Department of Fish and Game Comments on Key Issues of State Water Resources Control Board's May Workshop for Review of Standards for San Francisco Bay/Sacramento-San Joaquin Delta Estuary*

The Department of Fish and Game (DFG) has reviewed the key issues of this workshop and has the following comments:

1. Endangered Species Act Issues

The Estuary supports two Federal and State listed species, the endangered Sacramento winter-run chinook salmon *Orcorhynchus tshawytscha,* and the threatened delta smelt *Hypomesus transpacificus.* Another species, the Sacramento splittail *Pogonichthys macrolepidotus*, may soon receive Federal listing and several other fishes have declined to a level that suggests they also receive consideration for listing. The State Water Resources Control Board (SWRCB) should consider needs of these species when it sets new standards for the Estuary.

Winter-run Chinook Salmon

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 winter-run chinook salmon generally leave the ocean and migrate through the Sacramento-San Joaquin Delta to the upper Sacramento River from November through mid-May. Their spawning season generally extends from mid-April to August. Young downstream-migrant winter-run 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 in 1966 enabled accurate estimates of all salmon runs to the upper Sacramento River and documented the dramatic decline of the winter-run chinook salmon population. The estimated numbers of winter-run chinook salmon reaching the dam from 1967-1969 averaged 86,509. From 1990 to 1993 the spawning escapement of winter-run chinook salmon past the dam has been estimated at 441, 191, 1,180, and 341. The National Marine Fisheries Service (NMFS) believes these run sizes are dangerously low since it has been estimated that a run size of 400 to 1,000 fish is necessary to maintain genetic diversity in the winter-run salmon population.

The winter-run salmon cohort that is returning to spawn in 1994 is the progeny of the 1991 run which, at 191 fish, was the lowest on record. Thus, we are seriously

* Presented by Perry L. Herrgesell, Chief of Bay-Delta and Special Water Projects Division, May 16, 1994

concerned about survival of this cohort and will inform the SWRCB when its' status is known. A more detailed status report on the winter-run salmon is in Appendix A.

Delta Smelt

The delta smelt historically was one of the most common fish in the Sacramento-San Joaquin 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 persistent low abundance from 1983 to 1992 (Figure 1). In 1993, 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 1-year life cycle, unusually low fecundity for a fish with planktonic larvae, a limited diet, and reside primarily within the interface between salt and freshwater.

Because of a weak stock-recruitment relationship, there is no guarantee that the increased population in 1993 will produce a large population in 1994. In fact, habitat conditions in Suisun Bay, even with all the water management restrictions currently in place, are once again poor due to very low outflow this spring.

Sacramento Splittail

The Sacramento splittail is a large minnow endemic to the Sacramento-San Joaquin system. In November, 1992, the Natural Heritage Institute petitioned the U.S. Fish and Wildlife Service (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.

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). Young Sacramento splittail abundance and mean April-July Delta outflow are positively related (Figure 2).

The Interagency Ecological Program is currently planning field surveys and data evaluations this summer and fall to further assess the status of Sacramento splittail. We will keep the SWRCB informed about this effort.

Biological Opinions and Consultations

Currently, the Biological Opinions issued by NMFS and the USFWS concern the existing operations of the Central Valley Project (CVP) and State Water Project (SWP) and their impact on winter-run salmon and delta smelt. In conformance with the California Endangered Species Act, DFG has adopted the NMFS opinion for winter-run salmon, and is considering the USFWS opinion for delta smelt. These opinions establish reasonable and prudent alternatives (RPAs) to existing project operations to avoid jeopardy and reasonable and prudent measures (RPMs) to minimize take. These RPAs and RPMs restrict CVP and SWP operations more than D-1485 since D-1485 standards were in effect during those species' decline. These Opinions were based on the best information available at the time and, as additional information becomes available, they may be modified. Currently, the NMFS and DFG are in re-consultation with the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR) regarding their project operations in the Delta. As your decision concerning standards will apply to others besides the CVP and SWP, the scope of your reasonable protective measures should yield estuarine habitat of sufficient quality to restore and sustain species so current threatened and endangered species can recover, and the need for listing other species can be avoided.

The SWRCB has requested Endangered Species Act consultation with DFG on the Water Quality Control Plan and development of standards for the Bay-Delta Estuary. We would like to work with the SWRCB to develop such standards that a "no jeopardy" opinion on the Water Quality Control Plan will be appropriate. These standards should use the existing RPAs from the biological opinions to the SWP and the CVP as the environmental baseline. These standards may then be modified as needed to meet the SWRCB's goals for the estuary, to deal with non-SWP and CVP operations, and to reflect any changes in the Opinions on the SWP and CVP.

Conflicts With Introduced Species

The issue of introduced species potentially inhibiting recovery of listed species was raised at the April 26 Workshop. We do not believe that management for striped bass *Morone saxatilis*, or other introduced species precludes the recovery of endangered species. Hence, DFG has initiated appropriate consultations on striped bass management activities as required by the Endangered Species Acts to ensure our management of striped bass is accomplished in a manner compatible with recovery efforts for the Sacramento winter-run chinook salmon and the delta smelt. We also point out that both native and introduced species flourished when the estuarine environment was healthy. Now that the Estuary has become biologically dysfunctional, largely because of water development, both native and introduced species have declined. Debating the merits of restoration of important introduced species will only distract us from the pressing need to restore the Estuary's habitat values and function.

2. What are the effects of diversions throughout the Bay-Delta Estuary on beneficial uses?

CVP and SWP Diversions

During the 1992 hearings, DFG testified regarding the adverse impacts of the CVP and SWP water exports on the Estuary's fishes. Impacts fall into three general categories: 1) direct losses of fish entrained in diverted water, 2) effects associated with reduced Delta outflows, and 3) changes in flow patterns and volumes in the internal Delta channels which interfere with fish migration and reduce the Delta's value as fish nursery habitat. WRINT-DFG-Exhibits 1, 2, 3, 5, 6, 8, 9, 28 address these impacts, and potential impacts of other factors, in detail and demonstrate that water project diversions have substantially degraded the estuarine ecosystem over the past three decades.

To reiterate a general point made by the DFG during SWRCB proceedings in 1987 and 1992, direct losses of fish entrained in water diverted by the CVP/SWP are partly the result of the location of the export pumps in the Delta. This recognition led the DFG to urge the SWRCB to consider criteria that would require new water facilities. Other parties opposed this approach, and the SWRCB rejected it. Given DFG's view of the evidence and your current call for comments on effects of diversions on beneficial uses, we believe that the only remaining alternative is to curtail water exports. Export curtailments would also reduce impacts associated with changes in flows in internal Delta channels.

Regarding impacts associated with reduced Delta outflows, our statement at the April 26 workshop indicated that greater freshwater outflows and the associated movement of the salinity gradient downstream clearly benefits the entire estuarine ecosystem. The need for outflow and/or salinity standards to maintain estuarine fishes and their ecosystem is documented in WRINT-DFG-Exhibits 1, 2, 3, 5, 6, 8, 9, and 28; in the USFWS Biological Opinion for the delta smelt; in the San Francisco Estuary Project's (SFEP) entrapment zone workshop report (Schubel et. al 1992); and in EPA's proposed standards for the Estuary. Whether an outflow or a salinity standard is more appropriate from a cause-and-effect standpoint depends on the species. As we indicated in April, in cases where transport of young fish or losses of fish to water diversions are involved, regulation of outflows and exports would be more appropriate. Conversely, to meet needs of the Suisun Marsh or marine and estuarine fish and shrimp, regulation of salinity may be more relevant. EPA's proposed 2-ppt isohaline standards were an outgrowth of the SFEP entrapment zone report, which actually pointed to the need for an estuarine standard such as position of the 2-ppt isohaline (X2) in conjunction with flow standards.

It is important to provide year-round protection of the habitat and fish populations of the Estuary. Water exports have increased since the 1968 advent of the SWP and the CVP San Luis diversions, and fall-winter exports have increased at a

greater rate than spring-summer exports since implementation of SWRCB Decision 1485 (Figure 3).

Monthly proportions of total fish entrained and salvaged at the CVP/SWP vary annually in response to: 1) pumping schedules, 2) flows, 3) timing of fish spawning, 4) growth rate as it affects fish size, "salvageability" and susceptibility to entrainment, and 5) migrations as affected by environmental factors and physiological development. Generally, more than 70% of the annual entrainment of young American shad *Alosa sapidissima* outmigrants, occurs from August to December (Figure 4). Even for species for which entrainment typically peaks during spring and summer in response to inauguration of new year classes, significant entrainment has sometimes occurred in the winter. This was particularly striking for chinook salmon, striped bass, Sacramento splittail and delta smelt in winter 1977-1978 when water exports increased following the 1976-1977 drought (Table 1). Notably, the salvage of 146,000 pre-spawning delta smelt at the SWP in January, 1978, roughly equalled the total for all of 1977 and exceeds annual totals for all subsequent years (WRINT-DFG-Exhibit 9). Substantial members of pre-spawning delta smelt were entrained when exports increased similarly in winter 1992-93. Furthermore, studies conducted by the DFG since the 1960s (WRINT-DFG-Exhibits 2, 3, and 8) establish that striped bass year-class strength is modified considerably by environmental conditions, including losses to water diversions, during summer, fall, and winter. Finally, while we anticipate some incidental benefit to the three other chinook salmon races from actions taken to meet fall-run salmon smolt criteria, the timing of migration and residence in the Delta of these other races is sufficiently different to justify race specific, or year-round protective criteria.

Other Diversions in the Estuary

Diversions are made onto Delta agricultural lands and managed wetlands in the Delta and Suisun Marsh through many small unscreened intakes. Most of those intakes in the Delta are siphons averaging 14 to 16 inches in diameter and pumps with intakes averaging 12 inches. There are an estimated 1,800 such diversions in the Delta. Intakes in the Suisun Marsh are typically 24- to 48-inch intake culverts equipped with tidal flap gates. The amount of water diverted in the Delta approaches the amount diverted through the Tracy Pumping Plant of the CVP (Table 2).

Limited evaluations prior to 1970 documented losses of both salmon and striped bass by these diversions, but were insufficient to estimate the overall magnitude of such losses. Losses undoubtedly vary due to the uneven geographic and seasonal distribution of fish, differences in intake design and location, seasonal diversion patterns, and other factors. Legitimate concerns have been raised about the extent to which agricultural diversions entrain fish. Striped bass, particularly eggs, larvae, and juveniles, have been demonstrated to be susceptible to such entrainment (Allen 1975).

Brown (1982) estimated that, in the late 1970s, approximately 500 million striped bass eggs, larvae, and juveniles under 0.6 inches were being lost to Delta agricultural diversions.

More extensive evaluations of fish losses and potential screening methods are now underway. Preliminary results from evaluations conducted in 1992 and 1993 of two Delta diversions concluded that the larvae of chameleon goby *Tridentiger trigonocephalus*, threadfin shad *Dorosoma petenense*, prickly sculpin *Cottus asper*, and big scale logperch *Percina macrolepida*, comprised 93.0% of the total loss of fish larvae in 1992 and 92% of the total loss in 1993 (DWR 1994). Other sampling conducted in the southern Delta along the San Joaquin River (DFG 1994a) found a very low number of fish entrained during a period from May-July in 1993. Largemouth bass *Micropterus salmoides*, and bluegill *Lepomis macrochirus*, were the species most commonly sampled, and along with western mosquito fish *Gambusia affinis*, were the most commonly found species in the channel adjacent to the diversion. Less than 0.078 fish/acre-foot were diverted.

Because agricultural and wetland diversions generally have been in place for over 70 years, it is not reasonable to conclude that they have caused the declines in the Estuary's aquatic resources since the mid-1960s. Pursuant to the DFG's recently adopted screening policy (DFG 1994b), screening in waters with salmon or steelhead *Oncorhynchus mykiss* and in areas designated as critical habitat for listed species remains the highest priority.

The largest loss at single diversions other than the CVP and SWP occurs at PG&E's Contra Costa and Pittsburg power plants where the principal loss is fish eggs and larvae entrained in the cooling water for the plants. Structural and operational changes made in recent years pursuant to permits issued by the Regional Water Quality Control Boards have reduced such losses of striped bass by 50 - 70% in relation to losses occurring in the late 1970s.

Considering the relative magnitude of the various diversions and their associated impacts, the focus on recovery and maintenance of the Estuary's fisheries needs to remain on water project operations.

