CONSERVATION PLAN

For

The California Department of Fish and Game Striped Bass Management Program

Prepared as Part of an Application for
Incidental Take Permits Pursuant to
Section 10(a)(1)(B) of the
Endangered Species Act

Submitted by:

California Department of Fish and Game
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November 12, 1999

Table of Contents

Page

List of Tables

List of Figures

List of Appendices

Conservation Plan for Section 10 Permit Application

TITLE: Conservation Plan for the California Department of Fish and Game Striped Bass Management Program, prepared pursuant to Section 10(a)(1)(B) of the Endangered Species Act of 1973.

DATE: November 12, 1999

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EXECUTIVE SUMMARY

The California Department of Fish and Game (CDFG) is applying for permits pursuant to Section 10(a)(1)(B) of the Endangered Species Act of 1973, (ESA) as amended, for incidental take of the federally listed Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, Central Valley steelhead, delta smelt, Sacramento splittail, and giant garter snake, as well as the Central Valley fall-/late-fall-run chinook salmon should this species become listed pursuant to the ESA in the future (hereinafter referred to as "covered species"), that may result from implementation of its Striped Bass Management Program. CDFG will request permits from the National Marine Fisheries Service (for Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central Valley fall-/late fall-run chinook salmon and Central Valley steelhead) and the U.S. Fish and Wildlife Service (USFWS) (for delta smelt, Sacramento splittail, and giant garter snake) with terms of ten years.

The actions proposed to be covered by this Conservation Plan and its associated incidental take permits are: (1) annual stocking of one- and two-year-old striped bass in the San Francisco Bay/Sacramento-San Joaquin Estuary at numbers sufficient to stabilize and maintain a striped bass population of 712,000 adults; (2) possible recommendations to the Fish and Game Commission for changes in the striped bass fishing regulations to help reach and maintain the target population level; and (3) monitoring of the overall striped bass population and the success of the stocked fish. Each of these actions may result in take of one or more of the covered species or in circumstances leading to the take of one or more of the covered species. The Conservation Plan is designed to include flexibility in its implementation; a series of circumstances or "thresholds" are described which would require adjustments to the Striped Bass Management Program. Thresholds triggering adjustments to the plan include low cohort replacement rate for Sacramento River winter-run chinook salmon, low delta smelt abundance index, unanticipated changes in the striped bass population, the new listing under the ESA of any species not covered by the Conservation Plan, and, based on monitoring, estimates of striped bass predation on covered species that are higher than those anticipated in the development of the Conservation Plan.

The estimated maximum level of take of chinook salmon associated with the Striped Bass Management Program is 2.1% of the annual Sacramento River winter-run chinook salmon population (1.1% as a result of predation by stocked striped bass and 1.0% as a result of striped bass monitoring), 1.8% of the annual Central Valley spring-run chinook salmon population (0.8% as a result of predation by stocked striped bass and 1.0% as a result of striped bass monitoring) and 1.4% of the annual Central Valley fall-/late-fall-run population (all as a result of predation by stocked striped bass). These levels of take are not expected to have a significant effect on the chinook salmon populations over the ten-year permit period from that associated with the expected striped bass population that would exist if the Striped Bass Management Program were not implemented.

The estimated maximum level of take of delta smelt associated with the Striped Bass Management Program is 1.1% of the annual population (0.9% as a result of striped bass predation and less than 0.2% as a result of striped bass monitoring). Reductions of subsequent year classes resulting from this level of take would likely not be measurable because annual variation in delta smelt abundance measures indicate year class strength is largely controlled by environmental conditions, not abundance of spawners. Thus, this level of take is expected to have negligible effects on the delta smelt population.

The anticipated level of take of Central Valley steelhead associated with the Striped Bass Management Program is expected to be low because Central Valley steelhead smolts are larger and less vulnerable to predation than salmon smolts. The anticipated maximum level of take of Central Valley steelhead is 1.0% of the annual population (0.8% as a result of predation by stocked striped bass and 0.2% as a result of striped bass monitoring.) These levels of take are not expected to have a significant effect on Central Valley steelhead or to substantially increase the probability of their extinction over the ten-year permit period from that associated with the expected striped bass population that would exist if the Striped Bass Management Program were not implemented.

The maximum level of take of Sacramento splittail associated with the Striped Bass Management Program is expected to be considerably less than that for delta smelt because historical monitoring of striped bass diet indicates little to no consumption of Sacramento splittail. However, for development of this Conservation Plan, CDFG assumes a take level of Sacramento splittail no greater than for delta smelt (i.e., 1.1% of the annual population). The population impact of a maximum 1.1% take level is expected to be negligible because Sacramento splittail abundance is largely controlled by environmental conditions.

Based on historical studies of striped bass diet, CDFG anticipates little to no take of giant garter snakes by striped bass predation. However, because the ranges of the two species overlap, this Plan provides for the remote possibility that take will occur and allows for a maximum level of take of two giant garter snakes over the term of the permit.

As a part of this Conservation Plan, CDFG proposes to monitor the striped bass population, the striped bass diet (i.e., predation on the covered species), and the populations of the six covered fish species. This Plan also includes measures to minimize the impact of the take, such as a substantial reduction in the number of striped bass to be stocked compared with the Program originally proposed by CDFG, restrictions on the location and timing of striped bass stocking, a significant portion of the stocking to be formed by two-year-old bass (as opposed to all one-year-olds), and changes to some of the monitoring protocols to reduce the level of take of covered species. To mitigate for that level of take which cannot be avoided, CDFG proposes to install and maintain screens on water diversions in both the Bay-Delta (to offset impacts to delta smelt and Sacramento splittail) and the Sacramento River (to offset impacts to chinook salmon and Central Valley steelhead).

Chapter 1. INTRODUCTION

Pursuant to Section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended, (ESA), the California Department of Fish and Game (CDFG) submits the following Conservation Plan and application for incidental take permits for activities associated with management of striped bass, *Morone saxatilis*, in the Sacramento-San Joaquin Estuary (Estuary) for the ten-year period starting with the date of permit issuance. This Conservation Plan evaluates the potential for incidental take of five federally listed fish species, Sacramento River winter-run chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run chinook salmon, Central Valley steelhead (*Oncorhynchus mykiss*), delta smelt (*Hypomesus transpacificus*), Sacramento splittail (*Pogonichthys macrolepidotus*), and also Central Valley fall-/late-fall-run chinook salmon should it become listed pursuant to the ESA in the future (hereinafter referred to as "covered species"). Such take may result from CDFG striped bass management activities. The Conservation Plan also identifies appropriate conservation measures to be taken.

The potential for incidental take of Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central Valley fall-/late-fall-run chinook salmon; Central Valley steelhead; delta smelt; and Sacramento splittail exists in the Sacramento-San Joaquin River System and Estuary because striped bass are predatory fish that might eat young salmon, Central Valley steelhead, delta smelt, and Sacramento splittail that share the Estuary and the Sacramento and San Joaquin rivers upstream from the Delta. Therefore, this Conservation Plan and application for incidental take permits has been prepared according to ESA requirements. The NMFS would issue an incidental take permit for species under its jurisdiction (i.e., Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central Valley fall-/late-fall-run chinook salmon and Central Valley steelhead) and the USFWS would issue an incidental take permit for species under its jurisdiction (i.e, delta smelt and Sacramento splittail).

This Conservation Plan evaluates potential effects of maintaining or increasing the abundance of striped bass on Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central Valley fall-/late-fall-run chinook salmon, Central Valley steelhead, delta smelt, and Sacramento splittail. The Sacramento River winter-run chinook salmon was initially listed as threatened by the U.S. Government under the ESA (Federal Register, Vol. 55, No. 214, November 5, 1990) and subsequently reclassified as endangered (Federal Register, Vol. 59, No. 2, January 4, 1994). It was listed as endangered by the State of California in 1990 (Title 14, California Code of Regulations, Section 670.5, August 4, 1990). Central Valley spring-run chinook salmon is federally listed as threatened (Federal Register Vol. 64, No. 179, September 16, 1999). The Central Valley spring-run chinook salmon was listed as threatened by the State of California on August 28, 1998. Central Valley steelhead was listed as threatened under the ESA on March 19, 1998 (Federal Register Vol. 63, No. 53). The delta smelt was listed as threatened under the ESA on March 5, 1993 (Federal Register, Vol. 58, No. 42) and by the State of California in 1993 (Title 14, California Code of Regulations, Section 607.1(b), on

December 9, 1993). Sacramento splittail was listed as threatened by the Federal Government (Federal Register, Vol. 64, No. 25, February 8, 1999).

The CDFG is legally mandated as the public's trustee to restore, protect, and perpetuate all fish and wildlife resources including striped bass, chinook salmon, Central Valley steelhead, delta smelt, and Sacramento splittail. As that public trustee, the CDFG has, over many years, initiated programs designed to improve populations of these species (see Appendix A). Nevertheless, abundance of all has declined.

In addition to the six fish species covered by this Conservation Plan, the CDFG also seeks authorization for take incidental to its Striped Bass Management Program for a seventh species, the giant garter snake (*Thamnophis gigas*), listed as threatened under the ESA on October 20, 1993 (Federal Register Vol. 58, No. 201). The giant garter snake is therefore, also a "covered species," as the term is used throughout this document. There is no known evidence of striped bass preying on giant garter snakes, therefore CDFG does not anticipate that take of this species will occur at any significant level. However, the ranges of the two species overlap and thus, the remote possibility exists that striped bass may occasionally prey on young giant garter snakes. To ensure compliance with the ESA in the event that predation of giant garter snakes should occur, CDFG is seeking authorization for a limited level of incidental take of this snake. Take of giant garter snake would be authorized under the incidental take permit issued by the USFWS.

The biological goals and objectives of the Conservation Plan are: 1) to minimize and avoid losses of chinook salmon, Central Valley steelhead, delta smelt, Sacramento splittail, and giant garter snakes due to predation by stocked striped bass; and 2) to mitigate for what losses occur. Predation will be minimized by: 1) delaying the stocking of striped bass until most young salmon and Central Valley steelhead have emigrated from the Estuary; 2) stocking striped bass in the western Estuary downstream from the normal distribution of delta smelt, Sacramento splittail, and the giant garter snake; and 3) comprising part of the 1.275 million yearling equivalent striped bass stocking level with two-year olds (resulting in fewer fish released). Mitigation to offset losses of the covered species will occur through screening of water diversions. In the case of salmon and Central Valley steelhead, these mitigation screens will be located on diversions in the Sacramento River between Verona and Redding. Screens for delta smelt and Sacramento splittail will be placed on diversions in the western Delta and/or Suisun Marsh. Such screening of water diversions is consistent with task 1222 in the Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes (U.S. Department of Interior 1996). Monitoring will allow predation losses of all listed species to be evaluated over the 10-year duration of the permit, and changes to striped bass stocking locations and number of fish stocked may occur through an adaptive management strategy.

The long-term goal of CDFG, NMFS, and USFWS is to attain estuarine habitat of sufficient quality to assist in the recovery of currently listed species and sustain all species.

Chapter 2. BACKGROUND

A. Project Area And Environmental Setting

The Estuary is formed by the Sacramento and San Joaquin rivers joining and flowing through a series of embayments to the Pacific Ocean (Figure 1). The largest and most downstream embayment is San Francisco Bay. Some 1,130 km of channels interlace the triangular area formed by the junction of the two rivers, and this region is known as the Sacramento-San Joaquin Delta (Delta). Tidal action occurs to the upstream limits of the Delta or slightly farther but ocean salts intrude no further than the western Delta. Kelley (1966) describes the Estuary in more detail.

California is a semiarid state. To accommodate the growth in human population and agriculture, vast water-development projects have been built, resulting in major changes in stream flows. One result is that the freshwater flow to the ocean from the Sacramento-San Joaquin system has been reduced by about 60% (Nichols et al. 1986). While other factors such as toxicity, dredge spoil disposal, and accidental introductions of exotic species through ship ballast discharge have perturbated the Estuary, water management has had the most significant impact on the fisheries.

The San Joaquin system has been almost completely developed for upstream use. Much of the development of the Sacramento system has been designed to transport water through the Delta for use in the more arid, southern portions of the state. As a result, from 1970-1975 an average of 88% of the inflow to the Delta came from the Sacramento River.

Water is exported to the south via two large pumping plants in the southwestern Delta (Figure 1). One is a 130-m^3/s pumping plant built for the Central Valley Project (CVP) by the U.S. Bureau of Reclamation (USBR) in 1951, and the other is a 170-m^3/s plant completed by the California Department of Water Resources (DWR) in 1968.

Typical export rates substantially exceed the flow of the San Joaquin River; therefore, most water must come from the Sacramento River. Approximately the first 100 m^3/s of flow from the Sacramento River crosses the Delta through channels upstream from the mouth of the San Joaquin River. These channels are too small to carry greater flows, so at higher export rates, water is drawn up the San Joaquin River from its junction with the Sacramento River (Figure 2). Such net upstream flows in the San Joaquin River are typical in the spring, except in wet years, and in the summer and fall of most years.

The changes in magnitude and pattern of flow affect many species of fishes, including the covered fish species that are the subject of this Conservation Plan and striped bass.

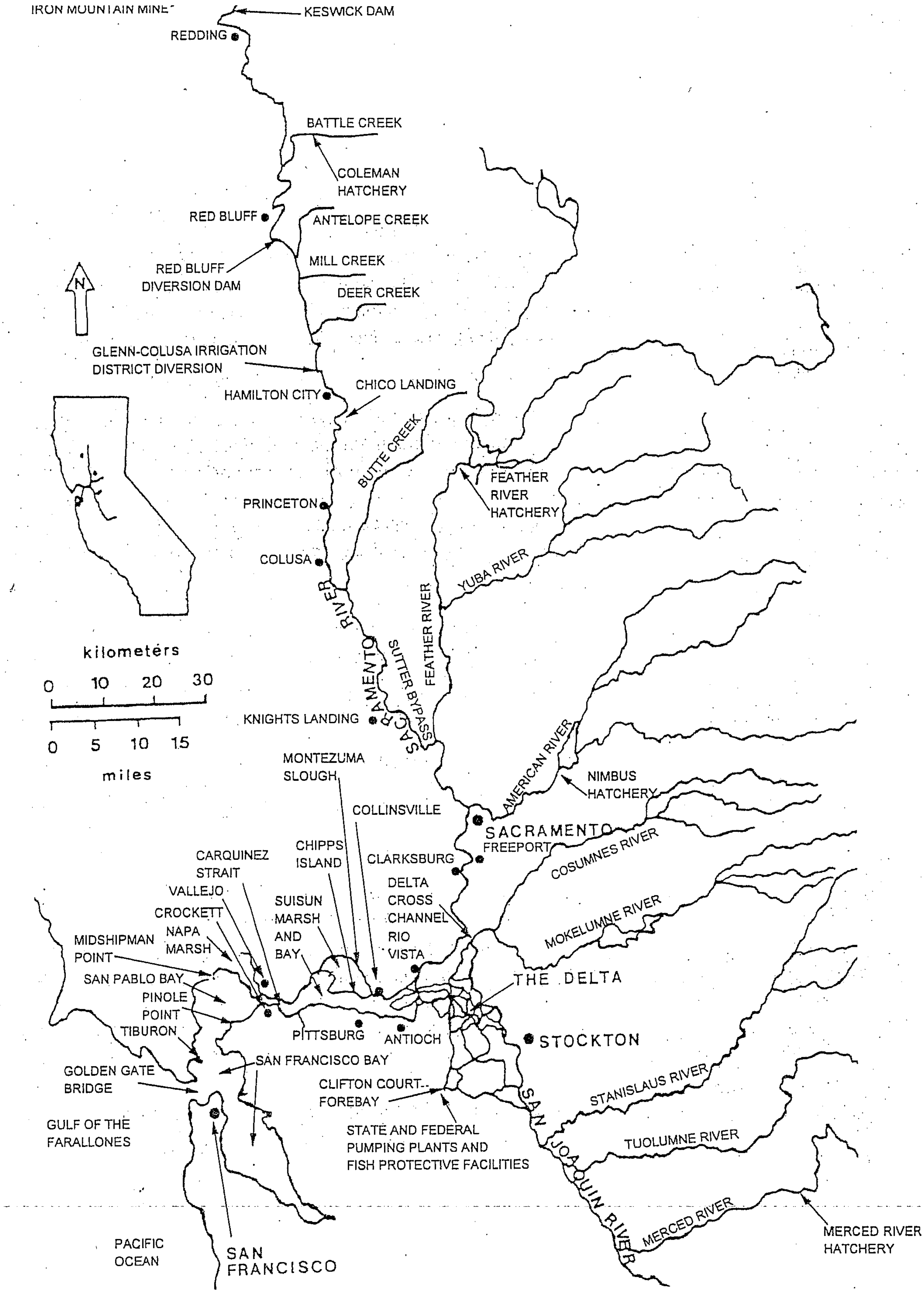


Figure 1. Project area for the Striped Bass Management Program.

