquatic Sciences, Number 1111. 7 pages.

Levings, C.D., C.D. McAllister, and B.D. Chang. 1986. Differential use of the Campbell River estuary, British Columbia, by wild and hatchery-reared juvenile Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 43:1386-1397.

Levy, D.A., and T.G. Northcote. 1981. The distribution and abundance of juvenile salmon in marsh habitats of the Fraser River Estuary. Westwater Research Centre, University of British Columbia, Technical Report no. 25. Vancouver, B.C., Canada.

Levy, D.A., and T.G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River estuary. Canadian Journal of Fisheries and Aquatic Sciences 39:270-276.

Lindley, S.T. 2006b. Large-scale migrations of green sturgeon. Presentation at Interagency Ecological Program 2006 Annual Workshop, Pacific Grove, California. March 3, 2006.

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

Lindley, S.T., M.L. Moser, D.L. Erickson, M. Belchik, D.W. Welch, E.L. Rechisky, J.T. Kelley, J. Heublein and A.P. Klimley. 2008. Marine migration of North American green sturgeon. Transactions of the American Fisheries Society. 137:182-194.

Lindley, S.T., R. Schick, A. Agrawal, M. Goslin, T.E. Pearson, E. Mora, J.J. Anderson, B. May, May, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2006a. Historical population structure of Central Valley steelhead and its alteration by dams. San Francisco Estuary and Watershed Science.

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

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

Luoma, S.N. and T.S. Presser. 2000 Forecasting selenium discharges to the San Francisco Bay-Delta Estuary: ecological effects of a proposed San Luis Drain extension. U.S. Geological Survey Open File Report 00-416, Menlo Park, CA.

MacFarlane, B.R., and E.C. Norton. 2001. Physiological ecology of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. Fisheries Bulletin 100:244-257.

Mantua, N.J., and S.R. Hare. 2002. The Pacific decadal oscillation. Journal of Oceanography. 58:35-44.

Marston, D. 2004. Letter to Mike Aceituno, Office Supervisor, Sacramento, CA regarding steelhead smolt recoveries for the San Joaquin River Basin.

Martin, C.D., P.D. Gaines and R.R. Johnson. 2001. Estimating the abundance of Sacramento River juvenile winter Chinook salmon with comparisons to adult escapement. Red Bluff Research Pumping Plant Report Series, Volume 5. U.S. Fish and Wildlife Service, Red Bluff, California.

Maslin, P., M Lennox, and W. McKinney. 1997. Intermittent streams as rearing habitat for Sacramento River Chinook salmon (*Oncorhynchus tshawytscha*). California State University, Chico, Department of Biological Sciences. 89 pages.

Matter, A.L., and B.P. Sandford. 2003. A comparison of migration rates of radio and PIT-tagged adult Snake River Chinook salmon through the Columbia River hydropower system. North American Journal of Fisheries Management 23:967-973.

Mayfield, R.B. and J.J. Cech, Jr. 2004. Temperature Effects on green sturgeon bioenergetics. Transactions of the American Fisheries Society 133:961-970.

McDonald, J. 1960. The behavior of Pacific salmon fry during the downstream migration to freshwater and saltwater nursery areas. Journal of the Fisheries Research Board of Canada 17:655-676.

McElhany, P., M. Ruckelhaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. NOAA Technical Memorandum, NMFS-NWFSC-42.

McEwan, D. 2001. Central Valley steelhead. *In* R .L. Brown (editor), Contributions to the Biology of Central Valley Salmonids, Volume 1, pages 1-44. California Department of Fish and Game, Fish Bulletin 179.

McEwan, D., and T.A. Jackson. 1996. Steelhead Restoration and Management Plan for California. California. Department of Fish and Game, Sacramento, California, 234 pages.

McGill, R.R. Jr. 1987. Land use changes in the Sacramento River riparian zone, Redding to Colusa. A third update: 1982-1987. Department of Water Resources, Northern District, 19 pages.

McReynolds, T.R., Garman, C.E., Ward, P.D., and M.C. Schommer. 2005. Butte and Big Chico Creeks spring-run Chinook salmon, *Oncorhynchus tshawytscha* life history investigation, 2003-2004. California Department of Fish and Game, Inland Fisheries Administrative Report No. 2005-1.