Other Concerns

We believe that any evaluation of environmental effects of estuarine standards should include a full evaluation of the potential to impact fish upstream from the Estuary. Specifically, DFG wants to insure that adequate carryover storage is maintained in all affected reservoirs. High water temperatures resulting from reservoir drawdowns could result in substantial loss of salmon or steelhead production. DFG has made recommendations to the SWRCB for minimum pool volumes at Shasta, Oroville,

and Folsom reservoirs which we believe will provide temperature protection (WRINT-DFG-Exhibits 15, 25, 30). We also are concerned that reduced reservoir releases in response to export curtailments would cause low or unstable flows that could seriously impact anadromous fishes such as salmon, steelhead, striped bass, and American shad. In WRINT-DFG-Exhibit 8, we recommended an appropriate Delta inflow standard at Sacramento to protect striped bass.

We again urge you to recognize your responsibilities and adopt measures which compel changes in the status quo, because we believe the evidence is overwhelming that the status quo means a continuing decline in fish populations. We urge you to aggressively pursue measures to initiate the fisheries restoration called for in the Governor's Water Policy and move as far as is feasible towards the interim goals that we have previously recommended (WRINT-DFG-Exhibit 8). With export curtailments, improved Delta inflow and outflow regimes, and non-flow measures as may be described by others, the SWRCB could achieve significant progress toward these goals.

3. Methods to analyze water supply and environmental effects of draft standards

During our 1987 and 1991 testimony, we presented several exhibits (for example, WRINT-DFG-Exhibits 3, 5, 6, and 28,) with regressions and/or correlations relating abundance of several species to delta outflows. These relations, some of which are updated in figures 5, 6, and 7, provide a basis for evaluating proposed outflow standards on those species. We caution, however, that regression equations can only be expected to reasonably predict the future if the outflows fall within the range of the observations upon which the regressions are based. Also, the accuracy of predictions will depend on whether outflow continues to be related to the actual mechanisms responsible for the relations between abundance and outflow as in the past. For some species such as striped bass and longfin smelt *Spirinchus thaleichthys*, spawning stocks and egg production have declined to the point where the production of young fish at any given amount of outflow is less than it was historically.

In our opinion, the series of regression equations relating adult striped bass abundance to antecedent ouflow and export conditions is the best method available for simulating water project impacts on striped bass. This is commonly called DFG's striped bass model and is described in detail in WRINT-DFG-Exhibit 3. Updated (adults and young-of-the-year through 1991, entrainment losses through 1989) regression equations are presented in Table 3.

During the April 26 workshop, the California Urban Water Agencies (CUWA) indicated that they had independently evaluated the EPA proposed standards on the Estuary's ecosystem using Interagency Ecological Program data and were making their methods and results available to the SWRCB. We acknowledge CUWA's initiative,

but have major reservations about their methods and conclusions. We will provide our critical technical review of CUWA's report to the SWRCB when it is complete.

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Allen, D. H. 1975. Loss of striped bass (*Morone saxatilis*) eggs and young through small, agricultural diversions in the Sacramento-San Joaquin Delta. Anadromous Fisheries Branch Administrative Report no. 75-3

Brown, R. L. 1982. Screening agricultural diversions in the Sacramento-San Joaquin Delta. Internal Department of Water Resources Report.

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Meng, L. 1993. Status report on sacramento splittail and longfin smelt. Report to U. S. Fish and Wildlife Service, August 25, 1993.

Schubel, J. R. et. al. 1992. Managing freshwater discharge to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: The scientific basis for an estuarine standard. San Francisco Estuary Project.

Table 1. Salvage of Fish at the State Water Project Fish Facilities in January 1978 Relative to Total 1977 Fish Salvage.

Species	January 1978 Salvage	Total 1977 Salvage	January 1978 Salvage as a percent of Total 1977 Salvage
Chinook salmon *Oncorhynchus tshawytscha*	49,794	28,338	176
Striped bass *Morone saxatilis*	591,202	593,852	100
White catfish *Ameiurus catus*	3,402	30,828	11
American shad *Alosa sapidissima*	43,716	300,917	14
Threadfin shad *Dorosoma petenense*	146,232	806,819	18
Sacramento splittail *Pogonichthys macrolepidotus*	19,892	2,082	955
Longfin smelt *Spirinchus thaleichthys*	2,718	39,683	7
Delta smelt *Hypomesus transpacificus*	146,154	145,935	100
Yellowfin goby *Acanthogobius flavimanus*	27,478	17,844	154
Inland silverside *Menidia beryllina*	10,316	14,098	73

Table 2. Average Annual Fresh Water Diverson by Water Users in the Sacramento-San Joaquin Delta.

Location	Average Annual Diversions (TAF)	Percentage
SWP North Bay Aqueduct	23	0.2
SWP Banks Pumping Plant	3,173	32.2
CVP Contra Costa	119	1.2
CVP Tracy Pumping Plant	2,922	30.6
Delta Diversions	2,352	24.6
PG&E (estimated)	1,070	11.2
Total	9,659	100.0

Table 3. Equations used to simulate adult striped bass abundance as described in WRINT DFG Exhibit 3. Equations have been modified from those in Exhibit 3 due to corrections in the data base, more rigorous statistical analysis, and updates of the adult striped bass population estimates with recaptures during the 1992 summer-fall creel census. Adult bass population estimates from 1969 to 1991 were used in the analysis. A major change from the model in Exhibit 3 is the inclusion of year-round outflow, as well as exports, in the present version; the model described in Exhibit 3 included outflows from April to December only. The change in the months when outflow appears important resulted from correction of the analysis to exclude the young-of-the-year index in 1966 and 1983 to calculate entrainment loss rate (entrainment losses/young-of-the-year index). For Exhibit 3, we included a calculated young-of-the-year index when none was measured (1966) and included a grossly underestimated index value (1983).

Exhibit 3 Page No.		
10	Legal-sized adults in year i = 3,801,443 + 14,182(weighted mean YOY index$_i$ - 625,944($\log_{10}$(weighted mean loss rate$_i$))	R^2 = 74%
9	Weighted mean YOY index$_i$ = (YOY$_{i-3}$ + 1.248(YOY$_{i-4}$) + 0.661(YOY$_{i-5}$) + 0.289(YOY$_{i-6}$) + 0.158(YOY$_{i-7}$))/5	
	YOY = Delta YOY + Suisun YOY + residual YOY	
26	Delta YOY = 69.33 - 0.005058 mean April-July diversions (cfs)	r^2 = 43%
26	Suisun YOY = -158.86 + 46.61 $\log_{10}$ mean April-July outflow (cfs)	r^2 = 68%
27	Residual YOY = (1/(0.0093 + (2.70/eggs))) - 60	r^2 = 38%
27	eggs = egg production (billions) = 49.27 + 88.01 (adults (millions))^2	r^2 = 71%
9	Weighted mean loss rate$_i$ = (loss rate$_{i-3}$ + 1.248(loss rate$_{i-4}$) + 0.661(loss rate$_{i-5}$) + 0.289(loss rate$_{i-6}$) + 0.158(loss rate$_{i-7}$))/5	
	loss rate = antilogy($\log_{10}$(loss rate))	
35	$\log_{10}$(loss rate) = 4.482 + 0.00015252(mean August-March export (cfs)) - 0.00000594(mean August-March outflow (cfs))	R^2 = 77%

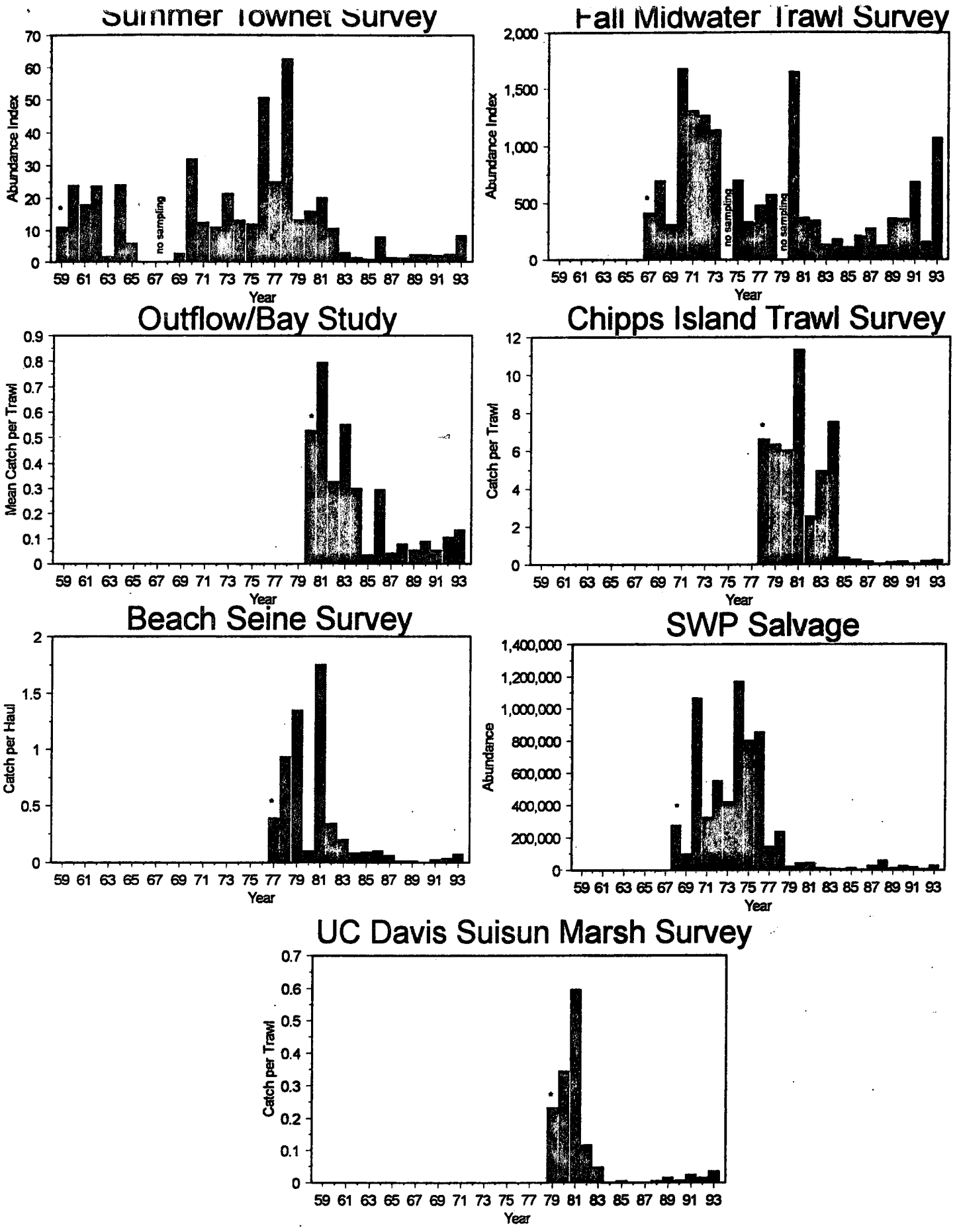

Figure 1. Trends in seven measures of delta smelt abundance in the Sacramento-San Joaquin Estuary. An "*" represents the first sampling year.