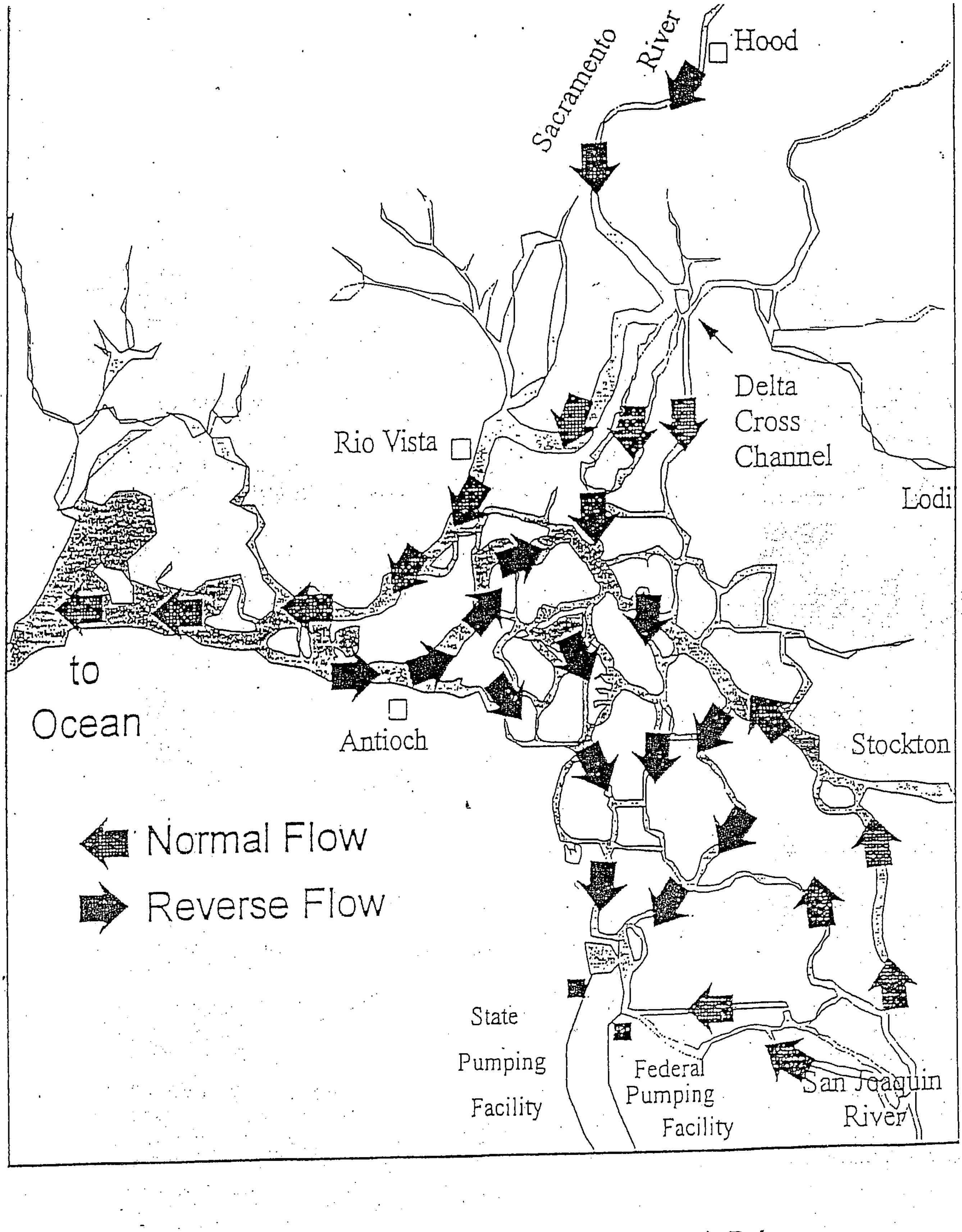


Figure 2. Flow Pattern in the Sacramento-San Joaquin Delta.

Nursery location of striped bass (Turner and Chadwick 1972), delta smelt (Moyle et al. 1992), and Sacramento splittail (Caywood 1974, Wang 1986), is closely tied to the amount of outflow from the Delta during spring and early summer. A greater proportion of these populations occurs in Suisun Bay when outflows are high; the proportion is greater in the Delta when outflows are low. Additionally, year class strength of striped bass (Turner and Chadwick 1972, Stevens 1977, Chadwick et al. 1977, Stevens et al. 1985) and Sacramento splittail (Daniels and Moyle 1983) clearly increases with outflow, and greatest abundances of delta smelt tend to occur when outflows are sufficient to place their nursery in Suisun Bay (Moyle et al. 1992).

Flow patterns created by Federal and State water exports transport many young fish to the CVP and State Water Project (SWP) diversion intakes. Annual losses at fish screens in the plant intakes are generally in hundreds of thousands for chinook salmon (all runs combined) and tens of millions for striped bass. Losses have not been estimated for delta smelt, Central Valley steelhead, or Sacramento splittail, but annual salvage is typically in tens to hundreds of thousands of delta smelt, thousands to tens of thousands of Central Valley steelhead, and tens of thousands of Sacramento splittail (however, through mid-August, more than 5 million Sacramento splittail were salvaged in 1995). Salvaged fish are returned by tank trucks to the Estuary near Antioch. However, numerous salvaged fish succumb due to predation by larger fish or various factors associated with their handling, trucking, and release. Predation occurs in the SWP Clifton Court Forebay (CCF) and immediately in front of the Federal screens. Also, numerous fish are lost because they are too small to be saved by the louver screens in front of the water intakes.

Examples of losses and mortality estimated for these various sources include:

(1) Skinner (1974) estimated that 69% of the striped bass approaching the SWP screens in 1970 were salvaged (31% were lost). The estimate of percentage salvaged is an overestimate because the smaller sizes of young bass were not evaluated.

(2) Estimates of losses of marked-hatchery raised salmon to predation in CCF range from 63% to 99% (Table 1).

(3) Raquel (1989) evaluated the effects of handling and trucking on striped bass salvaged at the SWP's John E. Skinner Delta Fish Protective Facility. He found that survival varied widely depending on the time of year and size of the striped bass. Handling and trucking mortality was lowest (generally <30%) during the fall, winter, and early spring, when temperatures were low and the young fish were greater than 75 mm fork length. Handling and trucking mortality was greatest (60% and >80%, respectively) in the late spring and early summer when young fish were less than 50 mm fork length.

Table 1. Summary of Clifton Court Forebay Pre-Screen Juvenile Chinook Salmon Loss Studies Conducted by the Department of Fish and Game

Date	Pre-Screen Loss Rate (%)	Temperature (avg/day °F)	Pump Exports (avg. af/day)	Predator Abundance	Size at Entrainment (mm fl)
Oct. '76	97.0	65.4	2,180		114
Oct. '78	87.7	57.5	4,351		87
Apr. '84	63.3	61.2	7,433	35,390	79
Apr. '85	74.6	64.1	6,367		44
Jun. '92	98.7	71.7	4,760	162,281	77
Dec. '92	77.2	45.4	8,146	156,667	121
Apr. '93	94.0	62.0	6,368	223,808	66
Nov. '93	99.2	53.7	7,917		117

Young fish are also lost through local agricultural diversions in the Delta (Allen 1975). About 110-m^3/s of water is diverted through hundreds of siphons and pumps, mostly 15 to 30 cm in diameter, for local use during the summer, and lesser amounts are diverted during the rest of the year. Furthermore, larval fish are also lost to operations of two power plants at Antioch and Pittsburgh which divert a total of about 90-m^3/s of water for once-through cooling.

In essence, reductions in freshwater outflows and large losses of fish to water diversions have substantially degraded the estuarine ecosystem over the past three decades; hence, the focus on recovery and maintenance of the Estuary's fisheries has been on reducing the impact of water project operations. The CDFG has been addressing this problem on several fronts, including recommending flow-standards and water export limitations to the State Water Resources Control Board (SWRCB); participation in the CALFED Joint State-Federal Framework Agreement which is charged with developing a comprehensive program to protect, restore, and enhance the Estuary; participation in consultations with the water management agencies (USBR and DWR) regarding Sacramento River winter-run chinook salmon and delta smelt as required by the Federal and State ESAs; and various coordination and negotiation activities with the water management agencies. These actions have led to various water management measures being implemented to protect Sacramento River winter-run chinook salmon, delta smelt, and also striped bass and other depleted fishery resources. Additional measures are currently being considered. The CDFG's goal is to attain estuarine habitat of sufficient quality to recover current listed species and sustain all species.

B. Permit Area

The geographic area covered by the Section 10(a)(1)(B) permits will be the Sacramento-San Joaquin Estuary, including San Francisco, San Pablo, and Suisun Bays; the Sacramento-San Joaquin Delta and rivers; and the various channels, embayments, and streams tributary to these bays, delta, and rivers as depicted in Figure 1 of this Conservation Plan.

C. Permit Duration

The CDFG is requesting permits from NMFS and USFWS for terms of ten years to cover incidental take of the covered species due to striped bass management activities. The agencies believe that ten years is an appropriate period for evaluating the effectiveness of the proposed striped bass stocking program in stabilizing and maintaining the striped bass population in the Sacramento-San Joaquin Estuary and for evaluating impacts of that program on the covered species. At least ten years is required because: 1) the CDFG estimates that five years of stocking at the proposed levels will be required to stabilize the population at the 1994 level; and 2) there is a three to four year lag between stocking yearling striped bass and collecting and processing tag recoveries after recruitment to the fishery at three-years of age.

D. Species Covered by this Conservation Plan

Appendices B1, B2, B3, B4, B5, C, D, and J provide detailed species accounts for the chinook salmon runs, Central Valley steelhead, delta smelt, Sacramento splittail, and giant garter snake, respectively, including life history, population status, and problems affecting the species. A brief summary for each of the covered species is provided below.

1. Sacramento River Winter-Run Chinook Salmon--Endangered

Sacramento River winter-run chinook salmon comprise a distinct population of chinook salmon in the Sacramento River. They are distinguishable from the other three Sacramento River chinook runs by the timing of their upstream migration and spawning season. Adult Sacramento River winter-run chinook salmon generally leave the ocean and migrate through the Sacramento-San Joaquin Delta to the upper Sacramento River from November through May. Their spawning season generally extends from mid-April to August. Young downstream-migrant Sacramento River winter-run chinook salmon may enter the Delta as early as September but peak emigration extends from late-January through April and some may remain until June.

Completion of the Red Bluff Diversion Dam (RBDD) in 1966 enabled accurate estimates of all salmon runs to the upper Sacramento River and documented the dramatic decline of the Sacramento River winter-run chinook salmon population. The estimated numbers of Sacramento River winter-run chinook salmon reaching the dam from 1967-1969 averaged 86,509. From 1990 to 1998 the spawning escapement of Sacramento River winter-run chinook salmon past the dam has been estimated at 441; 191; 1,180; 341; 189; 1,364; 940; 871; and approximately 2,500. The NMFS believes these run sizes are dangerously low. NMFS has estimated that 500 to 1,660 female spawners are necessary to maintain genetic diversity in the Sacramento River winter-run chinook salmon population.

a. Sacramento River Winter-Run Chinook Salmon Critical Habitat.

On June 16, 1993, NMFS designated critical habitat for the Sacramento River winter-run chinook salmon (58 FR 33212). Critical habitat for the Sacramento River winter-run chinook salmon includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge.

In addition, the designated critical habitat includes the physical and biological features of the habitats described above that are essential to the conservation of the species. These features are (1) access from the Pacific Ocean to appropriate spawning areas in the upper Sacramento River, (2) the availability of clean gravel for spawning subsstrate, (3) adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles, (4) water temperatures between 42.5 and 57.5F (5.8 and 14.1 C) for successful spawning, egg incubation, and fry development, (5) habitat areas and adequate prey that are not contaminated, (6) riparian habitat that provides successful juvenile development and survival, and (7) access downstream so that juveniles can migrate from the spawning grounds to San Francisco Bay and the Pacific Ocean.

Within the Sacramento River, critical habitat includes the river water, river bottom (including those areas and associated gravel used by Sacramento River winter-run chinook salmon as a spawning substrate), and the adjacent riparian zone used by fry and juveniles for rearing. In areas westward from Chipps Island, including San Francisco Bay to the Golden Gate Bridge, it includes the estuarine water column, essential foraging habitat, and food resources used by the Sacramento River winter-run chinook salmon as part of their juvenile outmigration or adult spawning migration.

2. Central Valley Spring-Run Chinook Salmon -- Threatened

Central Valley spring-run chinook salmon from Deer, Mill, and Butte creeks, like Sacramento River winter-run chinook salmon, are a distinct population of chinook salmon in the Sacramento River system. The salmon from these creeks are unique in that their gene pool apparently has not been significantly contaminated by hybridization with other runs. These Central Valley spring-run chinook salmon leave the ocean and migrate through the Sacramento-San Joaquin Estuary to the upper Sacramento River system primarily from February to June. Concern regarding their status results from a decline in spawning escapement to these three creeks from 3,190 in 1970-74, to 1,250 in 1991-94. During the past 20 years, except for 1995 when the estimated escapement was 9,315 (7,500 of which were in Butte Creek), escapement has never exceeded 2,400 fish.

Other spring-run chinook salmon occur in other portions of the Sacramento River system including the Feather, Yuba and mainstream Sacramento rivers, but there is less concern about their status because their escapement has been relatively stable. The gene pool of these spring-run chinook salmon is not pure in that they apparently have hybridized with Central Valley fall-run chinook salmon.

In Deer, Mill, and Butte creeks, adult Central Valley spring-run chinook salmon over-summer and spawn from August to October. The young Central Valley spring-run chinook salmon produced in Mill and Deer creeks typically remain there for about one year before migrating to the ocean as yearlings primarily from November to January of the following year. In years when water temperatures are warm or spring flows are high, many juvenile Central Valley spring-run chinook salmon move out of the spawning creeks in the spring as fingerlings.

The latter life history pattern also is the norm for juveniles in Butte Creek and the Sacramento, Feather, and Yuba rivers.

a. Central Valley Spring-Run Chinook Salmon Proposed Critical Habitat.

On March 9, 1998 NMFS proposed the designation of critical habitat for the Central Valley spring-run chinook salmon (63 FR 11482). Critical habitat consists of the water, substrate, and adjacent riparian zone of accessible estuarine and riverine reaches. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of chinook salmon. Inaccessible reaches are those above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) and specific dams within the historical range of each ESU (identified below). Adjacent riparian zones are defined as those areas within a slope distance of 300 feet from the normal line of high water of a stream channel or adjacent off-channel habitats (600 feet when both sides of the channel are included).

Critical habitat is designated to include all river reaches accessible to chinook salmon in the Sacramento River and its tributaries in California. Also included are river and reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas above specific dams identified below or above longstanding naturally impassable barriers.

<u>Dams/Reservoirs at the Upstream Extent of Critical Habitat</u>

- San Pablo Reservoir - San Pablo Bay area
- Calaveras Reservoir - Coyote Creek
- Nimbus Dam - American River
- Camp Far West Dam - Bear River
- Oroville Dam - Feather River
- Englebright Dam - Yuba River
- Black Butte Reservoir - Stony Creek
- Keswick and Shasta Dams - Sacramento River
- Whiskeytown Lake - Clear Creek

3. Central Valley Fall-/Late-Fall-Run Chinook Salmon

The Central Valley fall-run is the most abundant chinook salmon race in the Sacramento-San Joaquin System and is typically in the range of 100,000 to 400,000 spawning adults. It provides the primary support of the major sport and commercial salmon fishery in the Gulf of the Farallones. Adult Central Valley fall-run chinook salmon migrate into the river system from July through December and spawn from early October through late December. Peak spawning occurs in October and November, although the timing of runs varies from stream to stream. Egg incubation occurs from October through March and juvenile rearing and smolt emigration occurs from January through June. Although the majority of young chinook salmon migrate to the ocean during the first few months following emergence, a small number may remain in fresh water and migrate as yearlings. Central Valley fall-run chinook salmon mature at 3-4 years of age, although sexually mature 2-year-old males ("jacks") are common. Much of the area in which Central Valley fall-run chinook historically spawned was downstream from the major dam sites; therefore, this race was not as severely affected by early water project developments as were spring- and Sacramento River winter-run chinook salmon which historically spawned at higher elevations. The fall runs of the Sacramento and San Joaquin systems may be genetically distinct and the San Joaquin fall-run chinook may constitute a separate race.

Central Valley late-fall-run chinook salmon migrate into the Sacramento and San Joaquin rivers from mid-October through mid-April, overlapping the Central Valley fall-run chinook salmon spawning migration of July through December. Central Valley late-fall-run chinook salmon spawn from January through mid-April. Incubation occurs from January through June and rearing of fry and smolts occurs from April through mid-October. Significant emigration of naturally produced juvenile Central Valley late-fall-run chinook salmon occurs through November, into December, and possibly January. Emigration of hatchery produced Central Valley late-fall-run chinook salmon occurs well into February. Although the presence of late-fall-run chinook salmon in the Sacramento River was recognized prior to 1970, it was only after the construction of RBDD, that enumeration and racial separation was possible. Central Valley late-fall-run fish are not nearly as abundant as the Central Valley fall-run, but are substantially more abundant than the winter- and spring-runs. Since 1985, estimated spawning runs have ranged from about 6,000 to 14,000 fish.

a. Central Valley Fall-/Late-Fall-Run Chinook Salmon Habitat.

NMFS has determined that Central Valley fall-/late-fall-run chinook salmon habitat consists of the water, substrate, and adjacent riparian zone of accessible estuarine and riverine reaches. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of chinook salmon. Inaccessible reaches are those above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) and specific dams within the historical range of each ESU (identified below). Adjacent riparian zones are defined as those areas within a slope distance of 300 feet from the normal line of high water of a stream channel or adjacent off-channel habitats (600 feet when both sides of the channel are included).