Meehan, W.R. 1991. Introduction and overview. *In* W.R. Meehan (editor), Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19, pages 1-16. American Fisheries Society, Bethesda, MD.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distributions and life histories. *In* W.R. Meehan (editor), Influences of forest and rangeland management on salmonid fishes and their habitats, pages 47-82. American Fisheries Society Special Publication 19. American Fisheries Society, Bethesda, MD.

Michny, F., and M. Hampton. 1984. Sacramento River Chico Landing to Red Bluff project, 1984, Juvenile salmon study. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, California.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal marine fishes of California. California Department of Fish and Game, Fish Bulletin 157.

Monroe, M., J. Kelly, and N. Lisowski. 1992. State of the estuary, a report of the conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. June 1992. 269 pages.

Moser, M.L. and S.T. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. Environmental Biology of Fishes. 79:243-253.

Mount, J.F. 1995. California rivers and streams: The conflict between fluvial process and land use. University California Press, Berkeley.

Moyle, P. B., J. E. Williams, and E. D. Wikramanayake. 1989. Fish species of special concern of California. Wildlife and Fisheries Biology Department, University of California, Davis. Prepared for The Resources Agency, California Department of Fish and Game, Rancho Cordova.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berkeley.

Moyle, P.B., P.J. Foley, and R.M. Yoshiyama. 1992. Status of green sturgeon, *Acipenser medirostris*, in California. Final report sent to NMFS, Terminal Island, CA by UC Davis Department of Wildlife and Fisheries Biology. 12 pages.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-35. 443 pages.

Nakamoto, R. J., Kisanuki, T. T., and Goldsmith, G. H. 1995. Age and growth of Klamath River green sturgeon (*Acipenser medirostris*). U.S. Fish and Wildlife Service. Project # 93-FP-13. 20 pages

National Marine Fisheries Service and California Department of Fish and Game. 2001. Final report on anadromous salmon fish hatcheries in California. Prepared by Joint Hatchery Review Committee. June 27, 2001.

National Marine Fisheries Service. 1996a. Factors for decline: a supplement to the notice of determination for west coast steelhead under the Endangered Species Act. National Marine Fisheries Service, Protected Resource Division, Portland, OR and Long Beach, CA.

National Marine Fisheries Service. 1996b. Making Endangered Species Act determinations of effect for individual or group actions at the watershed scale. Prepared by NMFS, Environmental and Technical Services Branch, Habitat Conservation Branch. 31 pages.

National Marine Fisheries Service. 1997. National Marine Fisheries Service Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. NMFS, Southwest Region, Long Beach, California, 217 pages with goals and appendices.

National Marine Fisheries Service. 1998a. Factors Contributing to the Decline of Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors For Decline Report. Protected Resources Division, National Marine Fisheries Service. Portland Oregon.

National Marine Fisheries Service. 1998b. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443 pages.

National Marine Fisheries Service. 2005a. Green sturgeon (*Acipenser medirostris*) status review update, February 2005. Biological review team, Santa Cruz Laboratory, Southwest Fisheries Science Center. 31 pages.

National Marine Fisheries Service. 2005b. Final assessment of the National Marine Fisheries Service's Critical Habitat Analytical Review Teams (CHARTs) for seven salmon and steelhead evolutionarily significant units (ESUs) in California (July 2005). Prepared by NOAA Fisheries Protected Resources Division, Southwest Region. Available at: http://swr.nmfs.noaa.gov/chd/CHART%20Final%20Assessment/Final_CHART_Report-July_05.pdf

National Marine Fisheries Service. 2008. Letter from Rodney R. McInnis, NMFS, to Michael Kinsey, Bureau of Reclamation, transmitting a Biological and Conference Opinion on the San Luis Water District and Panoche Water District Interim Renewal Contracts. December 28, 2008.

National Marine Fisheries Service. 2009a. Letter from Rodney R. McInnis, NMFS, to Michael Kinsey, Bureau of Reclamation, transmitting a concurrence letter on the 3rd Use Agreement for the Grasslands Bypass Project. November 18, 2009.

National Marine Fisheries Service. 2009b. Letter from Rodney R. McInnis, NMFS, to Don Glaser, Bureau of Reclamation, transmitting a Biological and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. June 4. 844 pages plus 5 appendices.