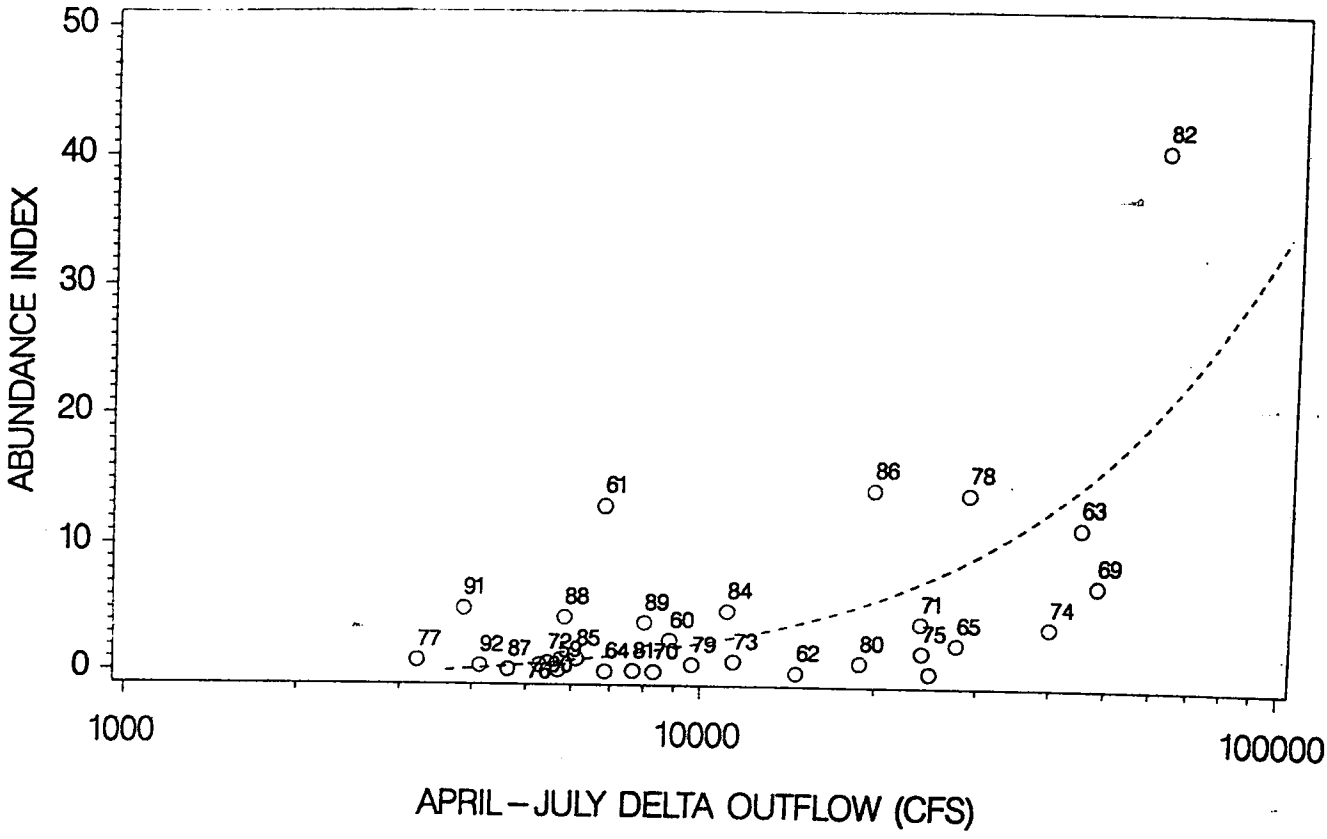

Figure 2. Relation between mean abundance index of splittail for the first two mid-summer tow net surveys and mean April-July Delta outflow. The regression equation: abundance = 12.21 ($\log_{10}$ [April-July outflow]) - 44.8 explains 30% of the variability in splittail abundance. No sample was taken in 1966 and no valid index was obtained in 1983.

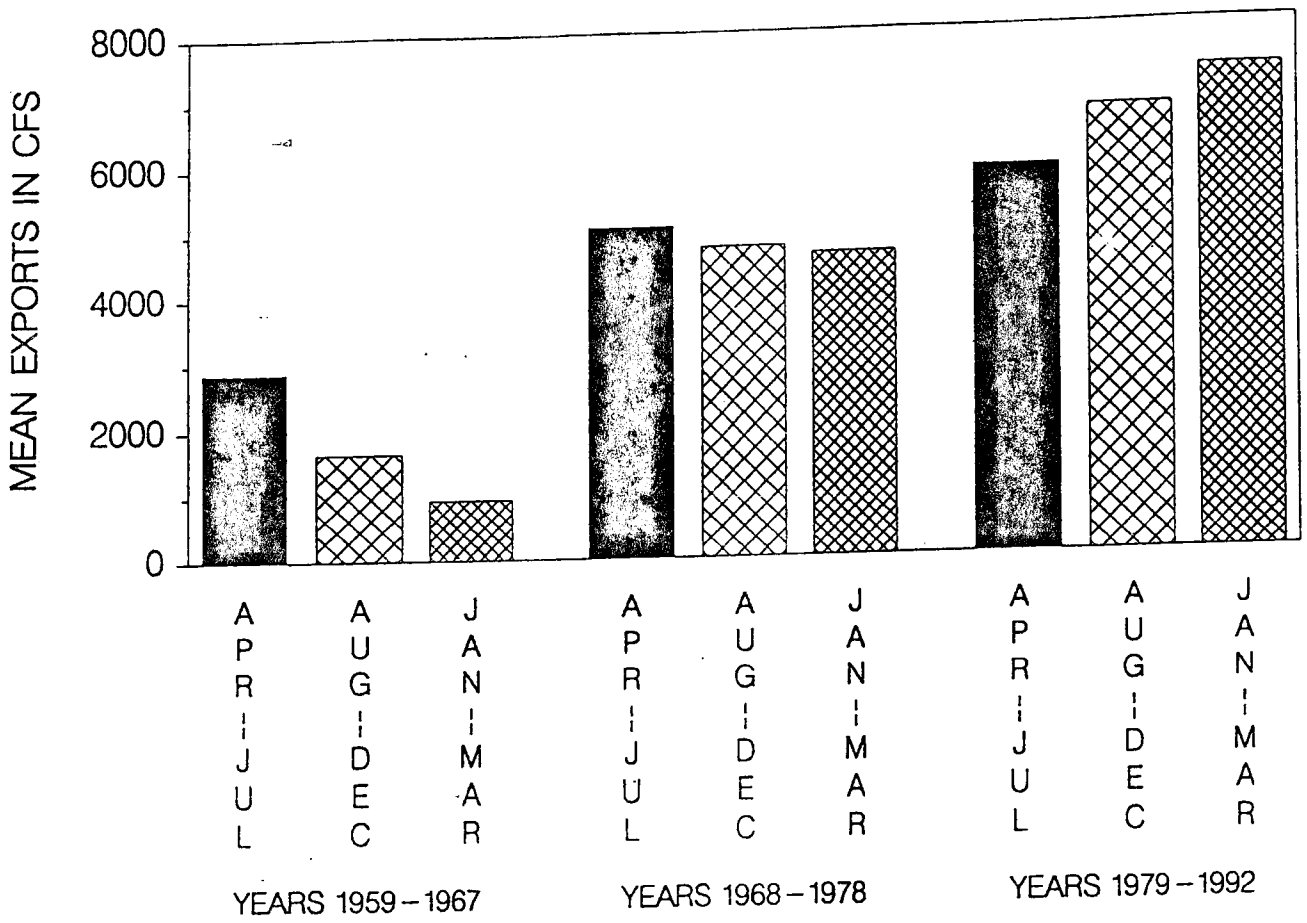

Figure 3. Comparison of mean seasonal water exports by the Central Valley Project and the State Water Project for the periods 1959-1967, 1968-1978, and 1979-1992.

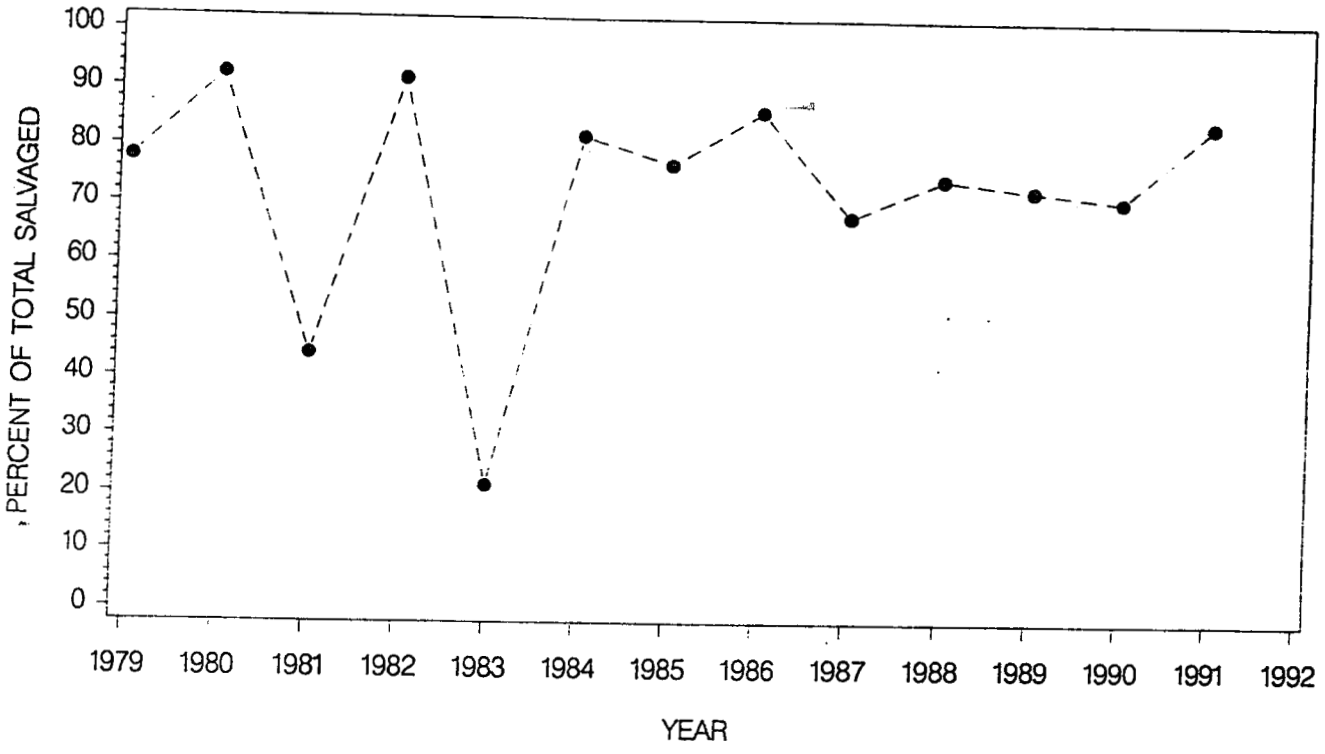

Figure 4. American shad salvaged during August-December at the CVP and SWP fish facilities as percent of total annual salvage.

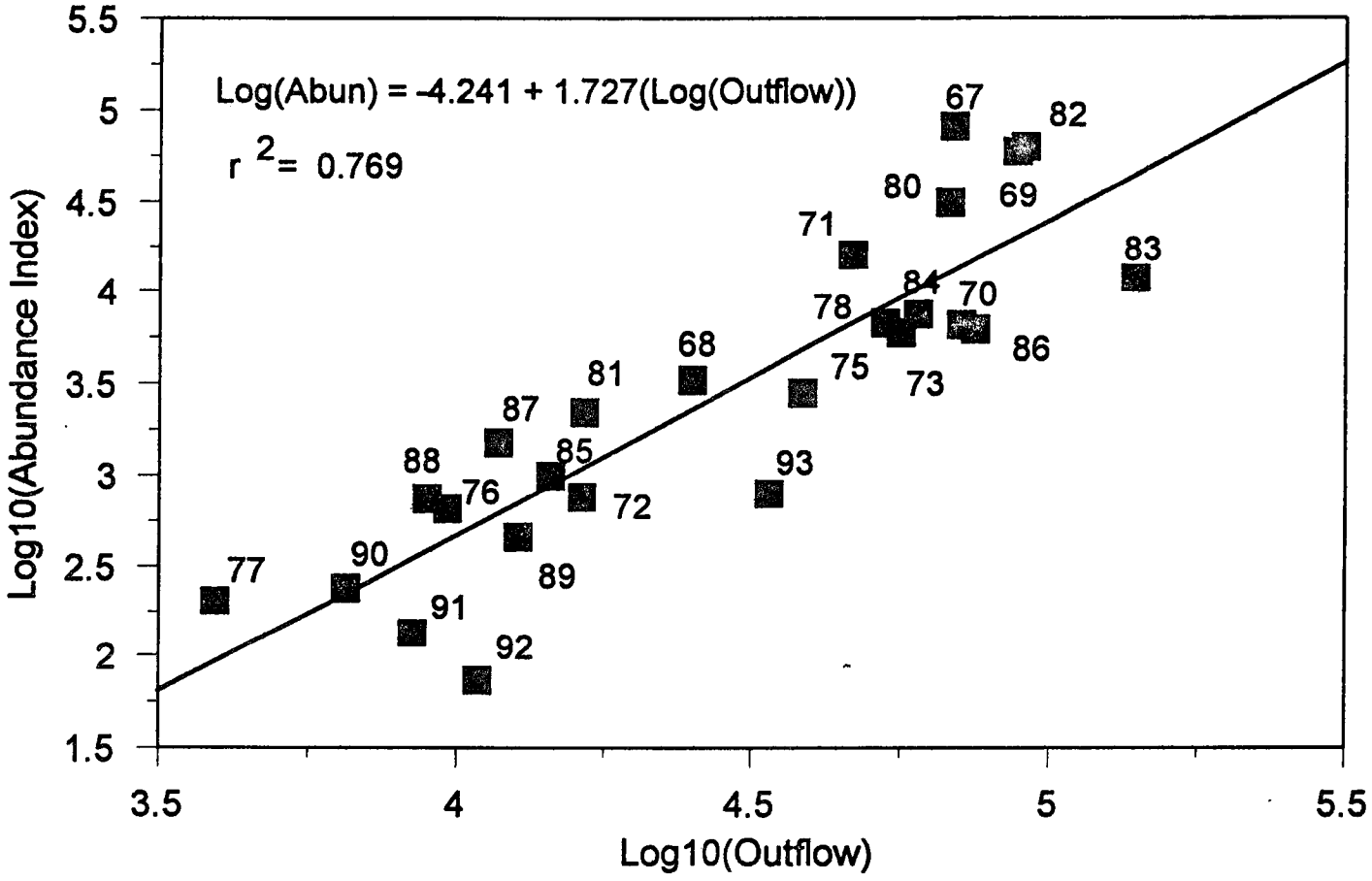

Figure 5. Relation between fall mid-water trawl index of longfin smelt abundance and mean December-May Delta outflow, 1967-1993.