Central Valley fall-/late-fall-run chinook salmon habitat includes all river reaches accessible to chinook salmon in the Sacramento and San Joaquin Rivers and their tributaries in California. Also included are river reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas upstream of the Merced River and areas above specific dams identified below or above longstanding naturally impassable barriers.

Dams/Reservoirs at the Upstream Extent of Habitat

- San Pablo Reservoir - San Pablo Bay
- Calaveras Reservoir - Coyote Creek
- Crocker Diversion La Grange - Merced River
- New Hogan Dam - Calaveras River and Mormon Slough
- Camanche Dam - Mokelumne River
- Nimbus Dam - American River
- Camp Far West Dam - Bear River
- Oroville Dam - Feather River
- Englebright Dam - Yuba River
- Black Butte Reservoir - Stony Creek
- Keswick and Shasta Dams - Sacramento River
- Whiskeytown Lake - Clear Creek

4. Central Valley Steelhead--Threatened

Average annual Central Valley steelhead run size in the Sacramento River system above the mouth of the Feather River for a six-year period beginning in 1953 was estimated to be 20,540 fish (Hallock et al. 1961). The California Fish and Wildlife Plan estimated an annual run size of about 30,000 Central Valley steelhead for this same area, and a total annual run size of 40,000 adults for the entire Central Valley (including San Francisco Bay tributaries) (CDFG 1966).

Although an accurate estimate is not available, the present annual run size for the total system, based on RBDD counts, hatchery counts, and past natural spawning escapement estimates for tributaries, is probably less than 10,000 adult fish. Central Valley steelhead counts at the RBDD have declined from an average annual count of 11,187 adults for the ten-year period beginning in 1967, to 2,202 adults annually in the 1990s. Recent counts at Coleman, Feather River, and Nimbus hatcheries are also well below the average for these hatcheries.

Presently, approximately 10% to 30% of the adults returning to spawn in the Sacramento system are of natural origin (Frank Fisher, CDFG Associate Fishery Biologist, pers. comm.). Hallock et al. (1961) reported that the composition of naturally produced Central Valley steelhead in the population estimates for the 1953-54 through 1958-59 seasons ranged from 82% to 97% and averaged 88%. Clearly, the decline of natural reproducing populations has been more precipitous than that of the hatchery stocks.

Steelhead in the Central Valley are all winter steelhead. Hallock et al. (1961) found that adult Central Valley steelhead migrate into the upper Sacramento River during most months of the year. They begin moving through the main stem in July, peak near the end of September, and continue migrating through February or March (Bailey 1954, Hallock et al. 1961). Although some fish have been observed during April and May (Hallock 1989) and June (Bailey 1954). Central Valley steelhead spawn mainly from January through March, but spawning can begin as early as late December and extend through April (Hallock et.al. 1961).

Natural and hatchery-maintained stocks in the Sacramento River system have been adversely affected by water development; inadequate instream flows caused by excessive water diversions for irrigation; rapid flow fluctuations due to water conveyance needs; lack of cold water releases from reservoirs; loss of spawning and rearing habitat due to dams which block access; and entrainment of juveniles into unscreened or poorly screened diversions. Operations of the Federal CVP and the SWP, particularly the pumps in the south delta, may affect Central Valley steelhead smolts in the Sacramento-San Joaquin Delta.

a. Central Valley Steelhead Proposed Critical Habitat.

On February 5, 1999 NMFS proposed the designation of critical habitat for the Central Valley steelhead (64 FR 5740). Critical habitat consists of the water, substrate, and adjacent riparian zone of accessible estuarine and riverine reaches. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of Central Valley steelhead. Inaccessible reaches are those above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) and specific dams within the historical range of each ESU (identified below).

Critical habitat is designated to include all river reaches accessible to listed Central Valley steelhead in the Sacramento and San Joaquin Rivers and their tributaries in California. Also included are river and reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas of the San Joaquin River above upstream of the Merced River confluence and areas above specific dams identified below or above longstanding naturally impassable barriers.

Dams/Reservoirs at the Upstream Extent of Critical Habitat

- San Pablo Reservoir - San Pablo Bay
- Calaveras Reservoir - Coyote Creek
- Crocker Diversion La Grange - Merced River
- New Hogan Dam - Calaveras River and Mormon Slough
- Camanche Dam - Mokelumne River
- Nimbus Dam - American River

- Camp Far West Dam - Bear River
- Oroville Dam - Feather River
- Englebright Dam - Yuba River
- Black Butte Reservoir - Stony Creek
- Keswick and Shasta Dams - Sacramento River
- Whiskeytown Lake - Clear Creek

5. Delta Smelt--Threatened

Delta smelt historically was one of the most common fish in the Estuary. Delta smelt abundance fluctuates greatly from year to year; however, information from seven independent data sets demonstrated a dramatic decline of the delta smelt population after the 1970s and essentially perpetually low abundance from 1983 to 1992. In 1993 and 1995, abundance, as measured by some of the indices, increased substantially in apparent response to an increase in available habitat brought about by a wet winter and spring. Fall abundance of delta smelt is usually higher when salinities of 2 ppt or less occur in Suisun Bay in the preceding spring. Delta smelt are sensitive to environmental perturbations because they have a one-year life cycle, unusually low fecundity for a fish with planktonic larvae, a limited diet, and a limited distribution within and just upstream from the interface between salt and freshwater which generally centers the population from Suisun Bay to the western Delta.

The stock-recruitment relationship is weak and the increased population in 1993 did not produce a large delta smelt population in 1994. The 1994 summer townet survey reflected increased production of young delta smelt (index of 13.0), but later, the fall midwater trawl survey index fell to an all time low. Habitat conditions in Suisun Bay, even with all the water management restrictions currently in place, were once again poor in 1994 due to very low outflow from the delta. In spring 1995, flood level flows probably swept many young delta smelt westward beyond Suisun Bay. The 1995, 1996, 1997, and 1998 summer townet indices were lower than in 1994, although they exceeded several indices during the 1980s. However, in 1999 the summer townet index increased again (index of 11.7).

Despite the low 1994 population and the low 1995 summer index, the fall 1995 midwater trawl survey index rebounded to the seventh highest on record; apparently, survival responded to favorable habitat associated with the high outflows. However, in 1996, the fall index fell again, resulting in the fourth lowest index on record. In 1997, this index increased moderately, but did not achieve the abundance and distributional recovery criteria set forth in the USFWS's Delta Native Fishes Recovery Plan (U.S. Department of the Interior 1996). Therefore, the five-year recovery period, which spans five generations, was restarted in 1998. In 1998, the fall index was again moderate with a slightly greater value than in 1997.

a. **Delta Smelt Critical Habitat.**

On December 19, 1994 (59 FR 65256) critical habitat for delta smelt was designated by the USFWS as all areas of water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the Delta, as defined in Section 12220 of the California Water Code.

6. Sacramento Splittail--Threatened

The Sacramento splittail is a large minnow endemic to the Sacramento-San Joaquin system. In November, 1992, the Natural Heritage Institute petitioned the USFWS to add the Sacramento splittail to the List of Endangered and Threatened Wildlife. On June 24, 1993, USFWS issued a finding that the petition presented substantial information indicating that the requested action may be warranted. On January 6, 1994, the USFWS published in the Federal Register a proposed rule to list the Sacramento splittail as threatened (Federal Register, Vol. 59, No. 4), and on February 8, 1999 the Sacramento splittail was listed as threatened (Federal Register, Vol. 64, No. 25).

Sacramento splittail exhibit unusually high salt tolerance for members of the minnow family and historically were commonly found in Suisun Bay and the Suisun and Napa marshes. An analysis for the USFWS indicates that Sacramento splittail have declined by 62% over the past 15 years (Meng 1993). However, DWR/USBR (1994) believe that adult Sacramento splittail abundance does not exhibit a discernable trend (see Appendix D). Notably, information from surveys and CVP/SWP salvage records indicate Sacramento splittail production was near or at a recent record high in spring 1995. Apparently, this production was in response to high river flows inundating flood plains and bypasses, thus creating optimum spawning and nursery habitat.

The CDFG, as part of a multi-agency Interagency Ecological Program (IEP), conducted field surveys in the summer of 1994 to further assess the status of Sacramento splittail. These surveys showed that adults were distributed through much of Suisun Bay, the Suisun Marsh, and western Delta. They were not found in the eastern Delta or rivers upstream from the Delta. Overall, 274 Sacramento splittail were caught in 1,370 hours of fishing by 100-foot long gill nets.

7. Giant Garter Snake -- Threatened

The giant garter snake (*Thamnophis gigas*) is one of the largest garter snakes, reaching a total length of at least 160 cm. Females tend to be slightly longer and stouter than males. The mass of adult female giant garter snakes is typically 500-700 grams. Dorsal background coloration varies from brownish to olive with a checkered pattern of black spots, separated by a yellow dorsal stripe and two light-colored lateral stripes. Background coloration and prominence of black checkered pattern and the three yellow stripes are geographically and individually variable (Hansen 1980). The ventral surface is cream to olive or brown and sometimes infused with orange, especially in northern populations.

Endemic to wetlands in the Sacramento and San Joaquin valleys, the giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways and agricultural wetlands, such as irrigation and drainage canals and rice fields. Giant garter snakes feed on small fishes, tadpoles, and frogs (Fitch 1941, Hansen 1980, Hansen 1988). Habitat requisites consist of (1) adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season; (3) grassy banks and openings in waterside vegetation for basking; and (4) higher elevation uplands for cover and refuge from flood waters during the snake's dormant season in the winter (Hansen 1980). Giant garter snakes are absent from larger rivers and other water bodies that support introduced populations of large, predatory fish, and from wetlands with sand, gravel, or rock substrates (Hansen 1980, Rossman and Stewart 1987, Brode 1988, Hansen 1988). Riparian woodlands do not provide suitable habitat because of excessive shade, lack of basking sites, and absence of prey populations (Hansen 1980).

The giant garter snake inhabits small mammal burrows and other soil crevices above prevailing flood elevations throughout its winter dormancy period (November to mid-March). Giant garter snakes typically select burrows with sunny aspects along south and west facing slopes. The breeding season extends through March and April, and females give birth to live young from late July through early September (Hansen and Hansen 1990). Brood size is variable, ranging from 10 to 46 young, with a mean of 23 (Hansen and Hansen 1990). Young immediately scatter into dense cover and absorb their yolk sacs, after which they begin feeding on their own. Although growth rates are variable, young typically more than double in size by one year of age (G. Hansen, pers. comm.). Sexual maturity averages three years in males and five years for females (G. Hansen, pers. comm.).

Fitch (1940) described the historical range of the species as extending from the vicinity of Sacramento and Contra Costa Counties southward to Buena Vista Lake, near Bakersfield in Kern County. The giant garter snake currently is only known from a small number of populations. The status of these populations and the threats to these snakes and their habitats are detailed in the final rule that listed the giant garter snake as threatened (Federal Register Vol. 58, No. 201). The largest extant population of the giant garter snake inhabits extensive agricultural lands in the American Basin, a large flood basin at the confluence of the Sacramento and American Rivers in Sacramento and Sutter Counties. Throughout this area, reconnaissance surveys indicate that about 570 hectares of giant garter snake habitat exist in the form of man-made irrigation channels and drainage ditches, and an undetermined number of acres of suitable habitat exist within approximately 5,260 hectares of adjoining rice fields.

E. Striped Bass Population Status and Limiting Factors

Appendix A provides a detailed discussion of striped bass life history, population status and trends, and factors affecting the species. A brief summary is provided below.

The Sacramento-San Joaquin Estuary's striped bass population boomed shortly after its introduction from New Jersey in 1879. By the early 1900s, the commercial net catch alone averaged over one million pounds annually. In 1934, commercial netting of striped bass was stopped by law because of concern for the developing major recreational fishery and its associated economy. Except for a brief decline in the mid-1950s, angling success was very good through the early 1960s. At that time there were about three-million adult bass (greater than 16 inches in length) supported by approximately 20-million naturally-produced yearlings. The annual angler catch was approximately 750,000 fish.

Over the past three decades, the striped bass population of the Estuary has experienced a severe decline. The population of about 3 million adult bass in the early 1960s eroded to about 604,000 fish in 1993, 712,000 in 1994, and 775,000 in 1996, the years of the most recent population estimates. Concurrently, young-of-the-year striped bass abundance suffered an erratic but persistent decline from high summer townet index levels sometimes exceeding 100 in the mid-1960s to the all-time-low of only 1.4 in 1998. Since 1977, average abundance of young striped bass has been less than one-third of previous average levels.

Over the past decade the CDFG has identified factors inhibiting the recovery of striped bass and other fishes of the Sacramento-San Joaquin Estuary. They are:

- Entrainment (and loss) of eggs, larvae, and young fish at State/Federal water diversions in the south Delta.
- Reduced spring outflows and encroachment of the salinity gradient upstream (result of storage behind dams and water exports) which hinders transport of developing striped bass larvae and young into Suisun Bay where bass food is abundant and bass are not entrained into water diversions.
- Upstream (reverse) flows (result of pumping in the south Delta) in the Delta east of Antioch which disrupts migrations of both young and adult bass.
- Unscreened private agricultural water diversions, primarily in the Delta, that entrain bass.
- Industrial water diversions that entrain young bass.
- Water pollution, including toxic chemicals and trace metals, harmful to striped bass of all ages.

- Shortages of important food organisms possibly limiting survival of young bass.
- Illegal take and poaching of young and adult bass.

Recently Bennett and Howard (1997) have suggested that striped bass may also be affected by a shift in global climate, and Kimmerer (1997) suggests that much of the effects of water exports and salinity encroachment may be suppressed by density-dependent mortality after the first summer. Nonetheless, all concerned scientists agree that there has been a long-term decline in striped bass abundance.

F. Interaction Between Striped Bass and the Covered Species -- Predation and Competition

1. Striped Bass Diet Studies

Several studies provide relevant information regarding potential for striped bass predation on chinook salmon, Central Valley steelhead, delta smelt, Sacramento splittail, and giant garter snake.

Scofield (1928, 1931) and Scofield and Bryant (1926) found no salmon or Central Valley steelhead in any striped bass stomachs examined in their studies in the Sacramento-San Joaquin Delta. Scofield and Bryant (1926) referred to striped bass eating Sacramento splittail in the rivers and Scofield (1928, 1931) referred to striped bass feeding on smelt and Sacramento splittail, as well as their own young, but did not present quantitative data.

Shapovalov (1936) found young coho salmon and steelhead in stomachs of adult striped bass from Waddell Creek lagoon in April. Waddell Creek is a small coastal stream with a restricted area, and feeding occurred during downstream migration of the salmonids. Shapovalov also referred to a collection of large striped bass from Coos Bay, Oregon, which contained young salmon.

Hatton (1940) examined stomachs from 224 adult striped bass taken near Pittsburg during March-May (when large numbers of downstream migrating salmon were known to be in the area) and found no salmon or Central Valley steelhead in any of the stomachs. He stated, "The results of this investigation seem conclusive that salmonid fry form no important part of the food of striped bass in the lower Sacramento River. It cannot be maintained, however, that young salmon are never eaten by bass, but numbers of fry so destroyed must surely be negligible." Hatton found osmerids (presumably delta smelt and/or longfin smelt) in 4.90% of the stomachs and Sacramento splittail in 3.57% of the stomachs.

Johnson and Calhoun (1952) examined stomachs of angler-caught striped bass (all over 12 inches long) from the San Joaquin River between Antioch and the mouth of Middle River from November to June and found no identifiable salmon or Central Valley steelhead. They found "smelt" (species not identified) in one of 229 and three of 158 stomachs collected in summer-fall and winter-spring, respectively. No Sacramento splittail were found in this sample.

Stevens (1963) examined 670 stomachs of striped bass taken in the Sacramento River primarily in the vicinity of the Paintersville Bridge near Courtland during late spring and summer, 1962. Salmon smolts were prevalent in these stomachs (86.5% by volume, 88% frequency of occurrence), but occurrence of this predation did not occur until mid-June after the bulk of naturally produced salmon outmigrants already would have passed. Based on enumeration of surface foraging activity, predation peaks clearly depended on releases of Central Valley fall-run salmon fingerlings from Nimbus hatchery several days earlier into the American River approximately 40 miles upstream. This problem of hatchery released salmon attracting foraging striped bass has shifted to San Pablo Bay where salmon smolts from State hatcheries are now routinely transported by truck for stocking.

Stevens (1966) examined the contents of 8,628 striped bass stomachs collected from many Delta locations in 1963-1964. As would be expected, no salmon were found in stomachs of young-of-the-year bass. Small numbers of salmon were found in juvenile bass in spring and summer; in sub-adult bass in fall, spring, and summer; and in adults in spring and summer. Essentially, bass two years and older fed extensively on small striped bass and threadfin shad, with salmon constituting a small proportion of the diet. (Annual average 1% to 3% by volume and less than 1% to 3% by frequency of occurrence with the greatest percentages applying to the oldest striped bass. Seasonally, these values ranged from 0 to 10% by volume and 0 to 6% frequency of occurrence. These percentages apply to all salmon runs combined with fall run probably predominating.) Areas of the Delta where salmon were consumed included the lower San Joaquin River, the Sacramento River, and the lower Mokelumne river. Chinook salmon was not considered a major item of the diet. Only about 1% of these juvenile, sub-adult, and adult bass had eaten delta smelt, and none had eaten Central Valley steelhead or Sacramento splittail. In the spring and early summer, adult bass reduced their food intake, probably because of spawning activities.