National Marine Fisheries Service. 2010. Letter from Rodney R. McGinnis, NMFS, to Mark Helvey, NMFS, transmitting the 2010 Biological Opinion on the proposed action of continued management of west coast ocean salmon fishery in accordance with the Pacific Coast Salmon Fishery Plan. April 30, 2010. 95 pages.

National Marine Fisheries Service. 2011. Letter from Maria Rea, NMFS, to Paul Fujitani, Bureau of Reclamation, transmitting the 2011 Juvenile Production Estimate (JPE) for Sacramento River winter-run Chinook salmon, 3 pages plus attachments.

Nichols, F.H., J.E. Cloern, S.N. Louma, and D.H. Peterson. 1986. The modification of an estuary. *Science* 231: 567-573.

Nielsen, J.L., S. Pavey, T. Wiacek, G.K. Sage, and I. Williams. 2003. Genetic analyses of Central Valley trout populations, 1999-2003. Final Technical Report to the California Department of Fish and Game, Sacramento, California. December 8, 2003.

Noakes, D.J. 1998. On the coherence of salmon abundance trends and environmental trends. North Pacific Anadromous Fishery Commission Bulletin 454-463.

Nobriga, M., and P. Cadrett. 2003. Differences among hatchery and wild steelhead: evidence from Delta fish monitoring programs. Interagency Ecological Program for the San Francisco Estuary Newsletter 14:30-38.

Orsi, J. 1967. Predation study report, 1966-1967. California Department of Fish and Game

Pacific Fishery Management Council. 2004. Review of 2003 Ocean Salmon Fisheries. Available: www.pcouncil.org

Peterson, J. H. and J. F. Kitchell. 2001. Climate regimes and water temperature changes in the Columbia River: Bioenergetic implications for predators of juvenile salmon. Canadian Journal of Fisheries and Aquatic Sciences. 58:1831-1841.

Phillips, R.W. and H.J. Campbell. 1961. The embryonic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. Annual Report to Pacific Marine Fisheries Commission. 14:60-73.

Pickard, A., A. Grover, and F. Hall. 1982. An evaluation of predator composition at three locations on the Sacramento River. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Technical Report No. 2. 20 pages.

Pimm, S.I., L. Jones, and J. Diamond. 1988. On the risk of extinction. American Naturalist 132: 757-785.

Primack, R. 2004. A primer of conservation biology, 3rd edition. Sinauer Associates., Sunderland MA.

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon, in Ecological studies of the Sacramento-San Joaquin Delta, Part II. (J. L. Turner and D. W. Kelley, comp.), pp. 115-129. California Department of Fish and Game Fish Bulletin 136.

Rand, G.M., P.G. Wells, and L.S. McCarty. 1995. Introduction to aquatic toxicology. *In* G.M. Rand (editor), Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition, pages 3-66. Taylor and Francis. Bristol, Pennsylvania.

Reynolds, F.L., T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Inland Fisheries Division, Sacramento.

Rich, A.A. 1997. Testimony of Alice A. Rich, Ph.D., regarding water rights applications for the Delta Wetlands Project, proposed by Delta Wetlands Properties for Water Storage on Webb Tract, Bacon Island, Bouldin Island, and Holland Tract in Contra Costa and San Joaquin Counties. July 1997. California Department of Fish and Game Exhibit CDFG-7. Submitted to State Water Resources Control Board.

Robison, G.E., and Beschta, R.L. 1990. Identifying trees in riparian areas that can provide coarse woody debris to streams. Forest Service 36:790-801.

Rutter, C. 1904. Natural history of the quinnat salmon. Investigations on Sacramento River, 1896-1901. Bulletin of the U.S. Fish Commission. 22:65-141.

S.P. Cramer and Associates, Inc. 2000. Stanislaus River data report. Oakdale CA.

S.P. Cramer and Associates, Inc. 2001. Stanislaus River data report. Oakdale CA.

S.P. Cramer and Associates, Inc. 2005. Stanislaus River rotary screw trap monitoring data. Available at: http://spcramer.com/spcramer.html

San Joaquin River Group Authority. 2007. 2006 Annual Technical Report: On implementation and monitoring of the San Joaquin River Agreement and the Vernalis Adaptive Management Plan. January 2007. 137 pages.

Schaffter, R. 1980. Fish occurrence, size, and distribution in the Sacramento River near Hood, California during 1973 and 1974. California Department of Fish and Game.

