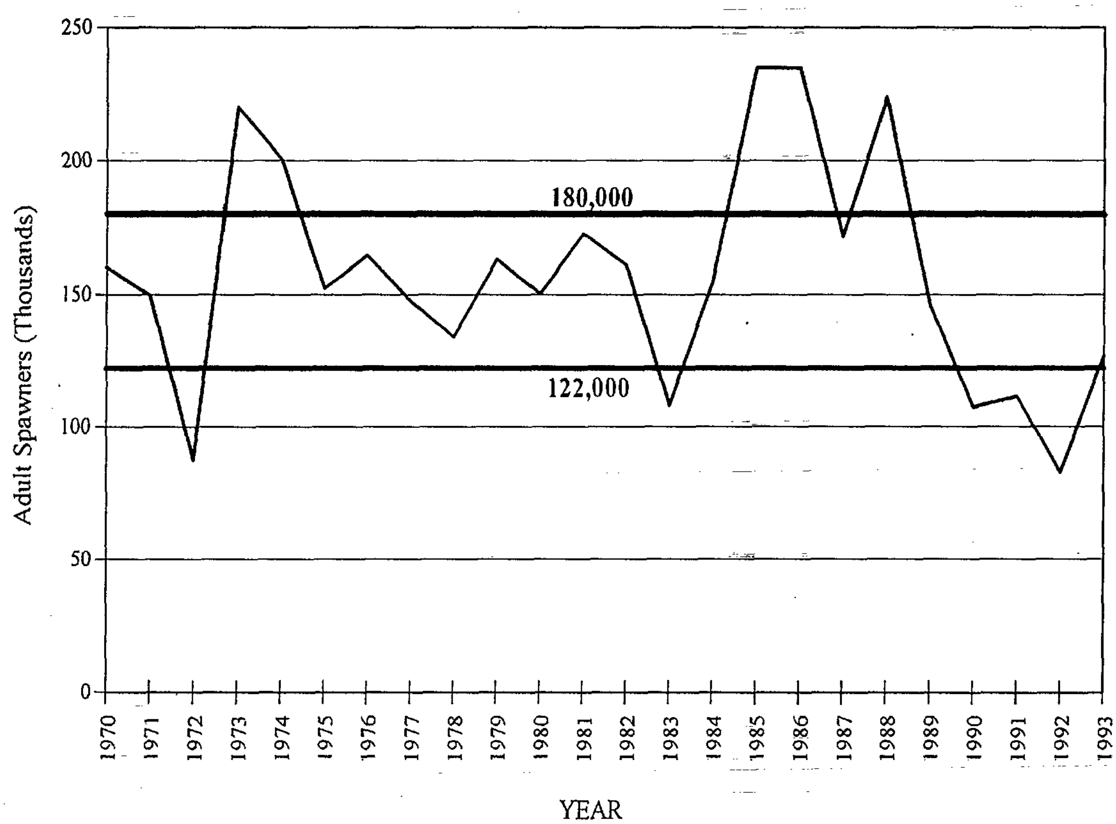
SACRAMENTO RIVER FALL CHINOOK REVIEW TEAM REPORT

AN ASSESSMENT OF THE STATUS OF THE
SACRAMENTO RIVER FALL CHINOOK STOCK
AS REQUIRED UNDER
THE SALMON FISHERY MANAGEMENT PLAN



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2130 SW Fifth Avenue, Suite 224
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December 1994

(Draft report presented to the Pacific Fishery Management Council, March 1994)

ACKNOWLEDGEMENTS

This report was prepared at the request of the Pacific Fishery Management Council by a team of scientists and individuals with special knowledge and experience in salmon fishery and habitat management relationships as they relate to Sacramento River chinook salmon. The Council expresses its deep appreciation to members of the Sacramento River Fall Chinook (SRFC) Review Team for providing this assessment of the status and management needs of the SRFC stock. In addition, the Council wishes to thank the team members' agencies and institutions for their willing support of this effort.