Thomas (1967) examined over 4,500 striped bass stomachs from the Estuary and rivers upstream from the Estuary during the period 1957-1961. About half of these contained food. Chinook salmon made up a significant portion of the diet of juvenile and adult striped bass in the lower (up to 30% frequency of occurrence and 60% volume in summer) and upper (up to 62% frequency of occurrence and 65% volume in spring) Sacramento River during the spring and summer months (Table 2). They occurred in 2% of the stomachs with food from the upper Sacramento River in fall and were absent in stomachs from that area in the winter. Salmon did not occur in stomach samples from the Delta at anytime. Salmon were also absent from the striped bass diet in the lower Sacramento River in fall and winter. Although forming 17% of sampled diet volume in spring, they occurred in 3% or less of the stomachs with food from Carquinez Strait and Suisun Bay from spring to summer and did not occur in stomachs from that area in fall and winter. Delta smelt occurred in 7% and 8% of Thomas' bass stomachs with food from the lower Sacramento river in spring and summer, respectively, and in 12% of the stomachs from Carquinez Strait-Suisun Bay in winter. Delta smelt were absent in stomachs from these eas during the remainder of the year and from other areas. Thomas did not find Sacramento splittail in any stomachs.

Striped bass also have been observed feeding on Central Valley fall-run chinook salmon in the clear water of the Woodbridge Dam afterbay on the Mokelumne River (upstream from the Delta near Lodi). During May-June 1993, salmon or partially digested fish that may have been salmon were in 57.7% of 120 striped bass stomachs that contained food (45% of total stomachs examined). Approximately 200-500 striped bass averaging 40 cm fork length were estimated to be in the afterbay (Boyd 1994). Occurrence of such large numbers of striped bass in the Woodbridge afterbay apparently is uncommon, and probably was due to unusually high spring flows attracting striped bass up the river. The following year (1994) there were no reports of striped bass in the afterbay as of May 24.

Since salmon formed a sizeable portion of the diet of Thomas' fish, particularly in the Sacramento River in the spring, when Sacramento River winter-run chinook salmon smolts may be present, it is important to recognize that striped bass food consumption is low during that period because striped bass, spring spawners, reduce feeding as spawning approaches. Stevens (1966) found food in only 12% of the 174 adults (age ≥3) and 29% of the 312 sub-adults (age 2) that he examined from March through May 1964.

Table 2. Striped Bass Predation on Chinook Salmon

Location[2/]	Spring 3/1-5/31		Summer 6/1-8/31		Fall 9/1-11/30		Winter 12/1-2/28	
	%occurrence[3/]	%volume	%occurrence	%volume	%occurrence	%volume	%occurrence	%volume
Upper Sacramento River	62	65	7	36	2	7	0	0
Lower Sacramento River	22	9	30	60	0	0	0	0
Delta	0	0	0	0	0	0	0	0
Carquinez Strait-Suisun Bay	3	17	2	5	0	0	0	0

1/ From Thomas 1967.

2/ Exact locations of these areas was not given in the publication but it is clear that the lower Sacramento River includes the area from about Rio Vista up to at least Courtland, and the upper Sacramento River includes the area near Sacramento and the lower American River. No salmon were found in samples collected in this study from San Francisco and San Pablo bays.

3/ % Frequency of Occurrence in Stomachs With Food.

While Thomas (1967) did not attribute predation on chinook salmon to any particular factor, it is possible that striped bass in his Sacramento River samples were induced to feed on young salmon in response to hatchery releases. At the time of his study, consumption of young salmon by striped bass commonly occurred at least as far downstream as Courtland on the Sacramento River following releases of young Central Valley fall-run salmon from Nimbus hatchery into the American River in late spring and early summer (Stevens 1963). Currently, only Coleman Hatchery on Battle Creek near Red Bluff routinely releases salmon smolts into the river. Central Valley fall-run salmon are typically released in April or early May and Central Valley late-fall-run salmon are released in winter. Food consumption by adult and sub-adult striped bass is relatively low during these periods. Nimbus and Feather River hatcheries now transport their salmon production for release in the western Estuary. Although not documented scientifically, it is known that striped bass are sometimes induced to feed by releases of hatchery reared Central Valley steelhead into the Feather River.

Information based on stomachs collected in an ongoing striped bass creel census in 1994 suggests that currently the incidence of striped bass predation on salmon, Central Valley steelhead, delta smelt, and Sacramento splittail is low in the Estuary and Sacramento River. Stomachs from 28 angler-caught striped bass from 19 to 30 inches long collected between March 26 and August 4, 1994, over the broad geographic area from the Golden Gate to the Sacramento River near Colusa contained no identifiable remains of listed species; 11 of these stomachs contained other food items. Similarly, no chinook salmon, Central Valley steelhead, delta smelt, or Sacramento splittail were found in stomachs from 100 striped bass from 18 to 41 inches long collected between October 2 and November 19, 1994, from San Pablo Bay to the west-central delta (Rio Vista and False River); 59 of these fish contained food organisms other than listed species.

An analysis of striped bass predation on salmon in Coos Bay, Oregon suggests that large striped bass populations may limit salmon abundance there (Johnson et al. 1992). In general, juvenile salmon were much more prevalent in striped bass stomachs (776 salmon in 4,155 striped bass stomachs) from the Coos River than in stomachs from the Sacramento-San Joaquin system. This difference in salmon consumption may reflect a difference in their vulnerability to predation related to habitat differences such as generally lower water clarity or greater abundance of buffer prey species in the Sacramento-San Joaquin system.

Giant garter snakes have not been found in any striped bass stomachs.

2. Analysis of Predation on Chinook Salmon -- Estuary and River System in General

The various food habit studies that are cited above provide the best available overview of the striped bass diet. However, for various reasons (including small samples for some areas and seasons, differences in digestion rates among food organisms, local geographic and temporal variability in food types, potential regurgitation of food associated with capture stress) these studies yield imprecise, loosely constrained measures of food consumption and predation rates ı salmon, Central Valley steelhead, delta smelt, and Sacramento splittail. Thus, actual predation rates may be much lower or higher than the estimates that have been derived from the models, based on various assumptions, described in Appendix E. Based on the available data and these models, the CDFG and NMFS have agreed that predation by a striped bass population of approximately 765,000 adults, (the mean of the 1992, 1993, and 1994 striped bass population estimates), may account for about 6% of the Sacramento River winter-run chinook salmon, 3% of the Central Valley spring-run chinook salmon, and 8% or less of the Central Valley fall-/late-fall-run chinook salmon outmigrations (see Appendix E for a more detailed discussion).

The diet studies (Scofield 1928 and 1931, Scofield and Bryant 1926, Hatton 1940, Johnson and Calhoun 1952, Stevens 1966, Thomas 1967, Boyd 1994) reveal that striped bass are less likely to eat salmon in Suisun Bay and the Delta than in the rivers above the Delta. The greater vulnerability of salmon in the rivers may be a result of the greater clarity and/or smaller width of the rivers. Small salmon are necessarily more concentrated when in the relatively narrow rivers than when in the broad and diverging channels of Suisun Bay and the Delta. The availability of small salmon to striped bass in the Estuary probably also is reduced because other forage fishes are more abundant than in the rivers and act as a buffer against predation on salmon.

Opportunity for striped bass large enough to prey upon salmon to encounter young chinook salmon is affected by several factors. In the early part of the Sacramento River winter-run chinook salmon outmigration, adult striped bass begin to assemble in the cold, generally turbid lower Delta and bays (from December through March) in preparation for spawning migrations in April, May, and June. During this period, striped bass metabolism (and feeding activity) is low due to low water temperatures. No salmon were found in striped bass stomachs in winter by either Stevens (1966) or Thomas (1967) although few stomachs were examined from bass captured in the Sacramento River during that season. Predation in spring when most Central Valley fall-run salmon emigrate is reduced because adult bass seldom eat on their spawning migration (Stevens 1966), and during that period, most younger bass large enough to prey on small fish remain in the Estuary where, as discussed previously, salmon have minimal susceptibility to predation. In the fall when most Central Valley spring-run chinook salmon and Central Valley late-fall-run salmon emigrate, predation by striped bass is buffered by the new year classes of more typical forage species such as their own young, threadfin shad and anchovies.

Salmon and striped bass populations coexisted in much greater abundance than the populations existing today, and available historical information on population trends does not suggest that high periods in striped bass abundance coincided with lower populations of salmon as would be expected if striped bass were a major factor limiting salmon abundance. Chadwick and von Geldern (1964), while evaluating the possible effects of introducing white bass into California, examined potential effects of striped bass on salmon. They stated as follows:

> "Yearling and two-year-old striped bass are abundant in the Sacramento River and its main tributaries. In local situations they feed extensively on salmon. We do

not have sufficient knowledge to determine precisely the effects of this predation. However, if it is a dominant factor controlling the salmon population, salmon year class size should be negatively correlated with the abundance of yearling and two-year-old striped bass in the spring when the year class migrated downstream. Precise measures of population size are not available for either species. The best available measure of the size of a salmon year class is the average commercial landings in the San Francisco area two and three years after they migrated downstream. The best measure of the abundance of striped bass is the catch per angler day on party boats in the San Pablo Bay-Carquinez Strait during the fall. Many ages of bass contribute to this catch, but it is primarily bass under five years old. Hence, the abundance of yearling and two-year-old bass in any year is reflected in party boat catches one to three years later. Therefore, to examine the effects of predation in any given year, we compared the average salmon catch two and three years later with the average striped bass catch one, two, and three years later. The correlation coefficient for this relationship for the years 1939-1961 is +0.52. This is significant at the 95 percent level. While it is difficult to interpret the causes for and therefore the meaning of such correlations, this positive correlation certainly indicates that striped bass predation is not a dominant factor controlling the salmon population."

The statistical analysis by Chadwick and von Geldern has not been updated; however, the concurrent declines of striped bass and salmon over the past two to three decades and evaluation of the impact of the current striped bass population and the proposed stocking program (see pages 45 to 55 and Appendix E) support their conclusion.

a. Predation in Response to Stocking of Hatchery Reared Salmon

Although not scientifically documented, it is well known that striped bass prey upon salmon smolts at sites in Carquinez Strait and San Pablo Bay where almost daily hatchery releases of large numbers of Central Valley fall-run chinook salmon smolts induce feeding by predatory striped bass in late spring and summer. Also, as previously described, predation on salmon in the Sacramento River near Courtland in 1962 was closely associated with releases of salmon from Nimbus hatchery into the American River (Stevens 1963). Thomas (1967) did not evaluate effects of hatchery releases when he found salmon in striped bass stomachs in the "lower" and "upper" Sacramento River; however, in describing his "lower Sacramento River" samples, he specified that salmon were in the diet of bass in the Courtland area (Thomas 1967, p. 53). At least part, if not all, of these samples were taken in 1961 at the same location and under the same conditions as sampled by Stevens (1963) in 1962. (D. Stevens, primary author of this Conservation Plan, assisted in collection of Thomas' 1961 samples at Courtland.) Thomas' "upper Sacramento River" samples also likely reflected predation stimulated by releases of salmon from Nimbus hatchery as those samples included bass from the lower American River (Thomas 1967, p. 53). Predation in the American River only applies to Central Valley fall-run chinook salmon.

b. Predation on Salmon at Various Structures, Including Clifton Court Forebay

While the incidence of striped bass predation on listed species is low in general, the potential for predation is enhanced at various human-made structures such as RBDD, the Glenn-Colusa Irrigation District intake (GCID), Suisun Marsh Salinity Control Structure (SMSCS), Clifton Court Forebay (CCF), and the U.S. Bureau of Reclamation Tracy Fish Collection Facility (TFCF) in front of the pumping plant.

Of these structures, sampling of striped bass stomachs has only occurred at SMSCS, CCF, and TFCF. A nominal amount of predation by striped bass on salmon has been documented at the SMSCS in Montezuma Slough. Stomachs of 647 striped bass ranging from 22-98 cm were examined between 1987 and 1993. The stomachs contained a total of four salmon (run unidentified), but no delta smelt or Sacramento splittail.

CDFG is concerned about striped bass predation on all species in CCF where striped bass concentrate and receive constant recruitment of prey size fish that enter the forebay with water transferred into and through the forebay to the water export pumps. These small fish may be vulnerable to predation because of lack of protective cover or exit routes from the forebay (except at the fish screening facilities).

In experiments, based on stocking groups of marked salmon smolts in the CCF, 63% to 99% of the stocked salmon have not successfully traversed the forebay (Table 1). It has been generally assumed that striped bass predation accounts for most of these losses as tens of thousands to several hundred thousand striped bass may inhabit the forebay. While this assumption regarding striped bass predation may be true, direct evidence is lacking. No striped bass stomach samples have been collected during the experiments, and more than 1,900 striped bass stomach samples collected during non-loss rate experiment periods in 1983-1984 and 1993-1995 provide seemingly contradictory evidence in that only one of these stomachs (0.05%) contained an identifiable salmon (Table 3). However, 55.6% of the stomachs contained unidentifiable fish. A variety of other fishes were found in these stomachs, especially threadfin shad. Nevertheless, it is still possible that striped bass predation has caused the experimental salmon losses as the salmon releases may attract (chum) striped bass just as salmon hatchery releases do at sites west of the Delta and formerly did in the rivers upstream. If so, the experiments may overestimate losses of salmon under normal conditions in the forebay. Other factors that could contribute to the high losses include salmon escaping from the forebay by passing into Old River through the forebay entrance, bird predation, and predation by other fishes (such as squawfish and the black basses, crappies, and catfishes).

Regardless of uncertainty about the rate of predation by striped bass on salmon in Clifton Court, predation on Sacramento River winter- and Central Valley spring-run chinook salmon should be minimal because the fraction of Sacramento River salmon outmigrants that arrive at the CVP/SWP fish screens is extremely small. Studies with tagged salmon show that on average less than 0.002% released into the upper Sacramento River (Battle Creek, Red Bluff, Princeton) and about 0.07% released into the lower Sacramento River (Sacramento- Ryde) arrive at the able 3. Incidence of Food Items in Stomachs of Striped Bass Collected From Clifton Court Forebay.

	Year					
	1983 and 1984	1993	1994	1995	Total	% stomachs containing item
Food Item:						
Chinook salmon	0	0	1	0	1	0.05
Central Valley steelhead	0	0	0	1	1	0.05
Striped bass	11	0	7	0	18	0.94
White catfish	1	0	0	0	1	0.05
American Shad	2	4	2	0	8	0.42
Threadfin Shad	59	27	22	0	108	5.64
Squawfish	0	1	0	0	1	0.05
Log perch	1	4	0	0	5	0.26
Carp	1	0	0	0	1	0.05
Inland silverside	0	1	0	0	1	0.05
Yellowfin Goby	6	14	3	0	23	1.20
Chameleon Goby	0	16	6	0	22	1.15
Lamprey	0	8	1	0	9	0.47
Staghorn sculpin	0	1	0	0	1	0.05
Riffle sculpin	0	1	0	0	1	0.05
Sacramento Blackfish	1	0	0	0	1	0.05
Bluegill	0	0	3	0	3	0.16
Brown bullhead	0	0	1	0	1	0.05
unidentifiable fish remains	297	390	284	94	1065	55.58
amphipods	74	152	108	33	367	19.15
chironomids	36	17	17	3	73	3.81
neomysids	0	9	7	5	21	1.10
odonata	0	1	4	0	5	0.26
molluscs	45	7	9	3	64	3.34
cladocerans	5	0	2	1	8	0.42
copepods	0	0	1	0	1	0.05
crayfish	0	0	3	1	4	0.21
other crustaceans	0	52	3	2	57	2.97
worms	2	0	6	2	10	0.52
leeches	0	0	4	1	5	0.26
mayflies	0	0	4	0	4	0.21
spiders	0	0	0	1	1	0.05
frogs	0	0	0	1	1	0.05
miscellaneous insects	0	0	13	5	18	0.94
other invertebrates	1	0	18	9	28	1.46
plant material	0	265	182	47	494	1.46

reens (Table 4). Conversely, percentages of marked salmon released into the San Joaquin River that subsequently have been salvaged are substantially greater, averaging around 5% and including an estimated 42% recovery of a release made into upper Old River in 1986.

At the TFCF, striped bass predation was evaluated during a predator removal program in 1992 (USBR 1994). Stomachs of 187 striped bass (3.4 to 15.2 inches in length) were examined in May, September, October, and December. Stomachs of 68 of these striped bass contained fish remains including smaller striped bass, chameleon goby, threadfin shad, American shad, big scale logperch and possibly smelt. No salmon were in these stomachs. Thus, there is no evidence of striped bass predation on salmon at TFCF under normal operating conditions.

In contrast, during some limited sampling of stomachs in 1993 when hatchery reared Central Valley fall-run salmon were released at the TFCF for experiments to evaluate screen efficiency, up to eight salmon were found in individual striped bass stomachs (C. Karp, USBR, pers. comm. April 24, 1996). Such results, contrasting with the lack of salmon in stomachs during normal operations, are consistent with other evidence indicating that striped bass predation may be stimulated by concentrated releases of hatchery-reared salmon.

c. Summary of Predation Impact on Salmon

In essence, diet studies provide evidence of a generally low incidence of predation by striped bass on juvenile salmon (the diet studies have not identified runs of the salmon that have been consumed). However, in the Estuary and Sacramento River instances of more intensive predation may occur. These instances have been at least partly influenced by releases of hatchery reared Central Valley fall-run smolts. The extent of striped bass predation at the water project intakes is uncertain; however, the fraction of Sacramento River salmon that arrive at the screens apparently is low and the low incidence of salmon in striped bass stomachs at the intakes, suggests any increase in predation on chinook salmon at the water project intakes due to the proposed stocking of striped bass should be extremely small. Factors influencing striped bass predation on salmon likely include: water clarity and/or river width, and artificial structures such as bridges, dams, and potentially rip-rap sites. During their outmigration, wild juvenile salmonids are subject to these factors, and if striped bass occur where salmon are vulnerable, salmon may be preyed upon.