Schaffter, R. 1997. White sturgeon spawning migrations and location of spawning habitat in the Sacramento River, California. California Department of Fish and Game 83:1-20.

Schmetterling, D.A., C.G. Clancy, and T.M. Brandt. 2001. Effects of riprap bank reinforcement on stream salmonids in the Western United States. Fisheries 26:8-13.

Shapovalov, L. and A.C. Taft. 1954. The live histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game, Fish Bulletin. 98.

Shelton, J. M. 1995. The hatching of Chinook salmon eggs under simulated stream conditions. Progressive Fish-Culturist 17:20-35.

Silvestre, F., J. Linares-Casenave, S.I. Doroshov, D. Kultz. 2010 A proteomic analysis of green and white sturgeon larvae exposed to heat stress and selenium. Science of the Total Environment. 408 (2010) 3176-3188.

Slater, D.W. 1963. Winter-run Chinook salmon in the Sacramento River, California, with notes on water temperature requirements at spawning. U.S. Fish and Wildlife Service, Special Science Report Fisheries 461:9.

Smith, A.K. 1973. Development and application of spawning velocity and depth criteria for Oregon salmonids. Transactions of the American Fisheries Society 10:312-316.

Snider, B. 2001. Evaluation of effects of flow fluctuations on the anadromous fish populations in the lower American River. California Department of Fish and Game, Habitat Conservation Division. Stream Evaluation Program. Tech. Reports No. 1 and 2 with appendices 1-3. Sacramento, California.

Snider, B., and R.G. Titus. 2000. Timing, composition, and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing, October 1996-September 1997. California Department of Fish and Game, Habitat Conservation Division, Stream Evaluation Program Technical Report No. 00-04.

Sommer, T.R., M.L. Nobriga, W.C. Harrel, W. Batham, and W.J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences. 58:325-333.

Spence, B., G. Lomnicky, R. Hughes, and R. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. Technical Environmental Research Services Corp., Corvallis, Oregon.

Stachowicz, J. J., J. R. Terwin, R. B. Whitlatch, and R. W. Osman. 2002. Linking climate change and biological invasions: Ocean warming facilitates non-indigenous species invasions. PNAS, November 26, 2002. 99:15497–15500

Stephenson, A.E. and D.E. Fast. 2005. Monitoring and evaluation of avian predation on juvenile salmonids on the Yakima River, Washington. Annual Report 2004. March 2005.

Stevens, D.E. 1961. Food habits of striped bass, *Roccus saxatilis* (Walbaum) in the Rio Vista area of Sacramento River. Master's Thesis. University of California. Berkeley, California.

Stillwater Sciences. 2002. Merced River corridor restoration plan. Stillwater Sciences, Berkeley, California. 245 pages.

Stillwater Sciences. 2004. Appendix H: conceptual models of focus fish species response to selected habitat variables. In: Sacramento River Bank Protection final Standard Assessment Methodology. July 2004.

Stillwater Sciences. 2006. Biological Assessment for five critical erosion sites, river miles: 26.9 left, 34.5 right, 72.2 right, 99.3 right, and 123.5 left. Sacramento River Bank Protection Project. May 12, 2006.

Stone, L. 1874. Report of operations during 1872 at the U.S. salmon-hatching establishment on the McCloud River, and on the California Salmonidae generally; with a list of specimens collected. Report to U.S. Commissioner of Fisheries for 1872-1873, 2:168-215.

Sweeney, B.W., Bott, T.L., Jackson, J.K., Kaplan, L.A., Newbold, J.D., Standley, L.J., Hession, W.C., and R.J. Horwitz. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services. National Academy of Sciences 101:14132-14137.

Tillman, T.L., G.W. Edwards, and K.A.F. Urquhart. 1996. Adult salmon migration during the various operational phases of Suisun Marsh Salinity Control Gates in Montezuma Slough: August-October 1993. Agreement to California Department of Water Resources, Ecological Services Office by California Department of Fish and Game, Bay-Delta and Special Water Projects Division, 25 pages.

Tucker, M. E., C. D. Martin, and P. D. Gaines. 2003. Spatial and temporal distributions of Sacramento pikeminnow and striped bass at the Red Bluff Diversion Complex, including the research pumping plant, Sacramento River, California: January, 1997 to August, 1998. Red Bluff Research Pumping Plant Report Services, Vol. 10. USFWS, Red Bluff, California 32 pages.