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This Sacramento River Fall Chinook Review Team Report is published by the Pacific Fishery Management Council pursuant to National Oceanic and Atmospheric Administration Award Number NA57FC0007.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACSST	Advisory Committee on Salmon and Steelhead Trout
BDOC	Bay–Delta Oversight Council
CCMP	Comprehensive Conservation and Management Plan
CDFG	California Department of Fish and Game
Council	Pacific Fishery Management Council
CV	Central Valley
CVI	Central Valley Index
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWT	coded–wire tag
DWR	(California) Department of Water Resources
FMP	fishery management plan
MAF	million acre–feet
OCN	Oregon coastal natural (coho)
ODFW	Oregon Department of Fish and Wildlife
RBDD	Red Bluff Diversion Dam
RM	river–mile
SRFC	Sacramento River Fall Chinook
SRI	Sacramento River Index
SWP	(California) State Water Project
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service

EXECUTIVE SUMMARY

The Sacramento River Fall Chinook Review Team was formed to determine why the escapement goal for Sacramento River fall chinook (SRFC) was not met in 1990–1992, and to recommend actions to assure future productivity of the stock.

The team began by exploring the direction and degree of error in the models used to project spawning escapement of SRFC. The preseason estimate of the Central Valley Index (CVI), an adult abundance index for combined Central Valley (CV) chinook races, is the starting point in determining the actual SRFC escapement. Once the estimated adult abundance is established, projected impacts by both the commercial and sport fisheries are set to allow the desired escapement to the river. For all three years, the team found the preseason projection of abundance (CVI) was overestimated by 5 to 40 percent and the actual harvest rates were generally higher than predicted. The combination of these two factors resulted in escapements below the established goal.

An exact estimate of adult abundance and the ability to accurately project the harvest rate are difficult to achieve. Variability within each parameter should be expected and incorporated into future management decisions.

The team was concerned that the CVI in 1990–1991 was generally lower than in years prior to 1970, and that the 1992 estimate was the lowest index measured over the period of record. Although actual catch (in numbers and pounds of fish) was reduced in the ocean fishery, the harvest rate index in the last three years was relatively high. The combination of low abundance and high harvest rate index resulted in low escapement.

The next question the team addressed was why adult abundance (CVI) has been so low in the last few years. Adult abundance is a function of (1) the abundance of juvenile fish entering the ocean (both hatchery and natural) and (2) the ocean survival of those fish. Both factors can vary significantly between years and do not necessarily vary in similar ways. Low adult abundance in 1990–1992 resulted from a combination of (1) average to slightly above average juvenile outmigrations in 1988–1990 and (2) average ocean survival for the 1987 brood and below average survival for the 1988 and 1989 broods.

Because it is unlikely that we can affect ocean survival, the most effective means of increasing adult abundance is to increase the number of juvenile salmon entering the ocean. This can be done by increasing releases of hatchery fish or increasing the survival of naturally produced fish before they enter the ocean. However, increasing hatchery production could increase competition for food and space with naturally produced fish in fresh water and would need to be evaluated.

The most efficient and effective way to increase juvenile abundance would be to increase survival during outmigration to the ocean, particularly during passage through the Sacramento–San Joaquin Delta. All naturally spawned and hatchery salmon from Coleman Hatchery have to pass through the delta to reach the ocean. Any improvements in delta survival would benefit natural production at a life stage when natural mortality is not density dependent and would result in a commensurate increase in adults if ocean survival is independent of freshwater survival.

Many action items to increase survival in the river and delta have been identified in various forums and need to be implemented as soon as possible.

CHARGE AND PURPOSE

The Magnuson Fishery Conservation and Management Act states: "Conservation and management measures shall prevent overfishing while achieving, on a continuous basis, the optimum yield from each fishery for the United States fishing industry." The implementation of Amendment 10 to the Pacific Fishery Management Council's salmon fishery management plan (FMP) in 1991 provided a definition of overfishing for each stock or stock complex covered by the FMP.

The Council's definition of overfishing states:

> Overfishing is an occurrence whereby all mortality, regardless of the source, results in a failure of a salmon stock to meet its annual spawning escapement goal or management objective, as specified in Section 3.5 of the salmon FMP, for three consecutive years, and for which changes in the fishery management regime offer the primary opportunity to improve stock status. While this condition is defined as overfishing in the broad sense, it is recognized that this situation may also be the result of nonfishing mortality and fishery management actions may not adequately address the situation.