Based on the striped bass diet studies (Stevens 1966, Thomas 1967) and salmon life histories (Appendix B), we know that striped bass have preyed upon salmon when and where juvenile salmon of all runs may occur, but also only when the numerous Central Valley fall-run would have been present.

3. Analysis of Predation on Central Valley Steelhead

Except for one Central Valley steelhead found in one of more than 1,900 stomachs of striped bass collected from Clifton Court (Table 3), Central Valley steelhead have not occurred in striped bass stomachs during any diet study in the Sacramento-San Joaquin Estuary or rivers.

Upper Sacramento Releases

Year	Total Number Released	Expanded Salvage Numbers SWP **	CVP **	Total Number Salvaged (Exp.)	Percent Recovered at SWP & CVP
1995	248,069	0	0	0	0
1994	263,087	0	0	0	0
1993	234,344	4	12	16	0.007
1992	260,531	2	0	2	0.0008
1991	180,470	0	0	0	0
1990	154,679	0	0	0	0
1989	154,593	18	0	18	0.012
1988	157,490	0	0	0	0
1987	154,784	0	0	0	0
1986	164,486	0	0	0	0
1985	196,816	0	0	0	0
TOTAL	2,169,349	24	12	36	0.0017

Lower Sacramento Releases

Year	Total Number Released	Expanded Salvage Numbers SWP **	CVP **	Total Number Salvaged (Exp.)	Percent Recovered at SWP & CVP
1995	101,889	0	12	12	0.012
1994	211,346	0	0	0	0
1993	336,950	17	60	77	0.023
1992	149,263	0	34	34	0.023
1991	207,180	0	9	9	0.004
1990	252,439	0	6	6	0.002
1989	593,586	44	0	44	0.007
1988	928,284	1,890	115	2,005	0.216
1987	303,332	322	47	369	0.122
1986	200,186	0	8	8	0.004
1985	207,787	0	0	0	0
TOTAL	3,492,242	2,273	291	2,564	0.073

Mokelumne & Georgiana Slough Releases

Year	Total Number Released	Expanded Salvage Numbers SWP **	CVP **	Total Number Salvaged (Exp.)	Percent Recovered at SWP & CVP
1995	249,095	0	0	0	0
1994	307,922	31	12	43	0.014
1993	305,122	28	204	232	0.076
1992	358,672	31	20	51	0.014
1991	279,282	151	305	456	0.163
1990	none				
1989	none				
1988	none				
1987	none				
1986	204,914	360	12	372	0.182
1985	201,622	90	13	103	0.051
TOTAL	1,906,629	691	566	1,257	0.066

Upper San Joaquin Releases

Year	Total Number Released	Expanded Salvage Numbers SWP **	CVP **	Total Number Salvaged (Exp.)	Percent Recovered at SWP & CVP
1995	331,142	2,225	5,409	7,634	2.305
1994	315,125	63	288	351	0.111
1993	none				
1992	none				
1991	none				
1990	171,888	1,341	756	2,097	1.22
1989	252,636	6,509	2,404	8,913	3.528
1988	140,463	8,537	7,689	16,226	11.55
1987	183,111	6,278	4,217	10,495	5.731
1986	417,064	28,141	14,750	42,891	10.28
1985	none				
TOTAL	1,811,429	53,094	35,513	88,607	4.892

Lower San Joaquin Releases

Year	Total Number Released	Expanded Salvage Numbers SWP **	CVP **	Total Number Salvaged (Exp.)	Percent Recovered at SWP & CVP
1995	462,266	232	6,044	6,276	1.358
1994	207,322	141	660	801	0.386
1993	210,311	328	4,588	4,916	2.337
1992	520,656	219	8,821	9,040	1.736
1991	397,762	5,993	6,626	12,619	3.173
1990	419,137	3,789	2,150	5,939	1.417
1989	255,348	5,749	2,414	8,163	3.197
1988	none				
1987	183,564	12,905	19,127	32,032	17.45
1986	195,776	7,982	74,310	82,292	42.03
1985	none				
TOTAL	2,852,142	37,338	124,740	162,078	5.683

** SWP and CVP salvage numbers for 1995 are preliminary.

Table 4. Estimated State Water Project (SWP) and Central Valley Project (CVP) Salvage of Marked Chinook Salmon.

The same factors affecting predation by striped bass on salmon would affect predation on Central Valley steelhead. Also, Central Valley steelhead would be less vulnerable than salmon to predation by striped bass because when most young Central Valley steelhead migrate through the river system and Estuary where striped bass are concentrated, the Central Valley steelhead are larger than salmon; thus, they swim faster and would be better at avoiding predators. However, some hatchery-reared Central Valley steelhead are preyed upon by striped bass near release sites in the Feather River.

4. Analysis of Predation on Delta Smelt in the Estuary and River System in General

As described for chinook salmon, the best available information yields imprecise, loosely constrained estimates of striped bass predation on delta smelt.

In contrast to chinook salmon, delta smelt has considerable distributional overlap with striped bass. However, striped bass rarely ate delta smelt when smelt and bass were both more abundant (Stevens 1966, Thomas 1967). Delta smelt occurred in only 0.3% of the striped bass stomachs sampled from the Estuary between 1957 and 1961 (15 out of 4,551 stomachs); of those 4,551 stomachs only 2,259 stomachs contained food, which translates to a 0.7% occurrence of delta smelt in those stomachs containing food (calculated from Thomas 1967). Twelve of the fifteen stomachs with delta smelt were from the lower Sacramento River (area not defined) in spring and summer and the other three were from Suisun Bay in winter. Stevens (1966) observed ten delta smelt in 4,781 stomachs from yearling and older striped bass from the Delta. Delta smelt did not occur in any of the stomachs sampled from 128 angler-caught striped bass in 1994, nor have they occurred in any of the stomachs from 647 striped bass sampled since 1987 near the SMSCS in Montezuma Slough, an area where delta smelt should be common. Thus, even though there is considerable overlap in the distribution of striped bass and delta smelt, delta smelt obviously are not a major target of foraging bass.

This lack of selectivity for delta smelt may occur because delta smelt are surface oriented (Radtke 1966) while striped bass tend to forage near the bottom unless attracted to the surface by massive schools of forage fishes such as threadfin shad, other clupieds, and anchovies. For fishes such as delta smelt which, based on CDFG trawl surveys, form smaller schools, perhaps striped bass surface foraging depends on water clarity being great enough to allow detection of prey from greater distances than is usually possible in the turbid waters of the Estuary and rivers immediately upstream.

Despite the low incidence of delta smelt in striped bass stomachs, the year-round overlap in distribution of delta smelt and striped bass results in an estimated annual consumption of about 5.3% of the delta smelt population by a striped bass population of approximately 765,000 adults (see Appendix E for a more complete discussion of this predation estimate). The following points suggest that factors other than striped bass predation are primarily responsible for the high annual variability in delta smelt abundance: (1) 5.3% of the delta smelt population is a relatively low consumption rate; (2) striped bass abundance has been in decline for several decades; (3) historically, annual delta smelt abundance has varied significantly; (4) the delta smelt population rebounded in 1993 to pre-decline levels after surviving six years of drought (1987-1992); and (5) delta smelt recovered to the seventh highest midwater trawl survey abundance index on record in 1995 following the record low index in 1994.

a. Predation on Delta Smelt at Various Structures

As for salmon, the potential for predation on delta smelt is increased at various human-made structures in the Estuary such as SMSCS, CCF, and the fish screening facilities at the State and Federal water project intakes in the southern Delta. Nevertheless, at the SMSCS, stomachs from 647 striped bass (22-98 cm) examined between 1987 and 1993 contained no delta smelt. Also, the more than 1,900 stomachs of striped bass examined from CCF between 1983 and 1995 contained no delta smelt, although they did contain a variety of other fishes (Table 3). Stomachs of 187 striped bass sampled at TFCF in 1993 (USBR 1994) possibly contained one delta smelt (a well digested fish that was possibly a delta smelt occurred in one stomach, L. Hess, USBR, pers. comm., April 19, 1996).

b. Summary of Predation Impact on Delta Smelt

Based on the striped bass diet studies discussed previously, striped bass have been known historically to feed on delta smelt. Based on the analyses described in Appendix E, CDFG and the USFWS have agreed that a predation rate of 5.3% of the annual delta smelt population is a reasonable estimate for the purposes of this Conservation Plan.

5. Analysis of Predation on Sacramento Splittail

Like delta smelt, there is considerable overlap in the distribution of Sacramento splittail and striped bass. However, Sacramento splittail did not occur in any of the thousands of striped bass stomachs sampled by Stevens (1966) or Thomas (1967) or in the stomachs sampled in 1994, although they apparently were found in striped bass stomachs several decades earlier (Scofield and Bryant 1926; Scofield 1928, 1931). Perhaps Sacramento splittail were relatively more abundant earlier in the century and more recent introductions of alternative forage species (e.g., threadfin shad) have buffered predation on Sacramento splittail. Based on the complete lack of Sacramento splittail in extensive sampling of striped bass stomachs in the 1960s by Stevens (1966) and Thomas (1967), and more recently since 1987 in Montezuma Slough, from 1984 to 1995 in CCF, at TFCF in 1993, and from angler-caught bass in 1994, it does not appear that striped bass consume any significant number of Sacramento splittail. However, the apparent presence of Sacramento splittail in striped bass stomachs earlier in the century and anecdotal information that some anglers use live Sacramento splittail as bait for striped bass suggests that some predation may occur. For the purposes of this Conservation Plan, predation of Sacramento splittail by striped bass is assumed to be no greater than the predation rates derived for delta smelt, and most likely, significantly lower.

ɒ. Analysis of Predation on Giant Garter Snake

No evidence has ever been documented of striped bass predation on giant garter snake. Predation would not be expected since striped bass generally inhabit open water habitat near the bottom unless attracted to the surface by large schools of bait fish. Giant garter snakes spend minimal time in open water habitat, and when they are there, it is only at the surface. Nonetheless, striped bass do sometimes move into the smaller streams and sloughs where giant garter snakes occur and forage near shore. Thus, while there is almost certainly overlap in the range of these two species, overlap in their use of aquatic habitat is minimal. Therefore, while there is a remote possibility that striped bass could occasionally and opportunistically prey on giant garter snakes, the extent of this predation is expected to be minimal if it occurs at all.

G. Other Considerations Regarding Predation on Covered Fishes

Water clarity has increased in the Estuary since the early 1970s (DWR and USBR 1994) which could increase the susceptibility of all fishes to predation by striped bass, but, while recent sampling has not been as extensive as that by Thomas (1967) or Stevens (1966) in the 1960s, there is no evidence of greater predation on any of the listed species based on the sampling of striped bass stomachs since 1987 (See Appendix H).

Evidence that striped bass have not caused the declines of the covered species comes from population trends during the last 30 to 40 years. During that time, striped bass abundance has fallen to one-fifth that at the start of the period, largely due to water management impacts. Had striped bass been the major factor controlling the abundance of the covered species, their populations would likely have increased commensurately with the decrease in striped bass abundance since the 1960s and 1970s. However, salmon, Central Valley steelhead, delta smelt, and Sacramento splittail have decreased during this period, like striped bass, apparently victims of habitat degradation.

It has been suggested (USFWS/NMFS letter to director CDFG, February 13, 1996) that if habitat degradation caused the decline of the covered species and currently limits reversal of those declines, then the significance of predation by striped bass may be masked (the covered species would not have increased if their habitat became degraded simultaneously with the striped bass population decline) and that actions directed only toward increasing striped bass abundance may increase predation impacts and impede recovery of the covered species. A top predator like striped bass, which became a dominant fish in the estuarine ecosystem following its introduction, must have initially caused some decrease in the abundance of native fishes. The available evidence is not sufficient to identify that impact; however, by now there is likely considerable buffering by unintentional introductions during the past four or five decades of readily consumed forage fishes, such as the threadfin shad, that have gained access to the Estuary in water discharged from Central Valley reservoirs and the several species of gobies that have entered the Estuary via ship ballast water discharges, and also by myriad other less frequently consumed fishes introduced since the late 1800s.

In any event, while factors other than striped bass predation precipitated the declines of the covered fishes, their populations presently are at a low level and the Sacramento River winter-run chinook salmon in particular, has a high probability of extinction. Any new activity, such as the proposed stocking of striped bass, which directly or indirectly increases mortality above current levels may impact species survival and recovery.

Competition for food is another potential interspecific impact of striped bass on the covered fishes as there is some overlap in diet, primarily planktonic crustaceans, among young striped bass and the covered species (Heubach et al. 1963, Sasaki 1966, Stevens 1966, Stevens et al. 1990, DWR and USBR 1994, Appendix D). However, numerous other fishes and larger invertebrates also feed on these same organisms including virtually all fishes in the Estuary during at least part of their life cycle. Thus, it is not possible to quantify effects of competition between striped bass and the covered species. In essence, competition by striped bass cannot be ruled out as impacting the covered species, but the long-term decline in striped bass abundance indicates that such competition is less today than under historical conditions.

H. CDFG Policy and Goals

With respect to striped bass restoration, the CDFG is committed to goals of:

- *Stabilizing and then restoring the striped bass fishery of the Estuary and to help restore and improve habitat for striped bass and other aquatic species in the Estuary.*
- *Insuring that programs designed to improve striped bass do not jeopardize the continued existence of Federal or State listed threatened/endangered species.*
- *Providing Bay-Delta striped bass which, when eaten, will not damage human health due to contamination from chemicals or trace-metals.*
- *Providing for significant striped bass angling, aesthetic, and educational use-opportunities.*

On April 5, 1996, the California Fish and Game Commission adopted the following striped bass policy:

"It is the policy of the Fish and Game Commission that:

I. The Department of Fish and Game shall work toward stabilizing and then restoring the presently declining striped bass fishery of the Sacramento-San Joaquin Estuary. This goal is consistent with Commission policy that the Department shall emphasize programs that ensure, enhance, and prevent loss of sport fishing opportunities.

II. The Department shall ensure that actions to increase striped bass abundance are consistent with the Department's long-term mission and public trust responsibilities including those related to threatened and endangered species and other species of special concern. Recognizing issues associated with potential incidental take of these species, an appropriate interim objective is to restore the striped bass population to the 1980 population level of 1.1 million adults within the next 5-10 years.

III. The long-term striped bass restoration goal, as identified in the Department's 1989 Striped Bass Restoration Plan, is 3 million adults.

IV. The Department shall work toward these goals through any appropriate means. Such means may include actions to help maintain, restore, and improve habitat; pen-rearing of fish salvaged from water project fish screens; and artificial propagation."

However, not withstanding this policy, the following chapter describes alternate striped bass stocking levels proposed under this Conservation Plan.

Chapter 3. PROPOSED ACTIONS

The striped bass management activities proposed to be covered under this Conservation Plan are annual stocking of striped bass in San Pablo Bay, oversight and enforcement of the striped bass fishing regulations, monitoring of the striped bass population, and installation operation and/or maintenance of fish screens..

A. Stocking Striped Bass

The goals of the State of California as stated by Fish and Game Commission policy are to restore striped bass abundance to 1.1 million adults in the near term and ultimately to 3 million adults. However, to minimize predation impacts on the covered species, during the Conservation Plan negotiation process the CDFG, NMFS, and USFWS jointly developed a Striped Bass Management Program which would prevent further decline, but not increase striped bass abundance above the 1994 population level. Thus, this Program proposes stocking sufficient striped bass to maintain the 1994 population level of 712,000 adults. For the purpose of this Conservation Plan, "adult" striped bass are defined as one-half of all age-three fish plus all older fish.

While historic CDFG activities such as testimony supporting flow and water quality standards probably have slowed the striped bass decline, they have not allowed the population to increase or even remain stable. There are too many factors beyond control of the CDFG. It is unlikely that habitat restoration measures alone will stabilize the striped bass population. While the Central Valley Project Improvement Act (CVPIA), CALFED, mitigation for the Central Valley Project and State Water Project, and other efforts are currently underway to assist in the stabilization and recovery of the striped bass population, the population continues to decline despite many similar historic activities attempting to maintain striped bass abundance (Appendix A).

The CDFG estimates that without stocking and assuming average Delta Accord outflows and water exports, the striped bass population will decline from its 1994 level of 712,000 adults to 515,000 adults within five years (Table 5). (CALFED, the Delta Accord, and CVPIA are addressed in more detail on pages 79 to 83). Estimation of the numbers of one- and two-year-old bass that would need to be stocked to stabilize and maintain 712,000 adult striped bass (see Table 5 and Appendix E) is based on: (1) using the CDFG striped bass model to estimate the abundance trend of naturally-produced striped bass; (2) survival of marked yearlings stocked in past years (Delisle and Coey 1994); and (3) an assumption regarding the way that survival between release and recruitment at age three is partitioned between the first and second year after release. Previously stocked yearlings were primarily progeny of artificially-spawned adults and reared in hatcheries. As indicated in Table 6, survival of various groups of those stocked fish to age three ranged from 3.7% to 17.5%.