Tucker, M. E., C. M. Williams, and R. R. Johnson. 1998. Abundance, food habits, and life history aspects of Sacramento squawfish and striped bass at the Red Bluff Diversion Complex, including the research pumping plant, Sacramento River, California: 1994 to 1996. Red Bluff Research Pumping Plant Report Services, Vol. 4. USFWS, Red Bluff, California. 54 pages.

U.S. Bureau of Reclamation. 2004. Long-term Central Valley Project and State Water Project Operating Criteria and Plan. Biological Assessment for ESA section 7(a)(2) consultation.Mid-Pacific Region. Sacramento, California.

U.S. Bureau of Reclamation. 2007. Central Valley Operations website, Fish Salvage Data. Available online at: http://www. usbr.gov/mp/cvo/

U.S. Department of Interior. 1999. Final Programmatic Environmental Impact Statement for the Central Valley Project Improvement Act. October 1999. Technical Appendix, 10 volumes.

U.S. Environmental Protection Agency. 1994. Methods for measuring the toxicity and bioaccumulation of sediment associated contaminants with freshwater invertebrates. EPA 600-R-94-024. Duluth, Minnesota.

U.S. Fish and Wildlife Service. 1995a. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. Portland, OR.

U.S. Fish and Wildlife Service. 1995b. Working paper: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volume 2. May 9, 1995. Prepared for the U.S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group, Stockton, California.

U.S. Fish and Wildlife Service. 2000. Impacts of riprapping to ecosystem functioning, lower Sacramento River, California. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. Prepared for US Army Corps of Engineers, Sacramento District.

U.S. Fish and Wildlife Service. 2001a. Abundance and seasonal, spatial, and diel distribution patterns of juvenile salmonids passing the Red Bluff Diversion Dam, Sacramento River. Draft Progress Report for Red Bluff Research Pumping Plant, Vol.14. Prepared by Philip Gaines and Craig Martin for the U.S. Bureau of Reclamation. Red Bluff, CA.

U.S. Fish and Wildlife Service. 2001b. Abundance and survival of juvenile Chinook salmon in the Sacramento-San Joaquin Estuary: 1997 and 1998. Annual progress report. 131 pages.

U.S. Fish and Wildlife Service. 2002. Spawning areas of green sturgeon *Acipenser medirostris* in the upper Sacramento River California. U.S. Fish and Wildlife Service, Red Bluff, California.

Van Eenennaam, J.P., J. Linares-Casenave, J-B. Muguet, and S.I. Doroshov. 2009. Induced artificial fertilization and egg incubation techniques for green sturgeon. Revised manuscript to North American Journal of Aquaculture.

Van Eenennaam, J.P., J. Linares-Casenave, S.I. Doroshov, D.C. Hillemeier, T.E. Wilson, and A.A. Nova. 2006. Reproductive conditions of Klamath River green sturgeon. Transactions of the American Fisheries Society 135:151-163.

Van Eenennaam, J.P., J. Linares-Casenave, X. Deng, and S.I. Doroshov. 2005. Effect of incubation temperature on green sturgeon embryos, *Acipenser medirostris*. Environmental Biology of Fishes 72:145-154.

Van Eenennaam, J.P., M.A.H. Webb, X. Deng, S.I. Doroshov, R.B. Mayfield, J.J. Cech, Jr., D.C. Hillemeir and T.E. Willson. 2001. Artificial spawning and larval rearing of Klamath River green sturgeon. Transactions of the American Fisheries Society 130:159-165.

Van Rheenen, N.T., A.W. Wood, R.N. Palmer, D.P. Lettenmaier. 2004. Potential implications of PCM climate change scenarios for Sacramento-San Joaquin river basin hydrology and water resources. Climate Change 62:257-281.

Varanasi, U. and N. Bartoo. 2008. Memorandum to D. Robert Lohn (NWR) and Rodney R. McInnis (SWR): Evaluating causes of low 2007 coho and Chinook salmon returns. 4 pages.

Vogel, D.A. 2008. Evaluation of adult sturgeon migration at the Glenn-Colusa Irrigation District Gradient Facility on the Sacramento River. Natural Resource Scientist, Inc. May 2008. 33 pages.