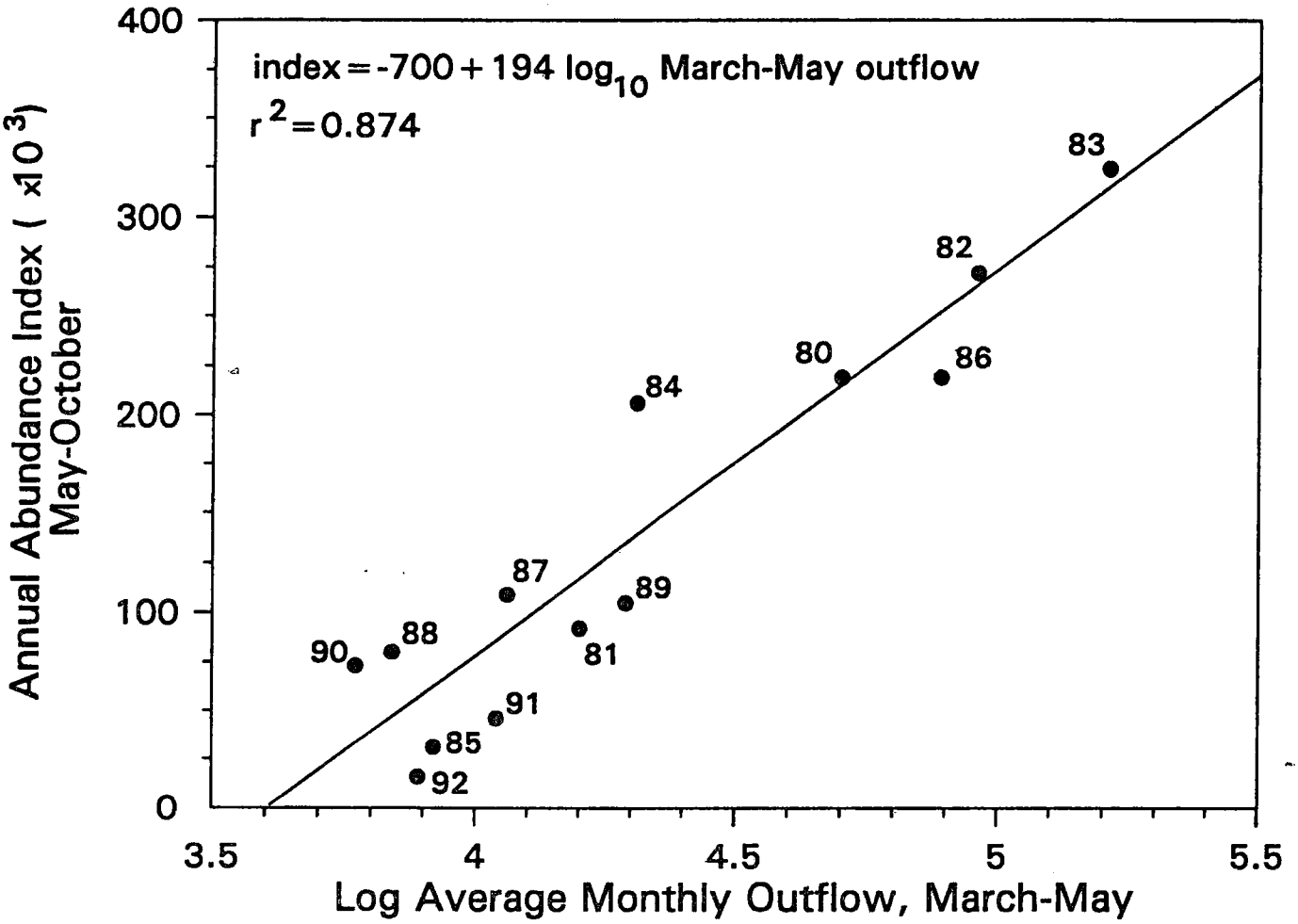

Figure 6. Relation between annual abundance index of immature *Crangon franciscorum* and average March-May Delta outflow, 1980-1992.

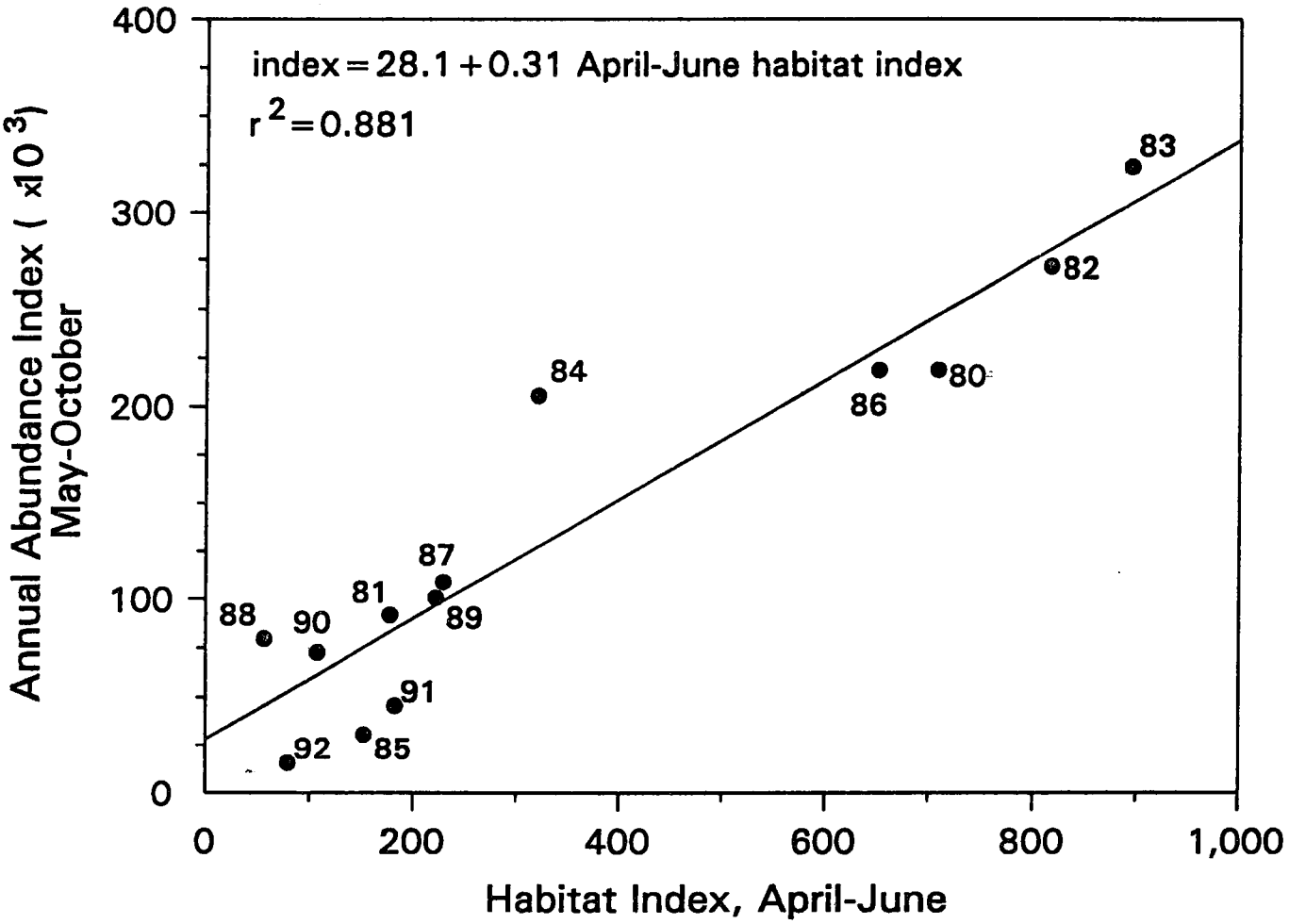

Figure 7. Relation between annual abundance index of immature *Crangon franciscorum* and annual April-June habitat index, 1980-1992. The habitat index represents the area of shoals within the 1.6-21.6 ppt salinity range.

Appendix A

Progress Report on Recovery Efforts for
Sacramento River Winter-Run Chinook Salmon
March, 1994

Red Bluff Diversion Dam (RBDD) Fish Passage Long Term Solution: The U.S. Fish and Wildlife Service (USFWS) completed their field evaluations of the effects of RBDD on adult salmon upstream migration in July 1992. USFWS is expected to complete a final report summarizing their evaluations in the near future

Due to strong opposition from the public regarding the replacement of RBDD with a permanent pumping plant, the U.S. Bureau of Reclamation (Bureau) has changed their protocol in finding a long-term solution to the fish passage problem at RBDD. They will now use a three step process to reach a decision. First, they will prepare a "Project Framework Document" which will briefly describe how the final report will be structured. This document is due in the spring of 1994. Second, a "Project Plan" will be prepared. This report is to be slightly longer than the project framework document and will have some detail about alternatives to achieve the final solution. Third, a "Work Plan" will be prepared which will contain extensive details about the preferred solution and the environmental effects. This same approach will be used for implementing other elements of the Central Valley Project Improvement Act.

The last engineering and biological reports will be completed by December 1998. The Bureau will use the information from the engineering and biological reports to develop the preferred long-term solution.

Red Bluff Diversion Dam (RBDD) Research Pumping Facility (RPF): The Bureau has changed the name of the pilot pumping plant to the "Research Pumping Facility". Initially, the Bureau had intended the facility to be used to design a large-scale project to replace gravity diversion at the site, however, they have now decided to use the smaller project to evaluate the efficacy of the technology. This change will result in a delay of several years in making a decision on a long-term solution at RBDD. Construction of the RPF began on schedule March 1, 1994 and will be completed by December 1994.

In June 1993, the Bureau reinitiated consultation with the National Marine Fisheries Service (NMFS) pursuant to Section 7 of the Federal Endangered Species Act (ESA) to address some minor modifications to the original design of the RPF. These changes included rotating the footprint of the facility out into the river by 15°, sediment removal and gate manipulation to achieve sweeping flows, and extending the completion date from October 1993 to December 1994. Because the construction of the RPF was delayed, the Bureau also proposed to remove the fish screens from the temporary pumps used to divert water into the Tehama-Colusa Canal in mid-March or early April

1994. Removal of the screens are necessary to accommodate installing a cofferdam in the river that will allow construction of the pumping facility. The February 1993 biological opinion concerning the long-term operation of the Central Valley Project (CVP) required the Bureau to operate and maintain the fish screens whenever temporary pumps are in operation beginning October 1, 1993. Based on the net benefits to fish passage at RBDD, NMFS has authorized the Bureau to operate and maintain the screens whenever the pumps are in operation commencing November 1, 1993, however, the screens may be removed in March and April of 1994 to accommodate cofferdam installation. The screens must be reinstalled before resumption of pumping operations in the fall of 1994. In addition, NMFS has authorized the Bureau to keep gates 8 through 11 in from March 1, 1994 through April 30, 1994 to accommodate cofferdam construction for the RPF. This will still allow free passage of chinook salmon via gates 1 though 7 which will be in the raised position.

Operation of Red Bluff Diversion Dam (RBDD): Table 1 gives the dates of gate operation at RBDD since December 1986. In 1993, the gates at RBDD were raised on September 15, even though the Bureau was not required to open them until November 1. The Bureau had offered to open the gates on September 1 but the fisheries agencies asked for the two week delay. The peak adult fall-run chinook salmon migration occurs at the first of September and the delay in raising the dam gates was requested to ensure adequate passage for these fish past the dam. The delay was not expected to have a measurable effect on the early migration of juvenile winter-run salmon. Even with the delay there were many adult and juvenile salmon stranded in the pools in East Sand Slough. The Bureau will attempt to solve this stranding problem by filling the pools with rock and by shaping and channelizing the slough. The intent is to eliminate holding pools and to establish escape channels. The dam gates are scheduled to be lowered on May 1, 1994 at which time counts will begin for returning adult winter-run chinook salmon passing upstream through the dam's fish ladder.