Table 5. Estimated Effects (abundance of adult striped bass and annual consumption of Sacramento River winter-run chinook salmon and delta smelt after 5 and 10 years) of Not Stocking Striped Bass and Seven Potential Stocking Scenarios Using Combinations of Yearling and Age 2 Striped Bass.

Higher numbers of bass are stocked in the first 5 years to attain the goal of returning abundance to approximately the 1994 legal-sized adult population of 712,000. Stocking in the next 5 years is reduced to a level that maintains that abundance. Predictions of striped bass abundance assume initial abundance of 712,000 and hydrologic conditions equivalent to 1922-91 mean outflow and export produced by a Department of Water Resources operations study of the December 15, 1994 Delta Accord. With no stocking, this hydrology causes a reduction in adult abundance to 515,000.

First 5 Years		Second 5 Years		Abundance after		Percent of Sacramento River winter-run chinook salmon salmon outmigrants consumed by stocked striped bass after		Percent of the June delta smelt population consumed by stocked striped bass after	
Yearlings stocked annually	Age 2 stocked annually	Yearlings stocked annually	Age 2 stocked annually	5 years	10 years	5 years	10 years	5 years	10 years
0	0	0	0	515,000	515,000	0	0	0	0
1,275,000	0	860,000	0	712,000	712,000	1.59	1.14	1.42	0.99
1,000,000	59,000	800,000	23,000	712,000	712,000	1.41	1.12	1.21	0.96
750,000	113,000	600,000	76,000	712,000	712,000	1.24	1.00	1.01	0.81
500,000	168,000	400,000	128,000	712,000	712,000	1.07	0.88	0.82	0.67
250,000	222,000	200,000	181,000	712,000	712,000	0.91	0.77	0.62	0.52
125,000	248,000	100,000	208,000	712,000	712,000	0.82	0.71	0.52	0.45
0	275,000	0	234,000	712,000	712,000	0.74	0.66	0.43	0.38

Table 6. Estimated Survival to Age 3 of Hatchery-Reared Yearling Striped Bass Stocked in the Sacramento-San Joaquin Estuary.

Year Class	Estimated Percentage Survival to Age 3
1981	0.099
1982	0.175
1983	0.167
1984	0.065
1985	0.111
1986	0.088
1987	0.053
1988	0.089
1989	0.084
1990	0.037
Mean	0.097

Based on 10% mean survival of yearlings to age three, stocking 1.275 million yearlings or an equivalent combination of yearlings and two-year olds (Table 5) annually for five years, on top of natural production estimated from average State Water Resources Control Board (SWRCB) conditions, would be required to stabilize and maintain an average population of 712,000 adults. That average population level could then be maintained by annually stocking 860,000 yearlings or an equivalent combination of yearlings and two-year olds in the remaining years of this ten-year program.

For purposes of estimating equivalent stocking rates for two-year-old fish needed to achieve 712,000 adult striped bass (as compared to yearlings), the approximate 10% mean survival between age-one and age-three was assumed to represent 25% survival during the first year and 40% during the second year after release. This partitioning should be a reasonable approximation based on: (1) an expectation that larger fish have greater survival, and (2) mark-recapture estimates of about 50% annual survival for three-year-old bass. This survival partitioning and the quicker contribution of two-year-old fish to the adult population yield an estimate that the adult population response is equivalent from stocking 275,000 age-two fish or 1.275 million yearlings (Table 5). Various intermediate combinations of one- and two-year-old fish would also provide equivalent benefits.

To mitigate losses to water diversions and help stabilize and maintain the average abundance of adult striped bass at 712,000 fish, the CDFG proposes:

- ***Annually stocking the equivalent of 1.275 million yearling net-pen or hatchery-reared striped bass, through a combination of yearling and two-year old fish, for five years (years 1 through 5). These fish will range from about 6 to 14 inches fork length. The numbers of one and two-year old striped bass that will be stocked in these years can be found in Table 13 (page 98).***

- ***Annual stocking of 860,000 yearling equivalents, through a combination of yearling and two-year old fish, for five more years (during years 6 to 10 of the ten-year project). The numbers of one and two-year old striped bass that will be stocked in these years can be found in Table 13 (page 98).***

Thus, the CDFG Striped Bass Management Program proposes a ten-year stocking plan. Stocked striped bass will be released in June or July to avoid immediate conflict with outmigrating Sacramento River winter-run chinook salmon and Central Valley steelhead. Releases will occur downstream from the primary habitat of delta smelt and Sacramento splittail in San Pablo Bay, west of the Interstate 80 bridge at Crockett.

Due to the greater genetic diversity of naturally produced fish, the CDFG's priority is to stock fish salvaged at the State and Federal fish screens and reared for one or two years in net-pens floating in the Estuary. However, it is unlikely that numbers of salvaged fish will consistently be sufficient to fully support the program. Pen-reared fish will have to be supplemented with fish produced by aquaculture. For example, despite efforts to collect larger numbers, only 22,200 salvaged bass were pen-reared into the yearling stage in 1995-96 and only 113,000 bass were reared in 1996-97. About 200,000 young striped bass were reared by a combination of pens and aquaculture in 1998-99. Less than 150,000 fish were available at the fish screens, and two aquaculture contractors were only able to produce about 150,000 fingerlings despite attempting to produce more than 1 million young striped bass. In contrast, based on the salvage of almost 8 million striped bass in June and July 1993, it is likely that the full allotment could have been met from salvaged fish that year (Figure 3).

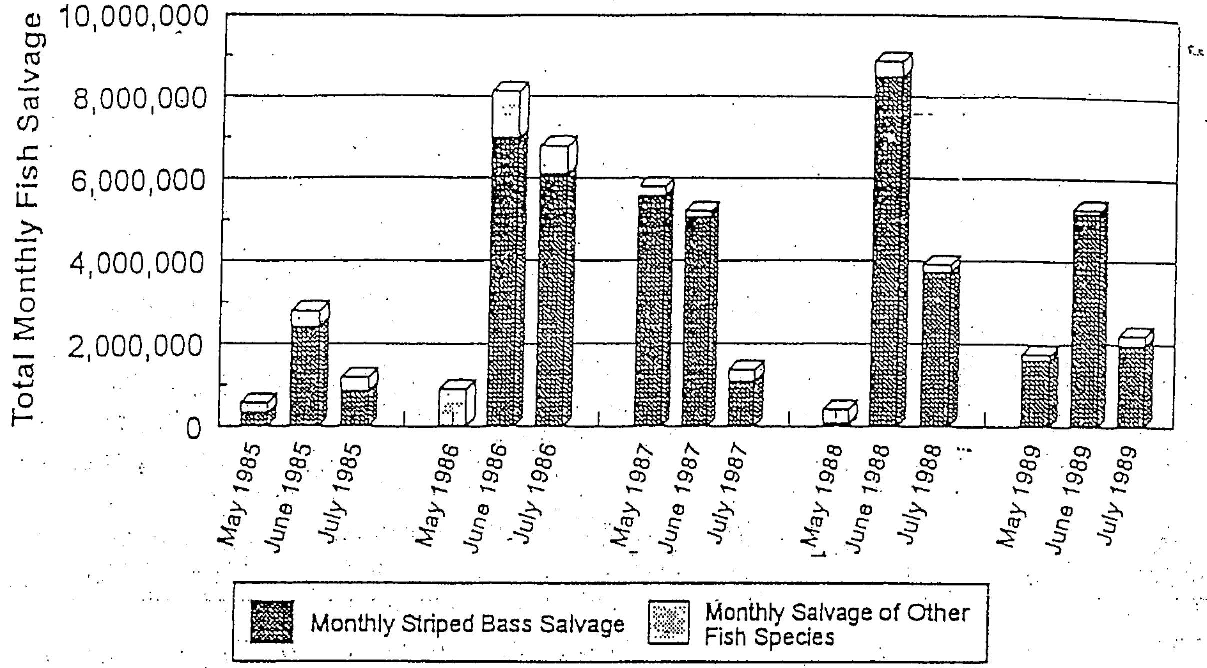
Striped bass spawn primarily during May, but salvaged fish are not available until late May, June, and July. Thus, each year, the numbers of salvaged fish available for pen-rearing will not be known until after artificial spawning would have to occur. The CDFG will attempt to ensure sufficient availability of fish each year by contracting with private aquaculture to begin culture of sufficient fish for the entire allotment. After the number of salvaged fish is known, excess aquaculture fish would be disposed of or perhaps used elsewhere by the CDFG and/or aquaculturists (e.g., reservoirs or food market). However, the experience in 1998 demonstrates that in spite of efforts to ensure a sufficient supply of fish, sometimes stocking goals will not be met.

Sufficient quantities of these stocked striped bass will be marked to allow evaluation of their contribution to subsequent adult populations and the relative benefits of: (1) conventional aquaculture and pen-rearing, and (2) stocking yearlings and two-year-olds. Rearing, marking, and monitoring of stocked fish will be funded by a combination of Department of Water Resources (DWR), U.S. Bureau of Reclamation (USBR), Pacific Gas & Electric Company (PG&E), USFWS, and CDFG funds, as authorized (see Chapter 16, Funding).

The scope of the stocking activities described for the purpose of this Conservation Plan is limited to the goal of restoring and maintaining average striped bass abundance at 712,000 adults. Further stocking that would be required to achieve longer-term abundance goals set by the California Fish and Game Commission (1.1 to 3.0 million) and CVPIA (2.5 million) is not addressed or covered by this Conservation Plan. Such increases in stocking to achieve higher abundance goals would require further action to comply with the ESA.

The proposed stocking program is consistent with, although does not fully implement, the striped bass policy (April 5, 1996) adopted by the California Fish and Game Commission (see Chapter 2, Section H).

J.E. Skinner Delta Fish Protective Facility
Months of May, June and July



Total Monthly Salvage - Striped Bass vs. Other Fish Species (1990-1994)
J.E. Skinner Delta Fish Protective Facility
Months of May, June and July

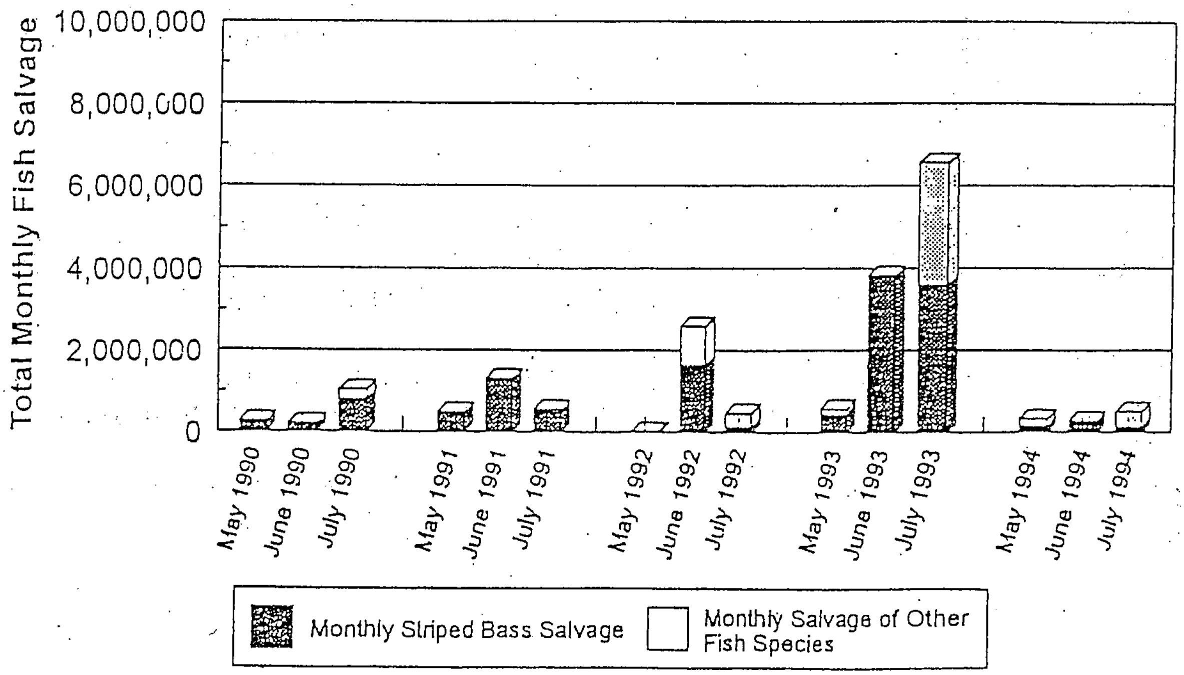


Figure 3. Salvage of Striped Bass and Other Species at the State Water Project Fish Screens, May-June, 1985-1994.

J. Striped Bass Fishing Regulations

The CDFG is responsible for management of the striped bass fishery through monitoring of the status of the fishery and population, recommending regulations to the California Fish and Game Commission and enforcement of regulations adopted by the Commission. The CDFG intends to recommend maintaining sport fishing regulations that protect striped bass and allow reasonable public angling opportunities. The most significant current regulations for striped bass are an 18-inch minimum size limit and a two-fish bag and possession limit (Current California fishing regulations are available at sporting good stores, bait and tackle shops, and other sporting related business throughout the state. They also are available at California Fish and Game offices.) The CDFG is not currently contemplating any recommendations for changes to these regulations; however, should the striped bass population experience an unanticipated decline, CDFG may consider recommendations for changes to the regulations. Such recommendations for changes may include increased size limits, reduced bag limits, and closed seasons and/or areas. This Conservation Plan and its associated Federal incidental take permits covers incidental take resulting from the current striped bass fishing regulations, as well as incidental take that may result from changes in regulations that are designed to meet or maintain the goal of 712,000 adult striped bass. The reason CDFG is seeking coverage under this Plan for fishing regulations is because striped bass anglers, as an indirect result of fishing regulations, may incidentally take chinook salmon and/or Central Valley steelhead. Regulation changes that would increase striped bass abundance above 712,000 adults are not covered by this Conservation Plan or its associated Federal incidental take permits.

C. Striped Bass Monitoring

As a part of its Striped Bass Management Program, CDFG proposes to monitor: (1) abundance of adult striped bass in the Estuary; (2) abundance of young striped bass; and (3) abundance and survival of stocked striped bass. Much of this monitoring is currently achieved through monitoring activities conducted by the Interagency Ecological Program (IEP), a State and Federal multi-agency program established to monitor physical and biological conditions in the Delta. These activities typically involve take of one or more of the fish species covered by this Plan. In fact, a good deal of knowledge about the status of delta smelt and Sacramento splittail has been gained largely as a side-benefit of the by-catch of those species during IEP monitoring aimed at striped bass. Appendix A (pages A-16 through A-19) describes in detail the existing programs designed to monitor striped bass or a combination of striped bass and other species. Below is a summary of those monitoring programs.

Summer Tow Net Survey: This survey measures abundance of young striped bass. It has been run annually since 1959 (except 1966). The townet generally catches young striped bass 17 to 50 mm fork length (FL). This survey also has provided a major measure of the status of delta smelt and may be of some limited value in indexing the trend in Sacramento splittail. Information from this survey is required by the ESA Section 7 consultation between the USFWS and the Bureau of Reclamation on the effects of the CVP and SWP on delta smelt, Sacramento splittail, and proposed delta smelt critical habitat (USFWS 1995). Each annual survey consists of three to five sub-surveys that take five days to complete. These sub-surveys usually begin in mid-June and consist of sampling at 30 stations scattered from eastern San Pablo Bay to the eastern delta. They occur at two-week intervals until the mean length of the bass in the catch exceeds 38 mm FL. This length generally has been attained between mid-July and mid-August.

Fall Midwater Trawl Survey: This survey monitors abundance of young striped bass in the fall. It has been conducted monthly from September to December each year since 1967 (except 1974 and 1979). Each monthly survey takes about six days to complete. One tow is made at each of 87 sampling sites scattered from San Pablo Bay through the delta. The fall midwater trawl surveys also provide an important measure of delta smelt abundance and are of value for measuring the trend in Sacramento splittail abundance; they are required by the Section 7 consultation between the USFWS and the Bureau of Reclamation on the effects of the CVP and SWP on the delta smelt, Sacramento splittail, and proposed delta smelt critical habitat.

Mark-recapture of Adult Striped Bass: Mark-recapture population estimates are used to monitor the abundance of adult striped bass (bass larger than 18 inches and age-three or older). These population estimates also are essential to evaluating the contribution of stocked yearlings and two-year-olds to subsequent adult populations and estimating survival of these fish between the time of stocking and their recruitment to the adult population. These population estimates were conducted annually from 1969-1994, but are now conducted every two years as a result of an IEP program review in 1994. Gill nets and fyke traps are used to capture bass for tagging while they are on their spawning grounds in the spring. Summer-fall or year-round censuses of angler catches are used to obtain estimates of tagged to untagged ratios. Tags recovered through the mail also are used to estimate harvest and mortality rates.