Vogel, D.A., and K.R. Marine. 1991. Guide to upper Sacramento River Chinook salmon life history. Prepared for the U.S. Bureau of Reclamation, Central Valley Project, 55 pages.

Vogel, D.A., K.R. Marine, and J.G. Smith. 1988. Fish passage action program for Red Bluff Diversion Dam. Final report on fishery investigations. Report No. FR1/FAO-88-19. U.S. Fish and Wildlife Service, Northern Central Valley Fishery Resource Office. Red Bluff, CA.

Waples, R.S. 1991. Pacific Salmon, *Oncorhynchus spp.*, and the definition of "species" under the Endangered Species Act. Marine Fisheries Review 53:11-21.

Ward, P.D., McReynolds, T.R., and C.E. Garman. 2002. Butte and Big Chico Creeks spring-run Chinook salmon, *Oncorhynchus tshawytscha* life history investigation, 2000-2001.California Department of Fish and Game, Inland Fisheries Administrative Report.

Ward, P.D., McReynolds, T.R., and C.E. Garman. 2003. Butte and Big Chico Creeks spring-run Chinook salmon, *Oncorhynchus tshawytscha* life history investigation, 2001-2002. California Department of Fish and Game, Inland Fisheries Administrative Report.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7.

Williams, J.G. 2006. Central Valley salmon: a perspective on Chinook and steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4(3): Article 2. 416 pages. Available at: http://repositories.cdlib.org/jmie/sfews/vol4/iss3/art2.

Wright, D.A., and D.J. Phillips. 1988. Chesapeake and San Francisco Bays: A study in contrasts and parallels. Marine Pollution Bulletin 19 (9): 405-413.

Yoshiyama, R.M, E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 2001. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. *In*: Brown, R.L., editor. Contributions to the biology of Central Valley salmonids. Volume 1. California Department of Fish and Game Fish Bulletin 179:71-177.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley Drainage of California. *In*: Sierra Nevada Ecosystem Project, Final Report to Congress, volume III, Assessments, Commissioned Reports, and Background Information (University of California, Davis, Centers for Water and Wildland Resources, 1996).

Yoshiyama, R.M., F.W. Fisher, and P.B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley region of California. North American Journal of Fisheries Management 18:487-521.

Zimmerman, C.E., G.W. Edwards, and K. Perry. 2008. Maternal origin and migratory history of *Oncorhynchus mykiss* captured in rivers of the Central Valley, California. Final Report prepared for the California Department of Fish and Game. Contract P0385300. 54 pages.

Enclosure 2

Magnuson-Stevens Fishery Conservation and Management Act

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended (16 U.S.C. § 1801 et seq.), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NOAA's National Marine Fisheries Service (NMFS) on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. The action area of the San Luis Water District (SLWD) and Panoche Water District (PWD) Interim Renewal Contracts 2011-2013 is within the area identified as EFH for Pacific Coast Salmon species identified in Amendment 14 of the Pacific Salmon FMP [Pacific Fishery Management Council (PFMC) 1999].

PFMC (1999) has identified and described EFH, and has identified adverse impacts and recommended conservation measures for salmon in amendment 14 to the Pacific Coast Salmon FMP. Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers et al. (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific Coast Salmon FMP that occur in the Central Valley.

A. Life History and Habitat Requirements

General life history information for Central Valley fall-/late fall-run Chinook salmon is summarized below. Information on Sacramento River winter-run and Central Valley spring-run Chinook salmon life histories is summarized in the preceding biological opinion for the proposed project (enclosure 1). Further detailed information on Chinook salmon evolutionarily significant units (ESU) are available in the NMFS status review of Chinook salmon from Washington,

Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (March 9, 1998, 63 FR 11482).

Central Valley fall-run Chinook salmon enter the San Joaquin River from July through December, and late fall-run enter between October and March. Fall-run Chinook salmon generally spawn from October through December, and late fall-run fish spawn from January to April [U.S. Fish and Wildlife Service (USFWS) 1998]. The physical characteristics of Chinook salmon spawning beds vary considerably. Chinook salmon will spawn in water that ranges from a few centimeters to several meters deep provided that the there is suitable sub-gravel flow (Healey 1991). Spawning typically occurs in gravel beds that are located in marginally swift riffles, runs and pool tails with water depths exceeding one foot and velocities ranging from one to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from one to four inches in diameter with less that 5 percent fines (Reiser and Bjornn 1979).