Under this definition, the determination of overfishing of a stock is a two-step process. The first step of the process is triggered when a salmon stock fails to meet its annual spawning escapement objective for three consecutive years. The second step involves a review by a Council-appointed work group to (1) investigate the causes of the shortfall and (2) report its conclusions and recommendations for assuring future productivity of the stock to the Council.

The stock, comprised of the hatchery and naturally produced fall chinook originating from the Sacramento River Basin, did not meet its spawning escapement objective in 1990, 1991 or 1992. Therefore, at its April 1993 meeting, the Council directed the formation of a work group to review the status of this stock and report its conclusions and recommendations prior to the development of 1994 ocean salmon fishery management options. This report, developed by the Sacramento River Fall Chinook Review Team and presented in draft form to the Council at its March 1994 meeting, fulfills that directive.

The team was chaired by Mr. L.B. Boydstun, California Department of Fish and Game (CDFG). The full group met on June 29, and September 27, 1993, and on February 10, 1994. Work subgroups met on additional occasions to draft materials for the final report.

A complete list of the members of the team can be found in the acknowledgements on the inside cover of this report.

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ASSESSMENT OF PROBLEM

The Council's salmon framework plan for SRFC salmon calls for an annual spawning escapement of between 122,000 and 180,000 adult fish, considered to be the optimum level for the basin. The goal range includes fish that spawn in hatcheries as well as those that spawn in the natural environment. There is no breakdown among spawning in specific sub–basin areas, although during the framework plan formulation process it was recognized that individual parts of the basin had optimum spawning levels.

Since 1970, estimated spawning escapement generally has been within or above the goal range (Figure 1), with serious escapement shortfalls occurring in 1972 and 1992. Less significant shortfalls occurred in 1983, 1990 and 1991. The latter two years, coupled with 1992, have led to the review summarized in this report.

In addition to failing to meet the Council's overall goal for the past three years, other items of concern include

1. the decline in parts of the sub–basin not heavily influenced by hatchery returns (such as the Yuba River and the upper mainstem Sacramento River);

2. the decline in late–fall and spring races within the Sacramento River system, as well as depressed San Joaquin River fall chinook salmon populations; and

3. the severe decline and endangered species status of Sacramento River winter chinook.

While these issues are not the focus of this report, they deserve the Council's attention.

RECOMMENDATIONS

SHORT–TERM

- The predictor models for SRFC should be refined to assure unbiased projection of the CVI and ocean fishery impacts under proposed and adopted ocean fishing regulations.

- The Council should continue to manage SRFC to ensure goal attainment in all years, recognizing the low precision in available fishery management models.

LONG–TERM

- The Council's Habitat Committee should continue to support full funding of salmon studies and restoration plans, developed or underway, that are intended to benefit CV fish and wildlife populations.

- Representative marking of all CV hatchery stocks should be undertaken for an extended period of years to estimate the contribution (and return) of hatchery and naturally produced fish to the fisheries and spawning escapements.