Survival and Abundance of Stocked Striped Bass: Sufficient quantities of stocked yearling and two-year-old striped bass will be marked with coded-wire tags inserted into the cheek muscle or other appropriate marking methods prior to release to allow estimation of their abundance during each year of adult striped bass population monitoring. Such estimates will be made for each age group by multiplying the total mark-recapture abundance estimate for that age group, based on tagging of adult striped bass, and the percentage of that age group formed by stocked bass, based on sampling for coded-wire tags or other marks applied to stocked striped bass. Survival from the time of stocking to adulthood will be estimated by dividing estimates of abundance of stocked fish as adults by the numbers stocked. Specific tag codes will allow stratification and comparison of abundance and survival estimates for pen-rearing and conventional aquaculture and for stocking of yearlings and two-year-olds.

D. Installation, Operation, and Maintenance of Fish Screens

To mitigate impacts of take of the covered fish species by the Striped Bass Management Program, the CDFG will fund the screening of water diversions as described in Chapter 13.

Chapter 4. ANALYSIS OF EFFECTS OF THE STRIPED BASS MANAGEMENT PROGRAM ON SACRAMENTO RIVER WINTER-RUN CHINOOK SALMON

A. Expected Level of Take

1. Stocking Striped Bass

a. Estuary/River System in General. The CDFG and NMFS estimated the rate of predation on Sacramento River winter-run chinook salmon based on a striped bass population consisting of 765,000 adults (the mean of the 1992, 1993, and 1994 striped bass population estimates). The population level of 765,000 adult striped bass was used because a population size was essential to estimating predation impacts and this population level reflects the three most recent years for which striped bass population estimates are available. The estimated predation rate for a striped bass population of 765,000 adults is 6% of the Sacramento River winter-run chinook salmon outmigrants each year (see Appendix E).

CDFG anticipates that the striped bass population would decrease to 515,000 adults if striped bass were *not* stocked. Without stocking, total predation by the expected striped bass population would be about 4% of the Sacramento River winter-run chinook salmon outmigrants each year and would range from 3.4% to 4.7% (515,000 ÷ 765,000 x 6% = 4%, then assuming variation of -15% to +16.5% as around the mean striped bass population from 1990-1994). Predation by stocked striped bass is estimated to cause a maximum annual increase in mortality of Sacramento River winter-run chinook salmon of 1.1 % (as shown in Table 13) over that which would occur without stocking and the commensurate decrease in predation. In the initial years of stocking, the predation impact would be less than 1.1% because there would be fewer stocked fish in the population before it returns to 712,000 adults. Also, the lower stocking rates after the sixth year would reduce the predation impact in the later years of the program. Nevertheless, 1.1% of the Sacramento River winter-run chinook salmon outmigrants is the anticipated level of annual "take" of Sacramento River winter-run chinook salmon resulting from predation by stocked striped bass to be covered by this Conservation Plan and its associated Section 10(a)(1)(B) permit.

The estimated maximum annual consumption of Sacramento River winter-run chinook salmon outmigrants by the total population of 712,000 adult striped bass maintained by the proposed stocking program is 5.1% (4% + 1.1% = 5.1%).

Stocking striped bass in San Pablo Bay in June or July, as proposed in this Plan, will not have an immediate effect on Sacramento River winter-run chinook salmon because few Sacramento River winter-run chinook salmon are in the Estuary in summer. Predation on Sacramento River winter-run chinook salmon could occur as early as the fall after stocking if some small Sacramento River winter-run chinook salmon enter the western Delta or bays. Predation impacts on Sacramento River winter-run chinook salmon have the potential for continuing eight to ten years or more after each release of striped bass, though these impacts should decline as stocked fish become older and die off.

b. Predation at Structures. To the extent that previous striped bass stomach sampling included bass captured at structures, e.g., the Clifton Court Forebay (CCF), the Suisun Marsh Salinity Control Structure (SMSCS), and others (see Chapter 2, section F.2.b), effects of predation at structures are included in the expected level of take for the Estuary/river system in general.

With regard to CCF, increased take of Sacramento River winter-run chinook salmon due to stocking striped bass is unlikely for several reasons:

- The proposed stocking level will only maintain the striped bass population; abundance will not increase above the 1994 level of 712,000 adults.
- Striped bass will be stocked in San Pablo Bay, which will minimize the likelihood of stocked striped bass traveling to CCF soon after stocking.
- Loss rates of "experimental" Central Valley fall-run chinook salmon released in CCF vary independently of striped bass abundance (Figure 4), indicating other factors influence loss rates of fish in CCF and high losses are just as likely to occur at low striped bass abundance levels as at high abundance levels.
- On average, less than 0.002% of marked chinook salmon released into the upper Sacramento River, where Sacramento River winter-run chinook salmon begin their life, arrive at the CCF fish screens. Assuming the generally accepted 75% predation rate in CCF, less than 0.008% of salmon emigrating from the upper Sacramento River would enter CCF and be exposed to predation there.

In sum, the level of incidental take of Sacramento River winter-run chinook salmon resulting from striped bass predation at structures, such as CCF, is not expected to increase the overall anticipated take level of Sacramento River winter-run chinook salmon described above for the Estuary and river system in general.

2. Maintaining Sport Fishing Regulations to Protect Striped Bass

Implementation of striped bass fishing regulations may indirectly result in take of Sacramento River winter-run chinook salmon as a result of incidental catch by striped bass anglers. Therefore, recommendations by CDFG to the Fish and Game Commission to maintain the existing striped bass fishing regulations or implement changes to the regulations that lead to the target population of 712,000 adults are covered by this Conservation Plan and its associated incidental take permits. The CDFG does not currently contemplate recommending to the Fish and Game Commission changes to the striped bass fishing regulations; however, CDFG may recommend to the Fish and Game Commission changes to the regulations during the permit period to assist in meeting the target population of 712,000 adult striped bass.

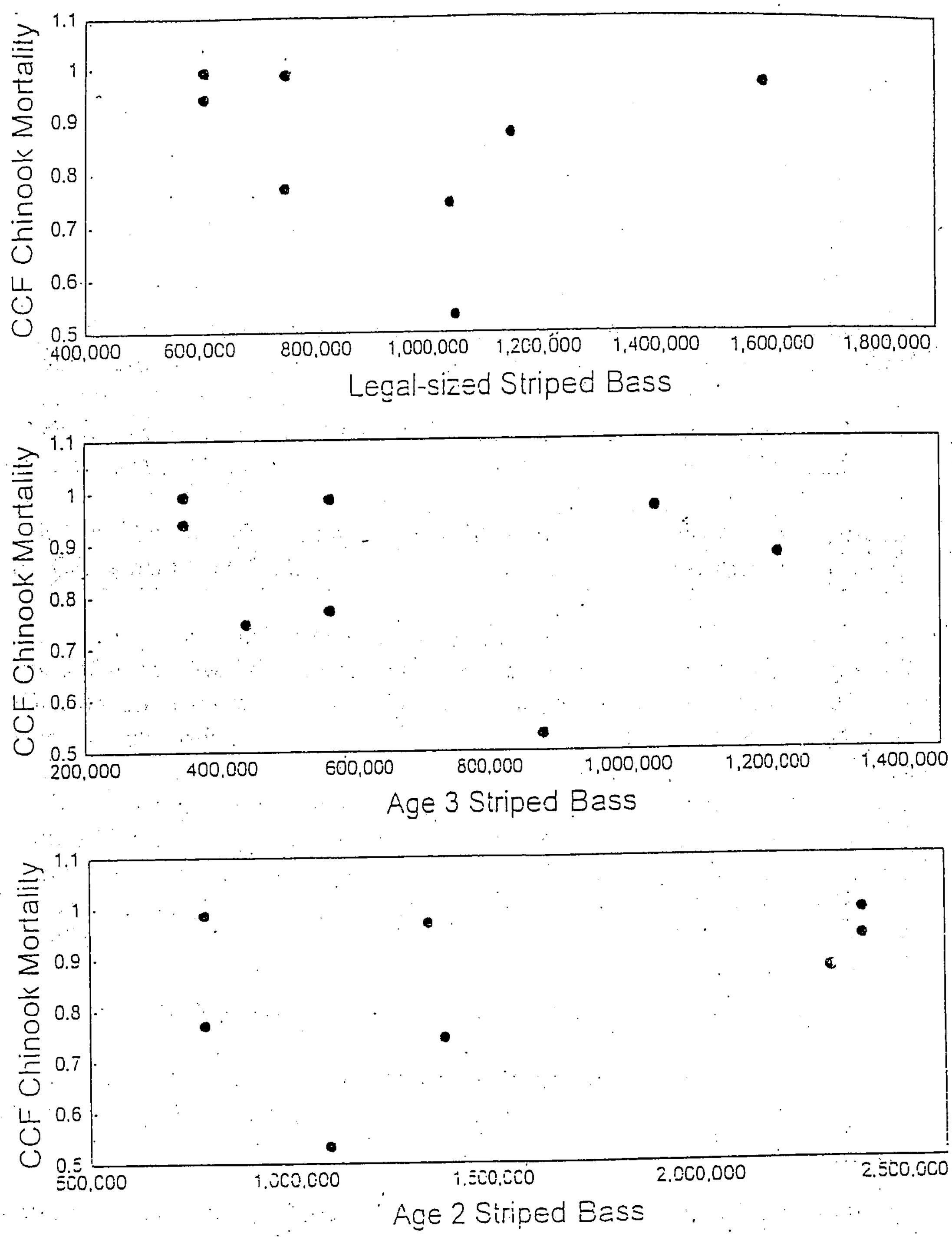


Figure 4. Estimated Loss Rates of Central Valley Fall-Run Chinook Salmon Released in Clifton Court Forebay (CCF) Vary Independently of Striped Bass Abundance.

Modifying regulations to achieve striped bass abundance of 712,000 adults will not result in take above that already described as a result of predation by stocked striped bass (i.e., up to 1.1% of the annual Sacramento River winter-run chinook salmon population) because that level of take assumes a population of 712,000 adult striped bass. Thus, there would be no additional predation impact on Sacramento River winter-run chinook salmon resulting from changes in the striped bass fishing regulations.

The striped bass fishery, however, does create potential for incidental take of adult Sacramento River winter-run chinook salmon through incidental catch by striped bass anglers. Although, as required by the California fishing regulations, any salmon caught during the Sacramento River winter-run chinook salmon migration periods must be released. There has been no monitoring of past incidental salmon catches by striped bass anglers, but it is likely that such catches are infrequent and have negligible impacts on the Sacramento River winter-run chinook salmon population because salmon are not susceptible to techniques generally employed by striped bass anglers. Nonetheless, any incidental take of Sacramento River winter-run chinook salmon that does occur as a result of striped bass angling, which while not quantifiable is expected to be minimal, will be covered by this Conservation Plan and its associated incidental take permit.

3. Monitoring

As noted previously, monitoring conducted to assess striped bass populations is an on-going activity, and is not, therefore, a "new" action proposed under this Conservation Plan. Furthermore, take of delta smelt and Sacramento splittail associated with the current monitoring programs for young striped bass is covered by existing ESA Section 7 consultations for Interagency Ecological Program (IEP) activities. Take of chinook salmon and Central Valley steelhead associated with the striped bass monitoring program, however, will be covered by this Plan and its associated incidental take permit. As noted in Chapter 3, Section C, if existing IEP monitoring programs should cease or change during the ten-year term of this Plan, CDFG will continue monitoring, as necessary, to measure the abundance of young and adult striped bass and the abundance and survival of stocked striped bass. In the unlikely event that CDFG does need to continue some of the monitoring programs now conducted by IEP to fulfill the goals of this Conservation Plan, take associated with such monitoring would be covered by this Plan and its associated incidental take permits. Therefore, this Plan includes a discussion of the take resulting from the relevant existing monitoring programs, which is representative of the level of take that could be expected to occur under this Plan should CDFG need to continue these monitoring programs. However, if substantial changes occur with respect to striped bass monitoring or the effects of monitoring on the covered species from what is described in this Conservation Plan, a permit amendment could be required, as described in Chapter 18, Section B, Permit Amendments.

a. Summer Townet Survey. The summer townet survey does not result in catch of chinook salmon; thus no take is expected to occur as a result of this action.

b. Fall Midwater Trawl Survey. Annual catch of young chinook salmon in the fall midwater trawl survey has ranged from 7 to 81 fish (Table 7). Total catch over the 28 surveys from 1967 to 1998 was 749 chinook salmon. Of 411 of these chinook salmon that have been measured, only one has fallen within the generally accepted Sacramento River winter-run chinook salmon size ranges developed by Frank Fisher (CDFG) and Sheila Green (DWR) in 1992; extrapolating this ratio (1 out of 411) to the total catch yields an estimate of a total of 1.8 Sacramento River winter-run chinook salmon having been caught over the 30 survey years, for an average catch of 0.06 Sacramento River winter-run chinook salmon smolts per year. Thus, the incidental take of Sacramento River winter-run chinook salmon resulting from the fall midwater trawl surveys is anticipated to be negligible (i.e., approximately 0.06 Sacramento River winter-run chinook salmon smolts per year).

c. Mark-Recapture of Adult Striped Bass. The fyke traps and gill nets used to capture adult striped bass for tagging incidentally capture some adult chinook salmon (Table 8), a few of which are potentially Sacramento River winter-run chinook salmon, but most of which probably are from other runs, particularly the spring run. Fish other than striped bass captured in the gill nets used in the Delta were not recorded until 1994; however, catches of fish other than striped bass in the fyke traps, used at various sites from Clarksburg to Colusa on the Sacramento River, have been recorded since 1974, except for 1980. Annual catches of chinook salmon in the fyke traps have varied substantially. At Clarksburg, salmon catches were lowest in 1984 (3 fish) and highest in 1975 (78 fish). Annual salmon catches at Knights Landing, the present trapping site, ranged from 6 in 1993 to 66 in 1990 and were closely associated with estimated Central Valley spring-run chinook salmon spawning escapement (r=0.91), less closely associated with Central Valley fall-run chinook salmon abundance (r=0.30), and inversely associated (r=-0.50) with estimated Sacramento River winter-run chinook salmon escapement. Hence, these associations suggest that most salmon captured by the fyke traps are Central Valley spring-run chinook salmon.

Starting in 1994, the NMFS and CDFG have attempted to identify the race (run) of salmon captured by the fyke traps and gill nets through skin brightness. During the trapping and netting period, NMFS considers salmon that are not bright (pale, darkening and dark) to be Sacramento River winter-run chinook salmon. In 1994, the percentage of classified, fyke-trapped salmon that were not bright (11%) applied to the total catch of fyke-trapped salmon in 1994 yields an estimate that 7 trapped salmon were Sacramento River winter-run chinook salmon (two of these salmon were dead, too decomposed to be classified, but assumed to be "not bright"). Additionally, two chinook salmon captured in the gill nets were classified as Sacramento River winter-run chinook salmon. Thus, based on these classifications total Sacramento River winter-run chinook salmon catch in traps and nets in 1994 was 9 fish (7 fish in the traps plus 2 fish in the gill nets). If identification was accurate, the "worst case" estimate is that the trapping and netting incidentally captured 5% of the Sacramento River winter-run chinook salmon in 1994.

Table 7. Catch of Delta Smelt, Sacramento Splittail, and Chinook Salmon for the Fall Midwater Trawl Survey (September-December) in the Sacramento-San Joaquin Estuary.

Year	Delta Smelt	Sacramento Splittail	Chinook Salmon
1967	398	60	22
1968	629	26	28
1969	254	17	45
1970	906	10	55
1971	669	8	31
1972	687	10	22
1973	1033	4	39
1975	604	5	12
1976	111	1	10
1977	513	0	3
1978	326	35	32
1980	1305	14	19
1981	331	20	68
1982	366	61	16
1983	134	69	28
1984	160	16	7
1985	89	15	70
1986	192	52	49
1987	236	28	37
1988	104	9	7
1989	322	5	10
1990	311	9	12
1991	613	17	13
1992	139	6	24
1993	965	9	25
1994	91	3	10
1995	855	68	11
1996	48	12	4
1997	287	1	25
1998	356	291	15

Table 8 Annual Catches of Chinook Salmon in Fyke Traps Set in the Sacramento River to Catch Adult Striped Bass for Tagging and Estimated Spawning Escapement for Winter, Spring, and Fall Run Chinook Salmon.

Year	Location	Total Fyke Trap Catch	Estimated Sacramento River Spawning Escapement		
			Winter-run	Spring-run	Fall-run
1974	Clarksburg	69	21,897	8,083	211,317
1975	Clarksburg	78	23,430	23,353	171,575
1976	Clarksburg	15	35,096	26,073	177,693
1977	None		17,214	13,830	162,802
1978	None		24,862	8,156	138,998
1979	Clarksburg	13	2,364	2,910	199,379
1980	Clarksburg and Colusa	No Record	1,156	11,815	136,305
1981	Colusa	59	20,041	21,315	188,078
1982	Clarksburg	37	1,242	26,172	172,784
1983	Clarksburg	54	1,831	4,481	130,390
1984	Clarksburg	12	2,663	8,361	115,542
1985	Clarksburg	3	3,962	11,423	253,258
1986	Clarksburg	9	2,464	18,896	240,095
1987	Clarksburg	9	1,997	11,507	217,329
1988	Clarksburg	25	2,094	11,653	224,358
1989	Freeport	5	533	7,188	140,786
1990	Knights Landing	66	441	5,324	92,942
1991	Knights Landing	25	191	1,641	98,616
1992	Knights Landing	13	1,180	1,677	65,871
1993	Knights Landing	6	341	1,310	111,330
1994	Knights Landing	63	189	4,316	139,691
1996	Knights Landing	8	940	2,584	115,339
Total	Clarksburg Knights Landing	324 181			
Mean	Clarksburg Knights Landing	29.5 30.2			

Occasionally the fyke traps are vandalized and fish are poached. In the present trapping location near Knights Landing, such vandalism of two or three traps has occurred two to three times per season. Vandalism probably will continue at this rate in the future. Although there has been no known incidence (fish scales on the river bank) of species other than striped bass having been taken, it is possible that Sacramento River winter-run chinook salmon have been and will be poached during such vandalism. However, based on the low average catch of Sacramento River winter-run chinook salmon in these traps, the probability of their take through vandalism is low and if it occurs it is likely to be one or two fish per season, at most. The CDFG special enforcement team has been alerted regarding this problem and they will put effort into "stakeouts."