Based on conditions set forth in the NMFS February 1993 biological opinion to the Bureau for long-term operations of the CVP, and subsequent amendments previously reported, future operations of RBDD gates for protection of winter-run chinook salmon will be as follows:

- The gates of Red Bluff Diversion Dam must be raised on November 1, 1993 (but were raised on September 15, 1993) and remain in the raised position through at least April 30, 1994;

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

- NMFS will review proposals by the Bureau for intermittent gate closures of up to 10

days one time per year on a case-by-case basis.

The Bureau will not reinitiate consultation with NMFS to modify the September 15, 1994 deadline for raising RBDD gates (as stated in the last biannual report). By the spring of 1995, when irrigation demands are made, the RPF will be on-line and providing water to the Tehama-Colusa Service Area.

Table 1.
Red Bluff Diversions Dam
Periods of Gates Out Operation

1986/1987	December 5 to January 25; February 4 to April 1
1987/1988	December 1 to February 18; March 5 to March 10
1988/1989	November 30 to Feb 5; February 15 to April 12
1989/1990	December 1 to April 1
1990/1991	December 1 to May 1
1991/1992	December 3 to May 1
1992/1993	November 1 to May 1
1993/1994	September 15 to --------

Adult Run Size Estimates: Table 2 is a summary of the historic estimated run size of winter-run chinook salmon counted passing RBDD. The 1993 winter-run size estimate was 341.

Spawning distribution in 1993, as determined by aerial flights, was concentrated in the uppermost reaches of the Sacramento River (Table 3).

The 1993 return of adult spawners was composed primarily of two-year-old (1991 broodyear) and four-year-old (1989 broodyear) fish with a noticeable scarcity of three-year-olds (1990 broodyear). This was undoubtedly due to poor survival of the 1990 broodyear which experienced higher than optimal water temperatures in the upper Sacramento River during the summer and fall of 1990. Water temperature predictions for 1993 by the Bureau proved to be relatively accurate and high water temperatures were not a problem as in past years.

Table 2.
Annual Estimated Winter-run Chinook Salmon Run Size at Red Bluff Diversion Dam, 1967 through 1993.

Year	Sacramento Winter-run Chinook Salmon		
	grilse	adults	total
1967	24.985	32.321	57,306
1968	10.299	74.115	84,414
1969	8.953	108.855	117,808
1970	8.324	32.085	40,409
1971	20,864	32.225	53,089
1972	8,541	28.592	37,133
1973	4.623	19.456	24,079
1974	3.788	18.109	21,897
1975	7.498	15.932	23,430
1976	8.634	26.462	35,096
1977	2.186	15.028	17,214
1978	1.193	23.669	24,862
1979	113	2.251	2,364
1980	1.072	84	1,156
1981	1.744	18.297	20,041
1982	270	972	1,242
1983	392	1.439	1,831
1984	1.369	794	2,663
1985	329	3.633	3,962
1986	451	2.013	2,464
1987	236	1.761	1,997
1988	708	1.386	2,094
1989	53	480	533
1990	16	425	441
1991	57	134	191
1992	58	1.121	1,181
1993	74	267	341
1994	NA	NA	NA

NA = Not yet available

Table 3.
Estimated Redd Distribution of Winter-run Chinook Salmon on the Sacramento River
DFG Aerial Counts

RIVER REACH	1987		1988		1989		1990		1991		1992		1993	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Keswick Dam to Anderson Cottonwood Irrigation District (ACID) Dam	1	0.3	12	0.9	3	6.5	0	0	0	0	1	1.9	1	1.6
ACID to Highway 44	49	15.4	342	26.4	26	56.5	38	39.2	8	66.9	15	27.8	104	81.9
Highway 44 to Upper Anderson Bridge	53	16.6	335	25.8	9	19.6	45	46.4	4	33.3	22	40.7	17	13.4
Upper Anderson Bridge to Balls Ferry	60	18.9	88	6.8	1	2.2	5	5.1	0	0	8	14.8	1	0.8
Balls Ferry to Jelly's Ferry	91	28.6	54	4.2	0	0	2	2.1	0	0	3	5.6	1	0.8
Jelly's Ferry to Bend Bridge	45	14.2	115	8.9	6	13.0	0	0	0	0	3	5.6	1	0.8
Bend Bridge to Red Bluff Diversion Dam	5	1.6	18	1.4	NS	-	0	0	0	0	0	0	0	0
Red Bluff Diversion Dam to Tehama	14	4.4	210	16.2	NS	-	5	5.1	0	0	2	3.7	1	0.8
Tehama to Woodson Bridge	0	0	123	9.5	1	2.2	2	2.1	0	0	0	0	0	0
Estimated Total Number of Redds	318		1,297		46		97		12		54		127	

NS - No survey in this river reach

Squawfish Control at RBDD: Predation on juvenile salmon by squawfish below RBDD is an ongoing concern. The development of a commercial fishery to alleviate this problem is still on hold while the Department of Health Services analyzes recently acquired data on reduced contamination levels. Several years ago squawfish were found to have unacceptable levels of dioxin and, as a result, there is a health advisory on consumption of this fish. Simpson Paper Company routinely monitors trout and sucker tissue for dioxin and related compounds and these analyses have shown a remarkable reduction in the contamination. Samples of squawfish collected by the USFWS at RBDD in 1993 indicated a similar reduction in dioxin. The Department of Health Services determinations for the recent samples are pending.

Tehama-Colusa Canal Screen Evaluation: Nineteen paired groups of fall-run chinook salmon and steelhead trout were released above and below the bypass facility at RBDD on the Sacramento River from May 24 through June 25, 1993. The releases were made as part of a pilot study to evaluate the effectiveness of the new fish screen's bypass system. A progress report titled, *Survival and condition of juvenile salmonids passing through the downstream migrant fish protection facilities at Red Bluff Diversion Dam on the Sacramento River, Spring 1993*, was forwarded to the Bureau in November 1993 and is now available for general circulation. Results suggest descaling (loss of scales) was greater in test fish than control fish. Results of this pilot study are being incorporated into a new plan of investigation which will refine methods for estimating survival and descaling. Use of physiological indicators of stress is also being explored.

The Tehama-Colusa Canal was sampled with fyke nets for 6,594 hours from May 3 to October 13 to detect possible entrainment of juvenile salmonids behind the fish protection facility at the RBDD. Two salmon were captured in sample nets. Total entrainment was estimated to be 20 salmon based on a catch of 2 and sampling 10% of diverted flow. Fish screens were inspected by SCUBA divers on two occasions. Most screen seals were found to be in good condition, however, one was reseated three times before meeting an 1/8-inch maximum gap criteria. During two Magnacide® treatments, May 10 and August 18 to control algal growth in the canal, 2 salmon and 1 rainbow trout were observed. A progress report is in preparation.

Temperature Control in the upper Sacramento River: The abundant rainfall conditions filled Shasta Dam and even produced flood release conditions as late as the first week of June, 1993. For the first time since the 1986 water year, temperature control was attained downstream to Bend Bridge. The end-of-year September 1993 storage for Shasta Reservoir was 3.0 MAF. Shasta Reservoir is currently holding 3.2 MAF but was predicted to have 3.1 MAF on February 15, 1994 for purposes of water rights contracts allocations. The 1993-94 water year is classified as critical. Under this water year classification (critical water year with high initial reservoir storage) the winter-run biological opinion requires that the Bureau operate to obtain 56°F from Keswick to

Jelly's Ferry from April 15 through September 30, 1994 (see Appendix A). The Bureau is currently working with NMFS to develop a water project operation for 1993-94 that will meet this requirement.

The Bureau was planning to install a water temperature monitoring device at Jelly's Ferry in August 1993 but was late in doing so. Installation was completed in December and temperatures have been recorded since January 1, 1994.

Trinity Reservoir did not fill during the 1992-93 water year because it has much less refill potential than Shasta Reservoir. The diversion of Trinity Reservoir water to the Sacramento River was limited to allow Trinity storage to recover. During low rates of Trinity diversion to the Sacramento River, the water has a higher heat gain in Lewiston and Whiskeytown reservoirs which the water must pass through as it is being diverted. Temperature control curtains were installed in Lewiston Reservoir to control the heat gain and the installation of two curtains in Whiskeytown Reservoir was complete in July 1993. In addition, the Bureau established an interpretive program to educate the public about the temperature control program. These structures are expected to lower the temperature of the Trinity River diversion where it enters the Sacramento River by 4 to 6° F. The two curtains in Lewiston, and the two in Whiskeytown, will give the water project the needed flexibility to provide cold water whether the diversion is at maximum rate or a slower rate; thereby reducing the conflicts between power and water supply operations and temperature control. The Bureau has reconvened the Temperature Task Force (meeting March 1, 1994) to determine the optimum timing and amount of Trinity River diversions this year.

A temperature control device for Shasta Reservoir has been planned but no authorization for funding has been obtained. The temperature control device will be a funding priority under the Central Valley Project Improvement Act.

The preparation of a daily temperature model for the Sacramento River system is continuing by the University of California under a grant from the U.S. Environmental Protection Agency (EPA) and funding by Proposition 70. This model will assist in deriving more precise cold water budgets that can be used for real-time operations. DFG is contributing to the studies focusing on the effects of shaded riverine habitat and agricultural drain water on water temperature in this important juvenile rearing area.

Spring Creek (Iron Mountain Mine): The planning process to enlarge Spring Creek Debris Dam is continuing under a one-million dollar plus contract issued by EPA to the Bureau.

Given the large runoff during 1993-94, it was extremely fortunate that the Iron Mountain Mine's emergency treatment plant's capacity for metal removal had been doubled early in 1993 to

accommodate 140 gallons-per-minute (gpm) of the 600 gpm inflow of toxic mine runoff. This allowed the spills at Spring Creek Debris Dam to occur later in the water year at a time when they were synchronized with flood releases from Shasta Dam. Even though the spills of toxic metals were large, they were timed with proportionately large flood release. There were some periods of emergency release criteria during the onset of the spills that produced elevated concentrations of metals; however these levels were not considered high enough to harm the more tolerant adult life stages of winter-run that were present at the time.

Under the EPA Superfund program a permanent treatment plant will be installed in the summer of 1994. This treatment plant will remove 70% of the metals from the discharge into the Sacramento River.

DFG secured a $100,000 Federal grant to characterize the risks from chemical sediments in Keswick reservoir as a result of Iron Mountain Mine discharge. Preliminary results show that the quantity of contaminated sediments is enormous, approximately 15 feet deep. The sediments contained contaminant levels equal to designation of hazardous waste levels and are, therefore, highly toxic. The risk to the river depends on mobilization of this hazardous material. Future studies will be conducted to determine the risk level and to develop appropriate remedies.

Spawning Gravel Restoration: The USFWS continued evaluation work on the gravel restoration project in the upper Sacramento River. Natural gravel recruitment throughout the upper river had all but ceased due to a number of hydroelectric and bank stabilization projects. Therefore, in 1990, eight locations along the upper Sacramento River were selected as gravel restoration sites. Substrate at these areas were mapped to obtain detailed pre-restoration baseline maps. Spawning-sized gravels were added to the river at each site. Gravels were either dumped over the bank, making it available to be disbursed by high flows, or graded under the low-flow water surface elevation. In either case, the intention was to allow high water flows to naturally distribute the gravel throughout the upper Sacramento River creating additional, and improving existing, spawning habitat. In 1992, a placement site just downstream of Keswick Dam was included in the study. Previous surveys had shown gravel at this site, dumped by the Department in 1989, had moved little prior to 1992.

During 1993, substrate surveys were conducted from the Anderson-Cottonwood Irrigation District Diversion (ACID) Dam upstream to Keswick Dam. Additional surveys were conducted at Market Street Bridge, Redding Riffle, and Shea Levee sites. Surveys were conducted using SCUBA techniques to document gravel movement.

Above average precipitation and warm weather combined in March, leading to high flow releases of over 50,000 ft^3/s from Shasta and Keswick Dams. These releases were the highest flows

occurring since gravel placement and well above mean monthly flows since 1964. Significant movement of gravel resulted at all sites. Roughly 30,000 yd^3 of spawning-sized gravel stockpiled at Keswick and Salt Creek (1 mile downstream of Keswick) sites literally disappeared into the turbid flows with 2 or 3 days of continued high releases. Tobiasson and Shea sites, 11 and 12 miles downstream of Keswick, also had visible quantities of gravel disbursed by these flows.