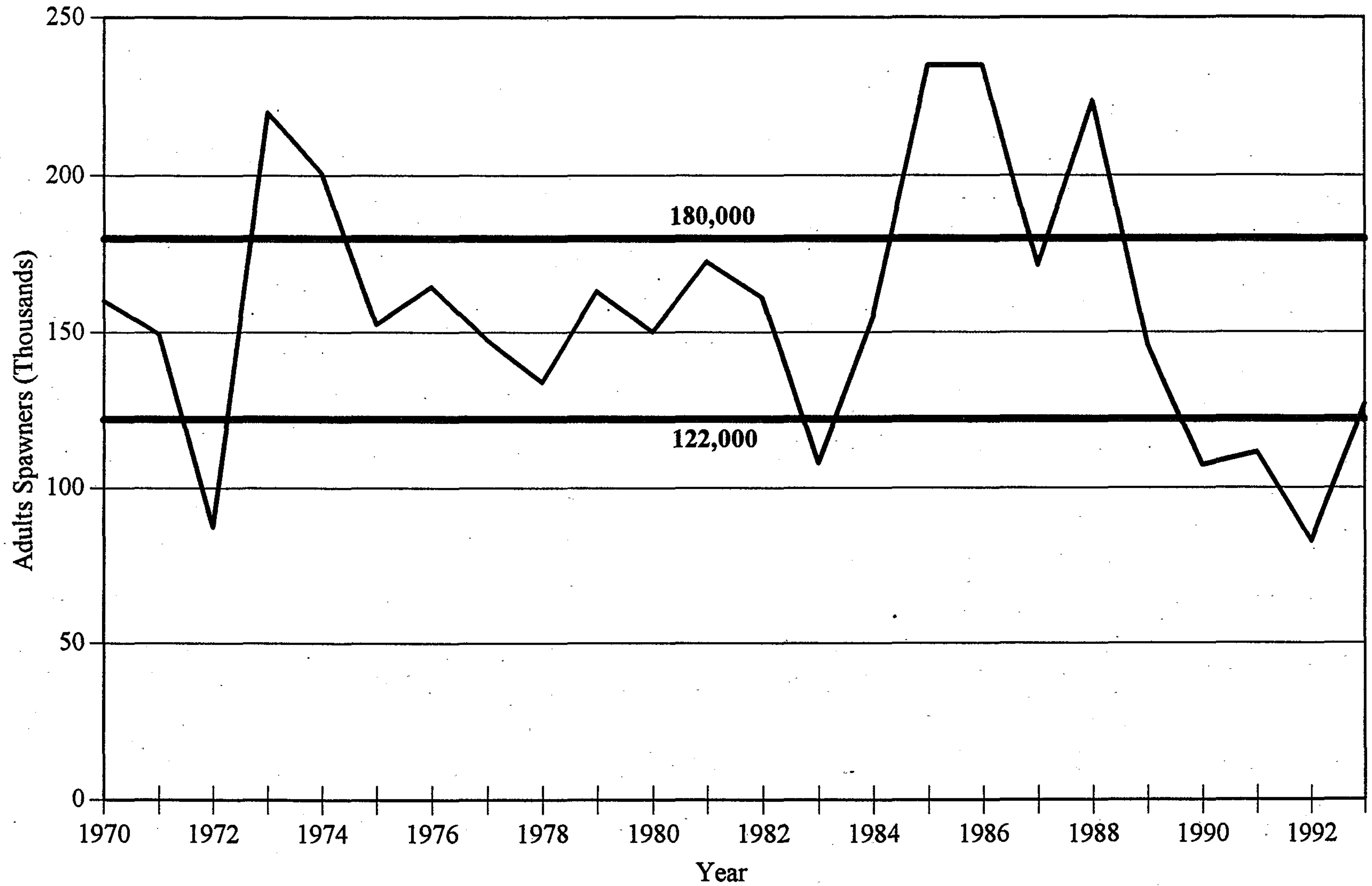

FIGURE 1. Spawning escapements of adult Sacramento River fall chinook, 1970-1993, and the goal range for the stock of 122,000 to 180,000 adult fish (1993 data is preliminary).

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PRODUCTION AND SURVIVAL OF SACRAMENTO RIVER FALL CHINOOK

Alteration of the rivers and streams of the CV for water diversion and flood protection has been well documented (ACSST 1971 and CDFG 1993). The major physical impediments or barriers to the upstream migration and spawning of adult fish, and to the production and survival of juvenile fish, are shown in Figure 2. For upper Sacramento River chinook, the major problem areas for adult fish are the Red Bluff Diversion Dam (RBDD) and Anderson–Cottonwood Irrigation District Diversion Dam, where upstream passage of adults is delayed. The RBDD is also a problem area for rearing and emigrating juveniles, but is only one of many problem areas the young fish must negotiate before reaching the ocean.

SRFC spawn primarily as age–3 fish, and to a lesser extent as age–2 and age–4 fish. Shortfalls in escapement of SRFC during 1990–1992, therefore, stem from problems in production and survival of the 1987–1989 broods. The parents of these broods spawned in the falls of 1987–1989 and their offspring reared in the river and its tributaries and migrated to the ocean during February through June of the following year (1988–1990). Most of the fish reared in the ocean for two and one–half years before returning to the river to spawn and repeat the cycle.

This section focuses on conditions and factors in the environment, other than fishing, that possibly affected production and survival of SRFC of the 1987–1989 broods. Separate sections address the impact of fishing on the resource.