Overall, the catches and "identifications" suggest the fyke traps and gill nets may have taken as many as 9 Sacramento River winter-run chinook salmon in years with adult striped bass mark-recapture activities. CDFG and NMFS estimate that approximately 1.2% of the returning Sacramento River winter-run chinook salmon adults may be taken every two years as a result of these activities. This estimate was made by dividing the estimated total catch (14 fish) of Sacramento River winter-run chinook salmon in 1994 (9 fish) and 1996 (5 fish) during striped bass mark-recapture activities by the total (1129) of the Sacramento River winter-run chinook salmon spawning escapement estimates in 1994 (189 fish) and 1996 (940 fish).

B. Impact of Take on Sacramento River Winter-Run Chinook Salmon

1. Stocking Striped Bass

Predation by stocked striped bass would reduce each Sacramento River winter-run chinook salmon cohort by an estimated 1.1%. Under this scenario, the lowest recorded spawning stock escapement since the 1990 listing as endangered (189 adults) would be reduced by two fish (one female assuming a 50/50 male to female ratio) and the largest recorded escapement (1,364 fish) would be reduced by 15 fish (approximately 7 or 8 females) ($189 \times 0.011 \approx 2$; $1{,}364 \times 0.011 \approx 15$).

If the actual numbers of striped bass stocked are less than proposed due to problems associated with culture such as unavailability of adequate numbers of fish from the SWP/CVP fish screens, lack of success in artificially spawning adult striped bass, and losses during rearing, the impact on Sacramento River winter-run chinook salmon would be commensurately lower.

Based on the results of a Sacramento River winter-run chinook salmon population model developed by NMFS, the estimated level of impact is not expected to substantially increase the probability of extinction over the ten-year permit period from that associated with the 1994 striped bass population (712,000 adults). This Sacramento River winter-run chinook salmon life cycle model examines how incremental increases in smolt mortality affect Sacramento River winter-run chinook salmon population dynamics. Because CDFG will not be increasing the striped bass population but will maintain it at its 1994 level, there should not be an increase in smolt mortality or the probability of extinction due to striped bass predation.

More specifically, the model follows fish as they pass through each life history stage and tracks how many fish survive. The number surviving depends on the sum of all competing mortality terms. The model has a yearly time step, and was run for 50 years, 100 times for each of two sets of assumptions: 1) the downward abundance trend has not changed, 2) the population has stabilized due to protective actions taken in recent years. There are still too few data to know whether the Sacramento River winter-run chinook salmon population has stabilized or still is in a downward trend; therefore' both possibilities were examined. Each run is different due to random changes in mortality rates and sampling effects. Population statistics were computed for each set of 100 runs, including the probability of extinction within 50 years, the mean time to extinction for populations that went extinct, and the mean size of extant populations after 50 years. To be consistent with NMFS's Sacramento River winter-run chinook salmon recovery planning, extinction was defined as three consecutive spawning runs with less than 100 females.

The model found that the Sacramento River winter-run chinook salmon has a probability of extinction of: 1) between 93% and 97%, assuming that the downward trend has not changed; and 2) about 11% assuming that the population trend has stabilized. As discussed above, the proposed striped bass stocking program should not increase these estimated extinction probabilities because the level of smolt mortality should not increase above the 1994 level.

In addition, the mitigation screening project proposed in this Conservation Plan and agreed to by NMFS and CDFG (see Chapter 13, Section E.1) is intended to compensate for predation mortality of Sacramento River winter-run chinook salmon by stocked striped bass.

2. Maintaining Sport Fishing Regulations to Protect Striped Bass

As previously described, there is probably a small incidental catch of Sacramento River winter-run chinook salmon by striped bass anglers. However, considering that such catches are likely to be infrequent, and regulations require that any such salmon be released unharmed, take resulting from striped bass fishing is expected to have a negligible impact on the Sacramento River winter-run chinook salmon population.

3. Monitoring

a. Fall Midwater Trawl Survey. The mean annual catch of Sacramento River winter-run chinook salmon, 0.06 smolts, is extremely low, and salmon captured by the midwater trawl are released immediately and generally appear to be in good enough condition to survive. Hence, the fall midwater trawl survey is expected to have a negligible impact on the Sacramento River winter-run chinook salmon population.

b. Mark-Recapture of Adult Striped Bass. Overall, considering the negative correlation between Sacramento River winter-run chinook salmon escapement and salmon catch in the traps and gill nets, and the generally good condition of captured salmon, striped bass fyke trapping and gill netting activities appear to kill few Sacramento River winter-run chinook salmon. In 1994, the estimated capture of 9 Sacramento River winter-run chinook salmon adults represented a maximum of 5% of the spawning escapement (e.g. 9 ÷ escapement of 189 fish = 5%). The five potential Sacramento River winter-run chinook salmon captured in 1996 represent only 0.5% of the spawning escapement..

The population impact of trapping and netting Sacramento River winter-run chinook salmon does not directly correspond to the capture rate, as most chinook salmon captured in the traps and gill nets are alive and in good condition when returned to the river. In 1994, 61 of 63 (97%) salmon captured in the traps and 13 of 17 (76%) salmon captured in the gill nets were released alive; thus, in 1994, 74 of 80 salmon (92%) were alive at release. Of those 74 live salmon, 55 were rated in good or excellent condition. In 1996, 81% of captured salmon were released alive (all of the eight salmon captured in the traps and 13 of 18 salmon captured in gill nets). All of the live fish released in 1996 were classified in good or excellent condition. Overall, for 1994 and 1996 combined, 95 of 106 (90%) of trap and net captured chinook salmon were released alive, resulting in a 10% mortality rate for all chinook salmon.

Assuming the 10% mortality of all chinook salmon associated with trapping and gill netting in 1994-1996 applies to captured Sacramento River winter-run chinook salmon, direct mortality of Sacramento River winter-run chinook salmon as a result of trapping and gill netting could be as high as 0.5% of the spawning escapement, based on the 1994 capture rate of 5% of the Sacramento River winter-run chinook salmon spawning escapement (i.e., 10% of 5% is 0.5%). Assuming delayed mortality and reduced spawning success due to physiological stress affects another 10% of the trapped and netted salmon, the total potential population impact could be as much as 1.0% of the spawning escapement.

However, CDFG has agreed as a condition of this Conservation Plan (see Chapter 13, Monitoring, Minimization, and Mitigation) to limit the take of Sacramento River winter-run chinook salmon during mark-recapture studies to 1%. This limitation will likely reduce the mortality impact of netting and trapping on the Sacramento River winter-run chinook salmon population to 0.2% (i.e., 10% mortality x 1% capture rate = 0.1%, plus another 10% for delayed effects yields a total 0.2% impact). This negligible level of impact every two years is less than the impact of the baseline trapping and netting program; thus, it would not increase the probability of extinction from that associated with the baseline program.

C. Summary -- Take of Sacramento River Winter-Run Chinook Salmon

The estimated take of Sacramento River winter-run chinook salmon by predation by stocked striped bass (1.1%) and as a result of striped bass monitoring (1.0%) combine to yield an estimated total maximum take of 2.1% of the annual Sacramento River winter-run chinook salmon population. However, take may be substantially less than this estimate because: stocking may not always be at the maximum level due to various factors that may reduce availability of fish. Further, the actual mortality associated with striped bass monitoring (i.e., netting and trapping) probably will not exceed 0.2% of the Sacramento River winter-run chinook salmon population since most captured fish would be released alive and unharmed.

Overall, average mortality of Sacramento River winter-run chinook salmon as a result of the striped bass management program is not expected to exceed 1.3% (1.1% predation rate plus 0.2% from trapping and netting). Based on the NMFS Sacramento River winter-run chinook salmon population model, this level of impact is not expected to significantly impair the survival and recovery of Sacramento River winter-run chinook salmon because: smolt mortality and take by monitoring should not increase above the 1994 level; thus, the extinction probability of Sacramento River winter-run chinook salmon should not increase. 2) Mitigation screening of water diversions will increase survival of Sacramento River winter-run chinook salmon in the upper river.

Chapter 5. ANALYSIS OF EFFECTS OF THE STRIPED BASS MANAGEMENT PROGRAM ON CENTRAL VALLLEY SPRING-RUN CHINOOK SALMON

A. Expected Level of Take

1. Stocking Striped Bass

a. Estuary/River System in General. Stocking yearling and 2-year old striped bass in June or July in San Pablo Bay will have no immediate, short-term effect on Central Valley spring-run chinook salmon because Central Valley spring-run chinook salmon are not in the Estuary then. However, as for Sacramento River winter-run chinook salmon, predation potentially could occur on Central Valley spring-run chinook salmon emigrating later in the year and subsequent year classes as the stocked striped bass grow and become more pisciverous.

CDFG anticipates that the striped bass population would decrease to 515,000 adults if striped bass were not stocked. Without stocking, total predation by the expected striped bass population would be about 2.3% of the Central Valley spring-run chinook salmon outmigrants each year. Predation by stocked striped bass is estimated to cause a maximum annual increase in mortality of Central Valley spring-run chinook salmon of 0.8% (as shown in Table 13) over that which would occur without stocking and the commensurate decrease in predation. In the initial years of stocking, the predation rate would be less than 0.8% because there would be fewer stocked fish in the population before it returns to 712,000 adults. Also, the lower stocking rates after the sixth year would reduce the predation impact in the later years of the program. Nevertheless, 0.8% of the Central Valley spring-run chinook salmon outmigrants is the anticipated level of annual "take" of Central Valley spring-run chinook salmon resulting from predation by stocked striped bass to be covered by this Conservation Plan and its associated Section 10(a)(1)(B) permit.

The estimated maximum annual consumption of Central Valley spring-run chinook salmon outmigrants by the total population of 712,000 adult striped bass maintained by the proposed stocking program is 3.1% (2.3% + 0.8% = 3.1%).

b. Predation at Structures. To the extent that previous striped bass stomach sampling included bass captured at structures (see Chapter 2, Section F.2), effects of predation at structures are included in the expected level of take for the Estuary in general. With regard to predation in Clifton Court Forebay, increased take of Central Valley spring-run chinook salmon due to stocked striped bass is unlikely for many of the same reasons discussed in the Sacramento River winter-run chinook salmon section (Chapter 4, Section A.1.b).

2. Maintaining Sport Fishing Regulations to Protect Striped Bass

Implementation of striped bass fishing regulations may indirectly result in take of Central Valley spring-run chinook salmon as a result of incidental catch by striped bass anglers.

Therefore, maintaining the existing striped bass fishing regulations or implementing changes to the regulations that lead to the target population of 712,000 adults are covered by this Conservation Plan and its associated incidental take permits. The CDFG does not currently contemplate recommending any changes to the regulations to the Fish and Game Commission; however, CDFG may recommend to the Fish and Game Commission changes to the regulations during the permit period to assist in meeting the target population of 712,000 adult striped bass.

Modifying regulations to achieve striped bass abundance of 712,000 adults would not increase the level of take over that already described as a result of predation by stocked striped bass because that level of take assumes a population of 712,000 adult striped bass. Thus, if the Fish and Game Commission were to change the regulations in response to any CDFG recommendations for such changes, no additional predation impact on Central Valley spring-run chinook salmon would result.

The striped bass fishery, however, does create potential incidental take of adult Central Valley spring-run chinook salmon through incidental catch by striped bass anglers. Although, as required by the California fishing regulations, any salmon caught during the Central Valley spring-run chinook salmon migration periods must be released. There has been no monitoring of past incidental salmon catches by striped bass anglers, but it is likely that such catches are infrequent and have negligible impacts on the Central Valley spring-run chinook salmon population because salmon are not susceptible to techniques generally employed by striped bass anglers. Nonetheless, any incidental take of Central Valley spring-run chinook salmon that does occur as a result of striped bass angling, which while not quantifiable is expected to be minimal, will be covered by this Conservation Plan and its associated incidental take permit.

3. Monitoring

See general information on monitoring in the Sacramento River winter-run chinook salmon chapter, (Chapter 4, Section A.3).

a. Summer Townet Survey. The summer townet survey does not result in catch of Central Valley spring-run chinook salmon; therefore, no incidental take is expected to occur as a result of this action.

b. Fall Midwater Trawl Survey. Based on length measurements, the 30 fall midwater trawl surveys conducted to date have captured no Central Valley spring-run chinook salmon. However, potential exists for capture of Central Valley spring-run chinook salmon by this survey. Any such take of Central Valley spring-run chinook salmon will be covered by this Conservation Plan and its associated incidental take permit.

c. Mark-Recapture of Adult Striped Bass. Central Valley spring-run chinook salmon are captured incidental to the trapping and netting of adult striped bass. Most of these salmon are in good condition and are returned to the river. Annual catches of salmon in the traps have ranged from three to 79 fish. At Knights Landing, the present trapping site, these annual catches have been closely associated with estimated Central Valley spring-run chinook salmon spawning escapement (r=0.91), suggesting that most of the trapped salmon are Central Valley spring-run chinook salmon. CDFG estimates that in the past, the fyke traps and gill nets combined may have captured as much as 1.8% of the Central Valley spring-run chinook salmon spawning escapement each year (Table 9). As described in Chapter 11, the CDFG has agreed as a condition of this Conservation Plan to stop these trapping and netting activities in any year when an estimated 1% of the Central Valley spring-run chinook salmon or Sacramento River winter-run chinook salmon escapement has been captured by this trapping and netting (estimated escapement = escapement of the parents of the current run which is the run three years earlier).

Table 9. Potential "Take" of Adult Central Valley Spring-Run Chinook Salmon by Striped Bass Trapping and Netting in the Sacramento River System if it is Assumed That all Adult Salmon Captured are Central Valley Spring-Run Chinook Salmon. Mortality Would be Substantially Lower Than "Take" Percentages.

Year	Fyke Traps	Gill Nets	Spring-run Escapement	% Caught by Traps	Total % Caught
1990	66		5,324	1.2	
1991	25		1,641	1.5	
1992	13		1,677	0.8	
1993	6		1,310	0.5	
1994	63	16	4,316	1.5	1.8
1996	8	18	2,584	0.3	1.0
Average				1.0	1.4

While the traps and gill nets could catch as much as 1.0% of the Central Valley spring-run chinook salmon escapement in striped bass tagging years, the generally good condition of captured salmon at release suggests striped bass trapping and gill netting activities will cause less than 1.0% mortality. Assuming 20% combined immediate and delayed mortality as for Sacramento River winter-run chinook salmon, if the total catch is 1.0% of the run, estimated mortality is 0.2% of the escapement (1.0 × 20%).

In the future, there will be less incidental take of Central Valley spring-run chinook salmon than in the past because striped bass trapping and netting activities will occur every second year rather than annually and due to the potential curtailment of those activities in response to the 1% take limit for Sacramento River winter-run chinook salmon or Central Valley spring-run chinook salmon.

The negligible 0.2% impact every second year is less than the impact of the baseline trapping and netting program; thus, it will not increase the probability of extinction from that associated with the baseline program.

B. Impact of Take on Central Valley Spring-Run Chinook Salmon

1. Stocking Striped Bass

At maximum, predation by stocked striped bass would reduce each Central Valley spring-run chinook salmon cohort by about 0.8%. Under this scenario, the average spawning stock escapement to Deer, Mill and Butte creeks from 1991-94 (1,250 adults) would be reduced by 10 fish (five females assuming a 50/50 male to female ratio).

If the actual numbers of striped bass stocked are less than proposed due to problems associated with culture such as unavailability of adequate numbers of fish from the SWP/CVP fish screens, lack of success in artificially spawning adult striped bass, and losses during rearing, the impact on Central Valley spring-run chinook salmon would be commensurately lower.

This level of impact is not expected to substantially increase the probability of extinction of Central Valley spring-run chinook salmon over the ten-year permit period from that associated with the 1994 striped bass population because the stocking program will not be increasing the striped bass population above that level.

2. Maintaining Sport Fishing Regulations to Protect Striped Bass

As previously described, there is probably a small incidental catch of Central Valley spring-run chinook salmon by striped bass anglers. However, considering that such catches are likely to be infrequent, and regulations require that any such salmon be released unharmed, take resulting from striped bass fishing is expected to have a negligible impact on the Central Valley spring-run chinook salmon population.

3. Monitoring

a. Fall Midwater Trawl Survey. Based on length data, no Central Valley spring-run chinook salmon, have been captured by past midwater trawl surveys. If any Central Valley spring-run chinook salmon are captured by this survey, they probably will survive because salmon captured by the midwater trawl are released immediately and generally appear to be in good enough condition to survive. Hence, the fall midwater trawl survey is expected to have a negligible impact on the Central Valley spring-run chinook salmon population.

b. Mark-Recapture of Adult Striped Bass. Considering the close correlation between Central Valley spring-run chinook salmon escapement and salmon catch in the fyke traps, striped