Preliminary survey results indicate a considerable increase in the amount of spawning substrate available to chinook salmon in the upper Sacramento River occurred. This area is particularly important for winter-run chinook salmon spawning and incubation as favorable water temperatures can be maintained in this reach of the river. However, at the current low spawner escapement estimates, it is very unlikely that habitat (spawning gravel) is limiting winter-run chinook salmon. Preliminary analysis indicates gravels in the uppermost sites, Keswick and Salt Creek, disbursed downstream over a mile, creating excellent spawning habitat in areas which were previously marginal. USFWS is currently analyzing this data and will release a final report by May 1994.

Anderson-Cottonwood Irrigation District (ACID): Annual installation of flashboards at ACID's dam on the Sacramento River was complete by April 1993. DFG provided the ACID engineer/manager with an elevation survey of the dam and all the water control adjustment points in the system to assist in developing a configuration of flashboards that would require less adjustment during the irrigation season. By use of the survey and hydraulic engineering principles the dam was installed with fewer flashboards this year than past years (estimated to use 4 fewer); thus reducing the probability for adjustment.

In the past, during adjustment of the flashboards, Keswick Dam releases were fluctuated causing stranding of juveniles in nearshore areas. The magnitude and duration of the flow fluctuation depended on the number and position of the flashboards that needed to be removed. The District has full discretion over the Keswick Dam releases under a contract with the Bureau.

In early June 1993, an emergency situation developed at the dam when the Bureau anticipated flood releases of up to 20,000 cfs at Shasta Dam. This required removal of the flashboards to avoid destruction of the dam. Since the minimum number of flashboards had been installed initially, only a small board adjustment was necessary. Excellent cooperation by the District resulted in extremely quick removal of the boards at higher than normal Keswick releases. The removals were so quick that the river did not drain down to elevations that produce large stranding risks before the Keswick releases were again increased. No adjustments of flashboards were necessary for the remainder of the season and the flashboards were removed the last week of October, 1993. Prior to complete removal of the flashboards, the flows at Keswick dam had been ramped down so that no flow fluctuation occurred and stranding of salmon was not a problem.

The District's Bonneyview Pump screen installation survived the flood flows in the river. This demonstrates the suitability of this type of installation for small pump diversions along the river.

Glenn-Colusa Irrigation District (GCID): In 1991, GCID brought suit against DFG in Superior Court in response to the 1991 federal court ruling that GCID had violated the federal ESA by taking the federally listed winter-run chinook salmon at their Hamilton City water diversion facility without ESA authorization by the NMFS. The federal court ruling spoke only to the issue of whether GCID's pumping activity caused irreparable harm to the winter-run. The federal judge stated that issues of responsibility for past screen design, maintenance, construction, and cost of building a new, effective fish screen were not a matter before the court and that GCID would have to seek resolution of these matters through other legal avenues.

GCID's resulting suit against DFG in State Superior Court alleged the Hamilton City water diversion fish screen is a public nuisance created by a defective design which failed to prevent entrainment of the federally listed winter-run chinook salmon into their diversion. This failure to prevent entrainment, in turn, resulted in federal legal action by NMFS against GCID.

During the spring of 1993, DFG discussed possible settlement terms with GCID. After failure to reach settlement, the case went to trial in June 1993. After two weeks of testimony, the judge ruled that, as a matter of law, the State was not responsible for replacing the GCID fish screen but was only responsible for routine maintenance of the screen pursuant to the 1968 contract between the Department and GCID.

A federal Joint Stipulation of Parties was renewed between GCID and NMFS in July 1993, superseding the April 1992 amended stipulation. The stipulation sets forth terms and conditions for operation of GCID's Hamilton City water diversion facility while development of long-term conservation measures proceed. The stipulation shall remain in effect until GCID's operation of their Hamilton City facility is covered by either an ESA Section 7 Biological Opinion and incidental take statement or a Section 10 permit.

GCID completed installation of an interim flat-plate screen across the existing trashrack structure during September 1993. The scheduled hydraulic and biological evaluations were limited due to the delay in completion of the interim screen, and are being proposed for continuation during the spring of 1994. Pumping operations were limited to the court imposed velocity criteria of 0.33 feet per second for the period of August through November of 1993.

GCID has made a request to the Corps of Engineers that their dredge permit be extended for an additional year and that two key provisions be relaxed. The District is proposing that the requirement for reduced pumping during the release of Coleman National Fish Hatchery fall

chinook be eliminated. They are also requesting that velocity criteria be based upon the increased surface area of the new flat plate screen.

Preparation of the Environmental Impact Report/Environmental Impact Statement (EIR/EIS) has been delayed and is not anticipated for completion until April 1995. The Bureau has assumed the designation of Federal Lead Agency and is now actively participating in the preparation of the EIR/EIS and will be responsible for administering federal funding for the long-term solution under the Central Valley Project Improvement Act.

Promulgation of Bay-Delta Water Quality Standards: EPA has promulgated draft water quality standards for the San Francisco Bay/Sacramento-San Joaquin Delta. EPA is consulating with NMFS pursuant to the ESA regarding potential effects of the water quality standards on the Sacramento winter-run chinook salmon. NMFS has requested additional information as to the effect such standards would have on the ability of DWR and the Bureau to comply with terms and conditions of the Federal biological opinion for the State and Federal water projects which was issued by NMFS in February 1993. Joint, formal public hearings with the USFWS will be held in late-February 1994 to receive comments from the public on actions to designate critical habitat for the Delta smelt, to list the Sacramento splittail as a threatened species under the ESA, and to establish the water quality standards for the Delta. The Department is presently drafting formal written comments to the EPA on the standards.

Winter-run Chinook Salmon Outmigration Monitoring Program: In April 1992 an ad hoc "Delta Salvage and Clifton Court Forebay (CCF) Predation Working Group" was established to evaluate the effects of State and Federal Delta pumping plant operations on winter-run chinook salmon during the time period of January 1 through May 31, 1992. A report detailing the findings of the group was signed by representatives of the Department, Department of Water Resources (DWR), Bureau, USFWS, and NMFS and distributed to each agency on October 30, 1992.

Concurrently, an ad hoc "Winter-run Monitoring Group" was meeting to discuss a pilot monitoring program for winter-run chinook salmon. The biological opinion issued to the Bureau on February 14, 1992, by NMFS required the Bureau and DWR to continue and expand a program of monitoring downstream migrating winter-run chinook salmon in cooperation with NMFS, DFG, and USFWS. Assistance by the Bureau and DWR was to include, but not be limited to, the provision of funds for this program. This group joined with the members of the "Delta Salvage and CCF Predation Working Group" in May 1992 and has been meeting regularly since then. This group is now known as the "Winter-run Chinook Salmon Monitoring and Loss Group".

Much of the basic life history information for winter-run in the lower Sacramento River and Delta was unknown. Historical data were few, therefore, the sampling efforts were designed to determine the presence and period of time winter-run chinook occur in these areas.

The monitoring elements include:

- USFWS monitoring on the upper Sacramento River;
- DFG monitoring at GCID;
- USFWS monitoring of the lower Sacramento River and Delta;
- DFG fish salvage operations at the John E. Skinner Fish Facilities; and,
- Bureau fish salvage operations at the Tracy Fish Facilities.

In addition, the group has been involved in issues such as predation and predator studies in CCF, the USFWS winter-run release from Coleman National Fish Hatchery, USFWS chinook salmon mark and release studies throughout the system, and all other issues with the potential to affect juvenile chinook salmon in the lower Sacramento River and Delta.

A report on the 1992-1993 monitoring results and recommendations for 1993-1994 was finalized in September, 1993 and is available upon request.

Winter-Run Chinook Salmon Propagation Program at Coleman National Fish Hatchery: Spawning of adult winter-run chinook salmon captured by the USFWS's Coleman National Fish Hatchery (CNFH) was concluded in late July 1993. A total of 24 adults were captured at the Keswick (18) and RBDD (6) fish traps, during the 1993 trapping period. Four of the adults captured at Keswick were returned to the river so as not to exceed the 20-fish limit directed by NMFS in the USFWS Section 10 permit. Two fish retained were later identified as spring-run, dropping the actual number of winter-run captured to 18. Age composition of the 18 adults retained, determined by scale pattern analysis, was 17% age-2, 33% age-3, and 50% age-4. The inability to sex adults early in the season resulted in a 2 to 1 female to male sex ratio of the adults retained (i.e. 12 females and 6 males). Of these, 10 females and 3 males were successfully spawned. One female and 3 males died prior to maturation; one other female produced no progeny after an unsuccessful attempt to fertilize eggs with cryopreserved semen.

Winter-run chinook salmon progeny resulting from the 1993 spawning, incubation and rearing operations were released in January 1994. Spawning and incubation operations in 1993 resulted in the production of 30,503 eyed eggs from a total collection of 47,157 green eggs. After approximately a four month rearing period, 19,745 juveniles in 13 sub-lots remained and were

adipose fin-clipped and coded-wire tagged. Each sub-lot received a unique tag code to allow future differentiation by family group. Also, in January 1994, 1,000 individuals were removed from the general population and PIT tagged for incorporation into the captive brood stock program. The actual release of the winter-run juveniles occurred on January 27, 1994 at Caldwell Park (river mile 299) in the city of Redding. The total number released was approximately 18,723. Average fork length of the juveniles released was 81.2 mm.

Recapture of marked juveniles will allow assessments of outmigration timing and potentially identify critical rearing areas. Marked juveniles recovered at pumping facilities and diversions will also assist in estimation of "take" at these sites. Within four days of the January 27,1994 release, some juveniles had emigrated approximately 100 miles from the release location. The cooperative juvenile outmigration monitoring program will continue to gather data both in-river and in the Delta.

In accordance with the requirements of the ESA, the USFWS completed a Section 7(a)(2) Biological Assessment on the Effects of Coleman National Fish Hatchery Operations on Winter-run Chinook Salmon to ensure actions authorized, funded, or carried out by CNFH and its cooperators (University of California at Davis' Bodega Marine Lab (BML), and California Academy of Science's Steinhart Aquarium) do not jeopardize the continued existence of winter-run chinook salmon. The Biological Assessment was finalized and submitted to NMFS in October 1993. After completion of the Biological Assessment, initiation of Section 7 Consultation between USFWS and NMFS, and the completion of a draft biological opinion by NMFS, it was determined that modification of the USFWS current Section 10 Research Permit was also required. Submission of both documents was deemed necessary to sort out directed versus incidental take issues. The permit modification request was forwarded to NMFS on December 17. As of February 1, 1994, the USFWS is currently awaiting response to the request, as well as NMFS' biological opinion on all CNFH operations.

Experimental Captive Broodstock Program: The Winter-run Captive Broodstock Program (WRCBP) was initiated in 1991 to insure against extinction of this species. The goal of the program is to produce 200 mature broodstock each year.

A committee oversees the direction and management of the WRCBP. The members of this committee include representatives from DFG, NMFS, USFWS, University of California at Davis and BML, Steinhart Aquarium, Pacific Coast Federation of Fishermen's Association, Tyee Club, Golden Gate Fishermen's Association, DWR, Bureau, and Arizona State University. A summary of the proposed ten year budget and the funding sources is attached (Table 7). DFG has been an active proponent of this program and has provided a total of $476,291 in funding since the program began. We are currently managing three contracts, two with BML and one with Steinhart

Aquarium, that cover costs associated with equipment purchase and maintenance, materials, and staff salaries.

The Winter-run Chinook Salmon Act of 1993 (H.R. 2457) was passed in the House of Representatives on November 21, 1993. The Act authorized the appropriation of $1,000,000 annually for five years (1994-1998). The Act was introduced by Congresswoman Nancy Pelosi, and several other California Representatives (Hamburg, Miller, and Fazio). It requires that at least 20 percent of funds necessary to run the program come from non-Federal sources. The WRCBP committee has requested Senators Feinstein and Boxer to sponsor a similarly worded bill in the Senate.

The 1991 broodyear are being reared in seawater at both BML and Steinhart Aquarium. BML has a total of 349 winter-run, and a total of 77 winter-run are being reared at Steinhart Aquarium. A total of 971 winter-run of the 1992 broodyear were transferred from CNFH to BML on February 17 and 19, 1993. There are now 513 winter-run chinook from the 1992 broodyear at BML. Steinhart Aquarium is completing the construction of facilities to house 1992 and 1993 broodstock.

CNFH has approximately 1,000 winter-run from the 1993 broodyear for incorporation into the captive broodstock program. These fish will be transferred to BML in early March 1994.