Egg incubation occurs from October through March, and juvenile rearing and smolt emigration occur from January through June (Reynolds *et al.* 1993). Shortly after emergence, most fry disperse downstream towards the Sacramento-San Joaquin Delta and estuary while finding refuge in shallow waters with bank cover formed by tree roots, logs, and submerged or overhead vegetation (Kjelson *et al.* 1982). These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. Smolts generally spend a very short time in the Delta and estuary before entering the ocean.

II. PROPOSED ACTION

Reclamation proposes to execute interim water service contracts that would authorize the continued delivery of water from the Central Valley Project to the San Luis and Panoche water districts for a period of 24 months beginning on March 1, 2011, and continuing through to February 28, 2013. The proposed action is described in the *Description of the Proposed Action* section of the preceding biological opinion (Enclosure 1).

III. EFFECTS OF THE PROPOSED ACTION

The effects of the proposed action on Pacific Coast salmon EFH would be similar to those discussed in the *Effects of the Proposed Action* section of the preceding biological opinion (Enclosure 1) for threatened Central Valley steelhead. A summary of the effects of the proposed action on Chinook salmon habitat are discussed below.

Adverse effects to Chinook salmon habitat will result from the execution of interim renewal contracts authorizing continued water deliveries to the SLWD and PWD lands which discharge agricultural subsurface drainage that contributes selenium to the waters, sediment, vegetation, and biota of the San Joaquin River and the Delta.

IV. CONCLUSION

Upon review of the effects of the SLWD and PWD Interim Renewal Contracts 2011-2013, NMFS believes that execution of the contracts will result in adverse effects to the EFH of Pacific salmon protected under the MSFCMA.

V. EFH CONSERVATION RECOMMENDATIONS

Considering that the habitat requirements of fall-run Chinook salmon within the action area are similar to the Federally listed species addressed in the preceding biological opinion (Enclosure 1), NMFS recommends that all the Terms and Conditions as well as all the Conservation Recommendations in the preceding biological opinion prepared for the Central Valley steelhead ESU be adopted as EFH Conservation Recommendations.

VI. ACTION AGENCY STATUTORY REQUIREMENTS

Section 305(b)(4)(B) of the MSA and Federal regulations (50 CFR § 600.920) to implement the EFH provisions of the MSA require Federal action agencies to provide a detailed written response to NMFS, within 30 days of its receipt, responding to the EFH conservation recommendations. The response must include a description of measures adopted by the Agency for avoiding, mitigating, or offsetting the impact of the project on Pacific salmon EFH. In the case of a response that is inconsistent with NMFS' recommendations, the Agency must explain their reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)).

VII. LITERATURE CITED

Healey, M.C. 1991. Life history of Chinook salmon. *In* C. Groot and L. Margolis: Pacific Salmon Life Histories. University of British Columbia Press. pp. 213-393.-96.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California, pp. 393-411. *In*: V.S. Kennedy (ed.). Estuarine comparisons. Academic Press, New York, NY.

Lister, D.B. and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Big Qualicum River, British Columbia. J. Fish. Res. Board Can. 27:1215-1224.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neeley, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-35. 443 pages.

Pacific Fishery Management Council. 1999. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. Amendment 14 to the Pacific Coast Salmon Plan, Appendix A. Pacific Fisheries Management Council, Portland, Oregon.

Reiser, D.W., and T.C. Bjornn. 1979. Influence of forest and rangeland management on anadromous fish habitat in western North America: Habitat requirements of anadromous salmonids. U.S. Department of Agriculture, Forest Service General Technical Report PNW-96. Pacific Northwest Forest and Range Experimental Station, Portland, Oregon. 54 pp.

Reynolds, F.L., T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley Streams: A Plan for Action. California Department of Fish and Game. Inland Fisheries Division.

U.S. Fish and Wildlife Service. 1998. Central Valley Project Improvement Act tributary production enhancement report. Draft report to Congress on the feasibility, cost, and desirability of implementing measures pursuant to subsections 3406(e)(3) and (e)(6) of the Central Valley Project Improvement Act. U.S. Fish and Wildlife Service, Central Valley Fish and Wildlife Restoration Program Office, Sacramento, California.