INSTREAM FLOW CONDITIONS

All of the major streams in the Sacramento Basin have been developed to meet California's agricultural and municipal water demands, most of which are south of the Sacramento Basin. Restoration or enhancement of California's fish and wildlife resources was an original objective of California's State Water Project (SWP) and has recently become an objective of the federal Central Valley Project (CVP).

The quantity of water that reaches the remaining salmon spawning and rearing areas below CV barrier dams is determined by (1) fish and wildlife maintenance agreements, (2) reservoir capacities, (3) flood protection constraints, (4) downstream water quality requirements and (5) downstream riparian rights and water diversion contracts.

Three major Sacramento Basin dams, and to a lesser extent the smaller dams in the system, work in concert to meet delta water quality requirements and, in recent years, to meet water needs for endangered species.

CVP's Shasta and Folsom dams store and release water mainly for CV irrigation, while SWP's Oroville Dam stores water for use in the Oroville and San Francisco Bay areas and south of the delta, including southern California. All three storage facilities are used to maintain delta water quality standards, although Folsom Lake water has been used to a larger degree in recent years because of retention of water in Shasta Lake for winter chinook spawning and rearing in the mainstem Sacramento River.

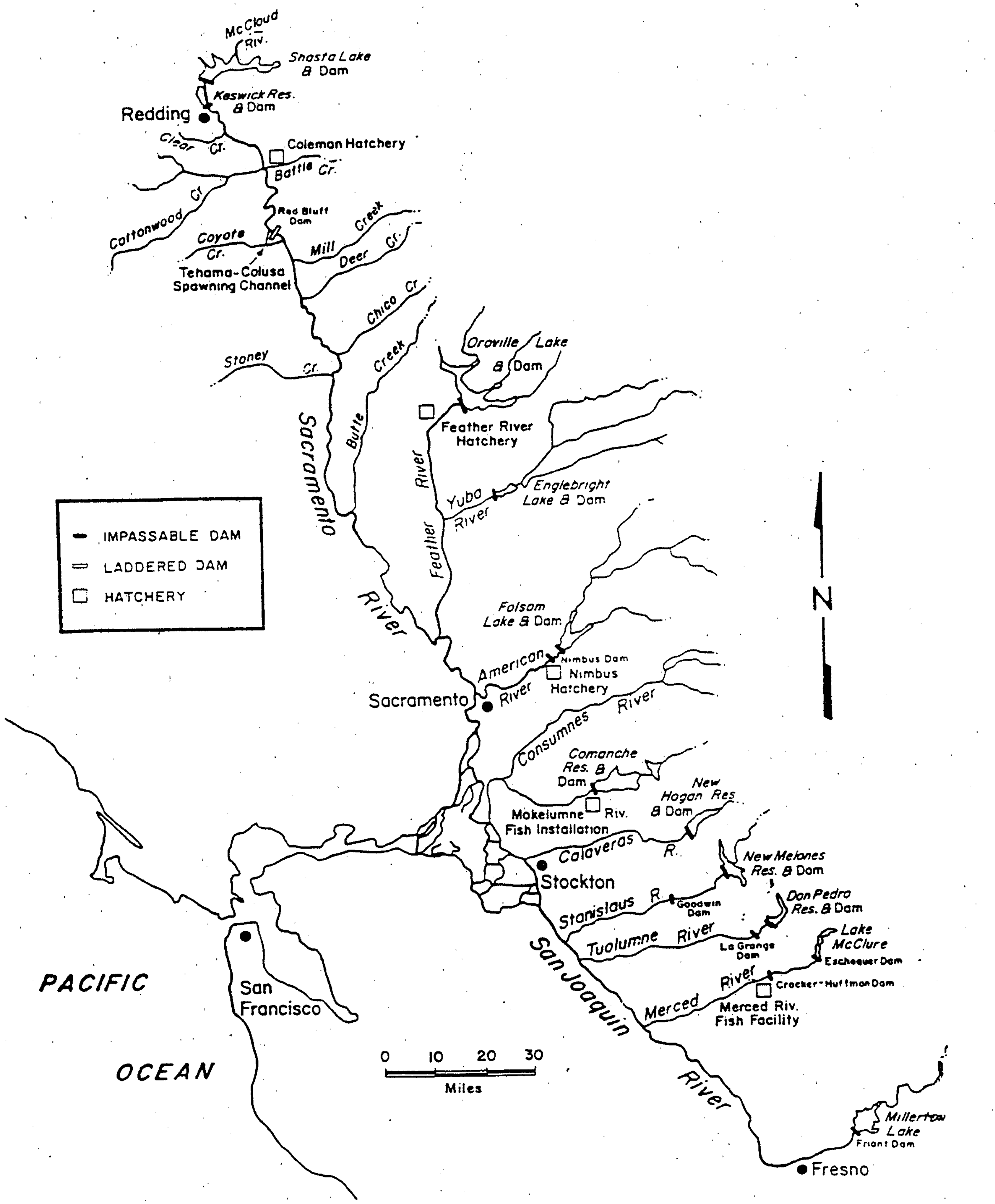

FIGURE 2. Salmon streams in the Central Valley.