USFWS Egg Incubation Temperature Tolerance Study: No temperature tolerance studies were conducted by the USFWS in 1993. Analysis of previous data is expected to be completed prior to the continuation of this multi-year research effort.

Modify the Keswick Fish Trap and Stilling Basin to Prevent Mortality to Winter-Run Chinook Salmon: The stilling basin acts as a trap to adult fish during spill events. Fish are attracted to the basin at spill and trapped when the spill ends. Testing of the escape fyke weir, which connects the basin to the fish ladder, was conducted by the Bureau in 1993. Results of the test indicate the fyke weir does not resolve the entrapment problem. Although the fyke weir was designed for one-way passage (i.e. from the basin into the ladder), testing demonstrated passage from both directions was possible. The Bureau is currently proceeding with design specifications for a channel from the basin directly to the river. Construction of this channel would avoid the undesirable connection to the ladder.

Table 7.
Winter-run Chinook Salmon Captive Broodstock Program
Summary of Proposed 10-Year Budget

	1992 93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999 2000	2000-2001	2001-2002	TOTAL
Steinhart Aquarium											
Original Budget	132,592										
Supplemental Budget	90,000										
Subtotal - Steinhart	222,592	89,448	53,014	55,654	68,437	86,648	64,427	67,648	71,031	74,583	853,472
Bodega Bay Marine Lab											
Original Budget	310,702										
Supplemental Budget	179,000										
Subtotal - Bodega	489,702	607,213	515,049	493,401	527,589	625,727	634,367	679,616	699,010	727,948	5,999,652
Genetic Management/ Molecular Genetic Analysis	225,000	219,597	230,503	244,925	235,131	236,331	247,953	260,372	273,740	287,981	2,461,133
Genetic Management Subcommittee	41,000	42,000	43,000	24,000	25,000	26,000	26,000	27,000	28,000	29,000	311,000
Coleman National Fish Hatchery Operations & Maintenance	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	2,880,000
TOTAL BUDGET	1,228,294	1,208,258	1,091,566	1,067,980	1,106,157	1,224,706	1,222,747	1,284,636	1,312,781	1,369,132	12,116,257
FUNDS ACQUIRED											
U.S. Fish and Wildlife Service	250,000	250,000	500,000[1]	250,000	250,000	250,000	250,000	250,000	250,000	250,000	2,500,000
Department of Fish and Game	241,291	200,000									
Salmon Stamp	25,000	10,000									
Bureau of Reclamation	100,000	200,000	300,000[2]								
Department of Water Resources	100,000	200,000									
National Oceanic Atmospheric Administration	500,000		250,000[2]								
SUBTOTAL - FUNDS ACQUIRED	1,216,291	860,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	4,976,291
ADDITIONAL FUNDS NEEDED	12,003	348,258	841,566	817,980	856,157	974,706	972,747	1,034,636	1,062,781	1,119,132	7,139,966

[1] $250,000 Coleman O & M and additional $250,000 recommended for President's budget
[2] Amounts recommended for President's budget

Clifton Court Forebay (CCF) Predation/Predator Study: During late November and early December 1993 DFG's Bay-Delta Division conducted another in a series of experiments designed to measure pre-screen losses of chinook salmon entrained at the SWP export facilities. As with the December 1992 experiment (reported in the last biannual report), the objective of the fall 1993 experiment was to examine the survival of relatively large juvenile salmon entrained under conditions of cool temperatures and high export rates. Conducting experiments under these conditions is critical to developing an understanding of pre-screen losses experienced by winter-run chinook. As with the fall 1992 experiment, hatchery-reared late-fall-run chinook salmon were used as surrogates for winter-run.

The data from the fall 1993 experiment have not been fully analyzed, but preliminary indications are that the observed survival rate was very low, on the order of 1-2 percent. This compares with survival rates during the fall 1992 experiment of about 25 percent. Factors affecting the outcome include; (1) water temperatures, (2) export pumping, (3) predator abundance, and (4) predator behavior which varies depending on temperatures and export rates. The 1993 experiment was conducted at warmer water temperatures and higher export rates. Unfortunately, no concurrent estimate of predator abundance was available since no recaptures were made of striped bass that were marked in November 1993. The 1993 experiment was conducted earlier than in 1992 because of concerns that the occurrence of wild winter-run chinook in the northern Delta or at the export facilities would prevent the SWP from exporting at the high levels (>6000 cfs) desired for the experiment.

Quarterly estimates of the CCF striped bass abundance are conducted by Bay-Delta field staff to monitor changes in abundance and age composition. Four studies were planned for 1993, however, only three were conducted and only two resulted in estimates of striped bass abundance. In February an estimated 156,667 striped bass were in CCF and in May an estimated 199,100 striped bass were present. The August study was cancelled and the November study was conducted but no recaptures of marked striped bass occurred, therefore, no estimate was possible. An abundance study began in late-February 1994, however, adequate numbers of striped bass were not available and, therefore, a viable population abundance estimate was not possible. The next abundance study is scheduled for May, but may be done sooner, if possible.

Preliminary planning is underway for an experimental, large-scale CCF predator removal effort in the fall and winter of 1994-95. The purposes of this effort are to reduce winter-run chinook pre-screen entrainment losses at the SWP in 1994-95 and to assess the efficacy of predator removal. It has not yet been decided by DFG whether or not this experimental removal will be conducted. At a workshop held in August, 1993, striped bass angler groups expressed their opposition to the program on the grounds that sub-adult and adult striped bass may be killed during removal and that any reduction in direct losses achieved by the removal will directly result in greater export pumping rates and, therefore, offsetting negative effects elsewhere in the Estuary. Concerns have also been expressed about where the removed predators will be returned to the Estuary. It appears likely that some form of environmental documentation will have to be prepared for the project so that all the issues can be addressed in

a formal manner. DFG and DWR are being apprised of these issues so that a decision can be reached as to whether or not to proceed with removal planning.

Georgiana Slough Acoustic Barrier Test: The 1994 program of studies to assess the benefits and affects of an acoustic barrier designed to discourage emigrating salmon smolts from entering Georgiana Slough and the central Delta is in the advanced stages of planning and environmental documentation. The acoustic barrier was in place for about four weeks during May and June 1993 and yielded inconclusive results with respect to its ability to prevent fall-run smolts from entering the Slough. The 1993 study was developed and submitted by the San Luis-Delta Mendota Water Authority, however, they did not provide any funding (correction from last Biannual Report). The funding for the study in 1993 came from DWR and the Bureau, with the State Water Contractors paying for the fisheries consultant and Westlands Water District paying for the project engineer.

The 1994 program is substantially larger in scope and cost than the one attempted in 1993. The basic program, as presently proposed, includes 8 to 10 weeks of barrier testing in April, May, and June during the fall-run juvenile emigration. It is hoped that this expanded period of testing will provide a more conclusive evaluation of the effectiveness of the barrier. The program includes several elements designed to answer questions about potential secondary impacts of the barrier, including,:

1) fall barrier operations combined with telemetric tracking of immigrating adult fall-run salmon to assess the potential of the barrier to delay or impede the upstream adult salmon migration,

2) creel census and hydroacoustic sampling to see if the barrier operations attract predators,

3) laboratory studies to examine potential physical effects of the sound generation on fish eggs and larvae.

The 1994 program is again being funded jointly by DWR and the Bureau. As in 1993, the program is being lead by Dr. Chuck Hanson, in coordination with the Interagency Ecological Study Program (IESP).

Interagency Ecological Studies Program (IESP) Section 7 Consultation: DFG, Bay-Delta and Special Water Projects Division submitted a draft biological assessment for the Interagency Ecological Study Program (IESP) sampling programs to NMFS in September, 1993. The draft assessment is still under review at NMFS. NMFS is soon expected to provide a letter authorizing take until the assessment can be finalized and a formal biological opinion prepared.

Of the 31 IESP elements adult winter-run chinook salmon appear to be significantly vulnerable to capture in two of the elements and in both cases captured adult salmon are

released alive. Juvenile winter-run chinook salmon are significantly vulnerable to capture in six elements. Protocols have been developed for each element to minimize the potential capture and mortality to juvenile winter-run due as a result of program operation. These protocols will be implemented with NMFS approval in the absence of a biological opinion.

Winter-run Chinook Salmon Occurrence at Tracy Fish Collection Facility and John E. Skinner Delta Fish Protective Facility for the 1992-93 and 1993-94 Juvenile Emigration Seasons: The 1992-93 final estimates of salvage and loss at the SWP were 411 salvaged and 1,797 lost. At the CVP they were 180 salvaged and 112 lost. This was a combined total loss estimate of 1,909. The February, 1993 biological opinion authorized a total combined incidental take limit of 2,700 winter-run chinook salmon from the 1992-93 season.

The incidental take statement of the biological opinion was updated by NMFS in October, 1993. It authorized a total "take" of 905 juvenile winter-run at the CVP and SWP Delta export facilities during the 1993-94 emigration season. "Take" is based on sampling of salvaged fish. The numbers of fish observed during salvage sampling is first expanded to account for periods when sampling is not occurring. "Take" is then calculated from expanded salvage by accounting for pre-salvage loss factors such as screen efficiency and pre-screen losses. Winter-run chinook salmon are classified as such by using length criteria developed by DFG biologists.

The first winter-run sized chinook salmon was observed this season on December 25, 1993 at the SWP. The first to be observed at the CVP arrived on December 31, 1993. At the time this report was being prepared 11 winter-run sized salmon had been observed at the two facilities yielding an estimated "take" of 149. The peak occurrences of winter-run at the facilities is expected in March.

Central Valley Project (CVP) and State Water Project (SWP): On February 26, 1991, NMFS requested the Bureau to formally consult with them pursuant to section 7 of ESA to determine whether its operation of the Central Valley Project (CVP) jeopardizes the continued existence of the threatened Sacramento River winter-run chinook salmon. Due to the complexity of the consultation, the Bureau and NMFS agreed to consult separately on 1992 project operations while pursuing completion of a "long-term" consultation which would address future operations under a full range of potential hydrologic and storage conditions.

NMFS issued a biological opinion and incidental take statement for 1992 operations on February 14, 1992. The opinion concluded that the Bureau's proposed operation of the CVP in 1992 was likely to jeopardize the continued existence of the Sacramento River winter-run chinook salmon and offered a reasonable and prudent alternative to avoid jeopardy. On February 12, 1993, NMFS issued a biological opinion which addressed the effects of proposed long-term operation of CVP and the SWP concluding operations are likely to jeopardize the continued existence of the Sacramento winter-run chinook salmon. The biological opinion provided reasonable and prudent alternatives, conservation measures, and reasonable and prudent measures to the Bureau and DWR to avoid jeopardy and minimize the effects of taking

winter-run chinook salmon (see Appendix A). The incidental take statement authorized take up to 1% of the estimated number of outmigrating winter-run juveniles. NMFS estimated that 270,000 winter-run would enter the Delta, therefore, the Bureau and DWR were authorized to take up to 2,700 winter-run at the CVP and SWP Delta pumping facilities from October 1, 1992 through May 31, 1993. For purposes of satisfying the California Endangered Species Act, the Department adopted the opinion on February 22, 1993 pursuant to Fish and Game Code Section 2095.

On October 1, 1993 NMFS issued an amended incidental take statement to the Bureau and DWR covering the period from October 1, 1993 through May 31, 1994. The authorized level of incidental take for the CVP and SWP Delta pumping facilities was set at 905 winter-run chinook salmon equalling 1% of the estimated number of winter-run chinook salmon outmigrants entering the Delta.

Reclassification of Federal Status: NMFS has determined that the Sacramento River winter-run chinook salmon should be reclassified from threatened to endangered effective February 3, 1994 (Federal Register Vol. 59, No. 2). NMFS began the review and reclassification process in response to a petition from the American Fisheries Society, California-Nevada Chapter on June 5, 1991. Under the ESA an "endangered species" is any species that is in danger of extinction throughout all or a significant portion of its range. A "threatened" species is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The reclassification is based on the continued decline and increased variability of run sizes since its first listing as a threatened species in 1989; the expectation of weak returns in certain years as the result of two small year classes (1991 and 1993), and continuing threats to the population.

San Francisco Bay Dredging: DFG Environmental Services Division staff continue to work cooperatively with the joint Long Term Management Strategy (LTMS) program to improve dredging practices in San Francisco Bay. DFG's primary objectives are to reduce the amount of dredged materials dumped into the Bay to levels that do not harm marine life or fishing, and to prevent the dumping of contaminated materials into the Bay. Recent LTMS progress towards these goals include: 1) The federal EPA published a draft EIS for a new ocean disposal site for clean dredged materials. This will provide an option to in-Bay disposal, and reduce impacts on the Bay; 2) The U.S. Army Corps of Engineers (Corps) set a limit on the volume of material that can be dumped at the Alcatraz disposal site; 3) The Corps adopted testing guidelines to help prevent disposal of contaminated materials into the Bay; and 4) The Regional Water Quality Control Board set guidelines to help prevent contamination of upland disposal sites for dredged materials. These actions, along with others under development, will help prevent dredging from harming winter-run salmon and other wildlife species.

Central Valley Project Improvement Act; Public Law 102-575, Title 34: On October 30, 1992, the President signed into law the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102-575), including Title XXXIV, the Central Valley Project Improvement Act (Act). This significant legislation amends the authorization of the Department of Interior's California Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic use and fish and wildlife enhancement as a purpose equal to power generation. The Act identifies a number of specific measures to meet these new purposes and sets a broad goal of sustaining natural populations of anadromous fishes produced in Central Valley rivers and streams at double their recent average levels. The Act also directs the Secretary of the Interior to operate the CVP consistent with these purposes, to meet the Federal trust responsibilities to protect the fishery resources of affected federally recognized Indian tribes, and to meet all requirements of Federal and California law.

The Act requires that 800,000 acre-feet of water from CVP yield be dedicated and managed for the primary purpose of implementing the fish, wildlife, and habitat restoration purposes and measures in the Act; to assist the State of California in its efforts to protect the waters of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; and to help to meet such obligations as may be legally imposed upon the CVP under state or federal law following the date of enactment of the Act including but not limited to additional obligations under the federal Endangered Species Act.

Fish and wildlife restoration activities specified in the Act which will have a direct consequence and benefit to Sacramento winter-run chinook salmon include:

- developing and implementing a program to mitigate for fishery impacts associated with operations of the Tracy Pumping Plant, develop and implement a program to mitigate for fishery impacts resulting from operations of the Contra Costa Canal Pumping Plant No. 1, install and operate a structural temperature control device at Shasta Dam;

- modify CVP operations as needed to control water temperatures in the upper Sacramento River, meet flow standards and objectives and diversion limits set forth in all laws and judicial decisions;

- develop and implement a program to eliminate losses of anadromous fish due to flow fluctuations caused by the operation of any CVP storage or re-regulating facility;

- develop and implement measures to minimize fish passage problems for adult and juvenile anadromous fish at the Red Bluff Diversion Dam;

- rehabilitate and expand the Coleman National Fish Hatchery;

- develop and implement a continuing program for the purpose of restoring and replenishing spawning gravel lost due to the construction and operation of Central Valley

Project dams, bank protection projects, and other actions that have reduced the availability of spawning gravel;

- develop and implement a program which provides for modified operations and new or improved control structures at the Delta Cross Channel and Georgiana Slough,

- develop and implement a program to resolve fishery passage problems at the Anderson-Cottonwood Irrigation District Diversion Dam as well as upstream stranding problems related to operations;

- re-evaluate existing operational criteria in order to maintain minimum carryover storage at Sacramento and Trinity River reservoirs to protect and restore the anadromous fish of the Sacramento and Trinity rivers; and,

- participate with the State of California and other federal agencies in the implementation of the on-going program to mitigate fully for fishery impacts associated with operations of the Glenn-Colusa Irrigation District's Hamilton City Pumping Plant, assist the State of California in efforts to develop and implement measures to avoid losses of juvenile anadromous fish resulting from unscreened or inadequately screened diversions on the Sacramento River; and,

- developing and implementing the Central Valley Anadromous Fish Restoration Program to increase the number of anadromous fish, including winter-run chinook salmon, that reach adulthood.

Sacramento Winter-run Chinook Salmon Recovery Team: The seven member Sacramento Winter-run Chinook Salmon Recovery Team has met 12 times since September 1992. Although progress on the draft recovery plan has been slow, the team has recently made significant progress. Much of the narrative for the plan has been developed and is being reviewed and edited. The most important element of a recovery plan is the stepdown outline of actions necessary for the recovery of a species. The winter-run chinook stepdown outline in nearly complete and a draft is expected by mid-March 1994. The list of necessary actions to recover the winter-run is extensive and addresses known problems throughout its inland habitat and provides some guidance regarding ocean harvest management.

The academic members of the team have made significant progress in determining population goals required for removing winter-run chinook salmon from the federal list of endangered species. During the past 25 years the population has been decreasing at a rate of 20 percent per year. Recovery to nonlisted status likely will take as long but will depend on the speed with which remedial measures are implemented.

The Recovery Team is attempting to complete its assignment this spring and to provide the NMFS with its draft recovery plan as soon as possible. Upon receipt of the draft plan, the

NMFS will initiate an internal review of the plan and may request clarification or modification by the Recovery Team. After NMFS is satisfied that the plan meets the intent of the law it will forward the plan to its office in Washington, D.C. The Washington office will have responsibility to distribute the plan for public comment.

Critical Habitat Designation: The final rule to designate critical habitat for the Sacramento winter-run chinook salmon was published June 16, 1993 (Federal Register, Volume 58, No. 114). As originally proposed, habitat for designation includes: The Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 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.

Reasonable and Prudent Alternatives:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Reasonable and Prudent Alternatives:
7. The Bureau must maintain the Delta Cross Channel Gates in the closed position from February 1 through April 30 to reduce the diversion of juvenile winter-run chinook salmon emigrants into the Delta.
8. Based on the observations of a real-time monitoring program in the lower Sacramento River, the Bureau must operate the gates of the Delta Cross Channel during the period of October 1 through January 31 to minimize the diversion of juvenile winter-run chinook salmon into the central Delta. The Bureau must develop the real-time monitoring program and fisheries criteria for gate closures and openings in coordination with the NMFS, FWS, DFG, and the California Department of Water Resources by August 1, 1993. The Bureau must ensure that continuous real-time monitoring is conducted between October 1 and January 31 of each year commencing in 1993.
9. Based on the 14-day running average of QWEST in cfs, the Bureau and the California Department of Water Resources must operate the Delta water export facilities to achieve no reverse flows in the western Delta from February 1 through April 30. The 7-day running average, if negative, must be within 1,000 cfs of the applicable 14-day running average during this period.
10. Based on the 14-day running average of QWEST in cfs, the Bureau and the California Department of Water Resources must operate the Delta water export facilities to achieve flows in the western Delta greater than negative 2,000 cfs from November 1 through January 31. The 7-day running average, if negative, must be within 1,000 cfs of the applicable 14-day running average during this period.
11. Continue and expand monitoring of winter-run chinook salmon in the lower Sacramento River and Sacramento-San Joaquin Delta to establish their presence, residence time, and serve as a basis for the real-time management of Delta Cross Channel gate operations. The Bureau must develop a real-time monitoring program including sampling locations, sampling equipment, sampling frequency and the fisheries criteria for gate closures and openings. The Bureau must ensure that continuous real-time monitoring is conducted upstream of the Cross Channel gates between October 1 and January 31 of each year commencing in 1993 to serve as a basis for operation of the Delta Cross Channel gates. Additional monitoring must be conducted throughout the lower Sacramento River and Delta between September 1 and May 31 of each year commencing in 1993 to provide information regarding the presence and residence time of winter-run chinook salmon juveniles in the lower river and Delta. The results of the program must be reported to NMFS in accordance with the reporting schedule in term and condition No. 13 of the incidental take statement.
12. The Bureau in coordination with the Contra Costa Water District must develop and implement a program to monitor entrainment loss of winter-run chinook salmon juveniles at the Rock Slough intake of the Contra Costa Canal. The Bureau in coordination with the Contra Costa Water District must develop and implement a program to monitor entrainment loss of winter-run chinook salmon juveniles at the Rock Slough intake of the Contra Costa Canal.
13. The Bureau and Department of Water Resources in cooperation with the California Department of Water Resources must monitor the extent of incidental take associated with the operation of the Tracy and Byron pumping facilities.

Conservation Recommendations:
1. Continue implementation of the Shasta temperature control device.
2. Continue implementation of the temperature control facilities and operational modifications at Whiskeytown Lake.
3. Modify the scheduling of Trinity River exports to the Sacramento Basin when effective for Sacramento River temperature control.
4. Improve sampling and analytical methodology for estimating total winter-run chinook salmon salvage numbers at Delta Fish Collection Facilities. Revised sampling methodology and salvage estimations should be designed for small sample sizes which may not be normally distributed.
5. Continue to refine and improve the upper Sacramento River predictive temperature model with the objective of developing a daily predictive model.
6. Provide funding to the USFWS to fully evaluate the newly installed Red Bluff Diversion Dam downstream migrant fish protection facilities under the full range of operating conditions.

Reasonable and Prudent Measures:

1. Continue and expand temperature monitoring in the upper Sacramento River. The Bureau must utilize an automatic temperature recording device in the Sacramento River at Jelly's Ferry (river mile 266) to monitor temperature conditions and compliance with the reasonable and prudent alternative.

   The device must be capable of recording water temperature at 1 or 2 hour intervals on a 24-hour basis. Water temperature data must be provided to NMFS in accordance with the reporting schedule outlined in term and condition No. 15. The device must be in operation by June 1, 1993.

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

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

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

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

   The Bureau must utilize analytical instruments capable of detecting copper and zinc at concentrations equal to that specified by the Sacramento River Basin Plan. The analytical methodology shall be consistent with the U.S. Environmental Protection Agency quality assurances and quality control guidelines.

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

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

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

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

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

Reasonable and Prudent Measures:

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

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

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

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

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

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

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

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

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

   During the period from October 1, through May 31, of each year, calculated estimates of winter-run chinook salmon loss must be performed by the Bureau and DWR on a real-time basis. The total level of incidental take at the Delta pumping facilities for this period must not exceed 1 percent of the estimated number of winter-run chinook salmon entering the Delta. NMFS and CDFG estimate that approximately 270,000 will enter the delta during the 1992-93 outmigration. Therefore, the total combined incidental take limit for the Delta pumping facilities covered in this biological opinion must not exceed an estimated loss of 2,700 juvenile winter-run chinook salmon.

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

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

Reasonable and Prudent Measures:
10. The California Department of Water Resources in coordination the Bureau must develop and implement a program of chinook salmon investigations at the Suisun Marsh Salinity Control Structure and within Montezuma Slough. Chinook salmon investigations must be designed to address the diversion rate of juveniles into the slough, predation at the control structure, survival during passage through Montezuma Slough, and passage of upstream migrant adults at the control structure. The California Department of Water Resources in coordination the Bureau must develop and implement a program of chinook salmon investigations designed to evaluate the effects of the operation of the Suisun Marsh Salinity Control Structure on winter-run chinook salmon. The investigations must assess the diversion rate of chinook salmon juveniles into the slough, predation at the control structure, survival of chinook salmon juveniles during passage through Montezuma Slough, and passage of upstream migrant adult chinook at the control structure. The proposed evaluation program must be submitted to NMFS for review and approval prior to October 1, 1993. Investigations shall be initiated during the spring of 1994.
11. The Bureau and California Department of Water Resources must ensure that the fish collection facilities are fully staffed for monitoring incidental take and the screens fully operated whenever the Tracy and Banks pumping plants operation from October 1 through May 31. The Bureau and the California Department of Water Resources shall at no time allow unscreened water to pass through the Tracy or Skinner Fish Collection Facilities from October 1 through May 31. If either fish screening facility is not fully operational due to maintenance or equipment failure, the operation of the associated pumping plant must simultaneously be discontinued until the screening facility returns to full operation. The Bureau and the California Department of Water Resources are required also to ensure the fish collection facilities are adequately staffed to perform the necessary sampling and monitoring of incidental take outlined in term and condition No. 15 from October 1 through May 31.
12. The Bureau in coordination with the California Department of Water Resources must develop and implement a demonstration screening program designed to promote the advancement of state-of-the-art positive-barrier screening technology at small unscreened diversions along the Sacramento River and within Delta waterways.
13. The Bureau in coordination with the California Department of Water Resources must submit daily, weekly, and annual reports to NMFS regarding operation of project facilities, temperature and hydrological conditions, and the results of monitoring programs.
14. The Bureau must establish a working operations and management group that includes the NMFS to address the implementation of the reasonable and prudent alternative.
15. The Bureau in coordination with the Department of Water Resources must develop new sampling and analytical methodologies for estimating winter-run chinook salmon salvage and loss numbers at the fish collection facilities that is acceptable to NMFS.
16. The Bureau must develop in consultation with NMFS a winter-run chinook population model that can be used to evaluate the long-term effects of CVP operations plans on the winter-run chinook salmon survival and recovery.