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The CV dam operators store (or release) water based on flood control capacity of each reservoir as determined by the U.S. Army Corps of Engineers. The operators usually try to reach flood control capacity before October, the onset of the rainy season. Fall and winter runoff is then stored up to flood capacity and any excess is released. Usually beginning in mid–March, depending on the snow pack, an increasing percentage of the runoff is diverted to storage.

Water is released from the dams for municipal purposes throughout the year, but most of the storage is released during the summer for irrigation purposes. The reservoirs reach capacity in normal or wet years in late May or early June. In drought years, however, they reach maximum pool earlier and begin to drop with the onset of the irrigation season, which commences earlier during low runoff years.

Dams have reduced historic salmon spawning areas in the CV, although much of that habitat was badly degraded before the dams were built. Hatcheries have been built in the Sacramento Basin generally to mitigate losses in salmon production that historically occurred above the dams.

Salmon production in the remaining CV habitat, and in the hatcheries in some years, is dependent on the quality and quantity of water released from the dams in addition to retention of suitable quantities of other important environmental components (gravel, juvenile fish niches, etc.) below the dams.

Water Availability

Precipitation in the CV occurs mainly in the form of rain, but snowmelt contributes significant runoff in the basins that drain the Sierra Nevada. Most of the runoff originates from the north and east sides of the CV, while very little originates from the west.

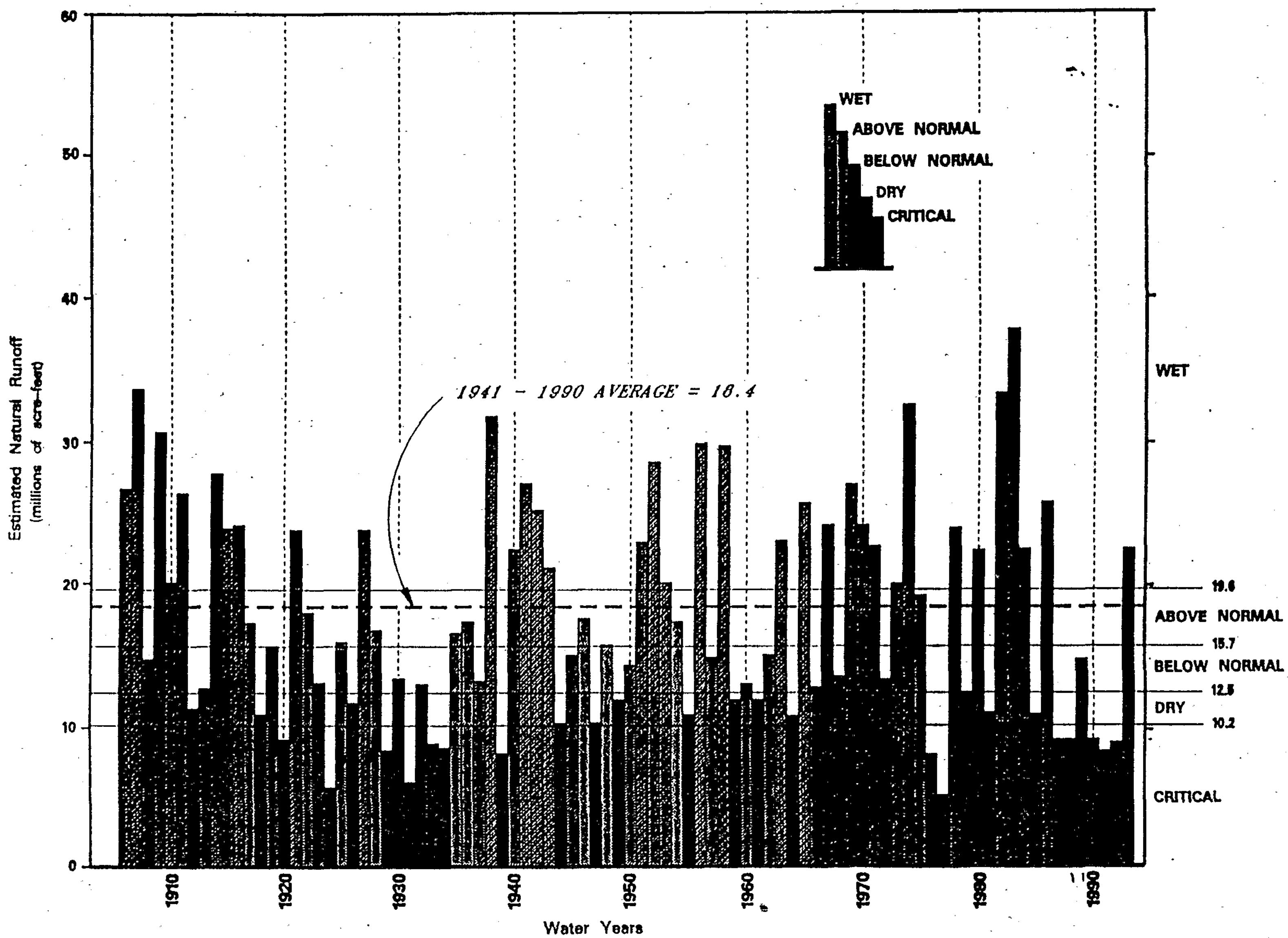
The Sacramento River Index (SRI) is the sum of the unimpaired runoff in the Sacramento River near Red Bluff, the Feather River at Oroville, the Yuba River at Smartsville and the American River at Folsom. It is used as a "yardstick" of the quantity of Sacramento River runoff that is available to reach the Sacramento–San Joaquin Estuary (DWR 1993). The SRI is available for water years 1906–1992 (Figure 3).

During water years 1988–1990, the SRI ranged from 9.2 to 14.8 million acre–feet (MAF) and averaged 11.1 MAF, 63 percent of the 1906–1992 average of 17.7 MAF. Two years, 1988 and 1990, were classified as critically dry years while 1989 was below normal.

The comparable index for the San Joaquin Basin during 1988–1990 ranged from 2.5 to 3.6 MAF and averaged 2.9 MAF, 50 percent of 1941–1990 average of 5.8 MAF.

Dam Operations

During droughts, minimum flows (with a floor established for fish releases) are released from Sacramento Basin dams during the salmon spawning and rearing season to retain water to meet downstream riparian uses and water delivery contracts, maintain delta water quality and meet future demands should the drought continue. In recent years, releases from Folsom Dam have been used to help maintain delta water quality to counter late season releases from Shasta Dam to protect winter chinook in the upper Sacramento River.



NOTE: The Sacramento River Index is the sum of unimpaired runoff from the Sacramento River at Bend Bridge, Feather River inflow to Oroville, Yuba River at Smartville and American River inflow to Folsom.

FIGURE 3. Sacramento River Index since 1906.

The American River is an important production area for naturally spawning and hatchery SRFC. Thus, the team examined the flow situation in the American River during water years 1983–1990.

Under pre–dam conditions, runoff in the lower American River gradually increased from January through May, with May being the peak outflow month. The flows then decreased, with the lowest flows usually in September. Changes in runoff flow would be gradual except during major storm events.

Under present impoundment conditions, the water release records show that in wet years such as 1983 and 1984 (Figure 3), peak flows in the American River below Nimbus Dam, near the city of Sacramento, occurred from December through June, while in dry or critical years such as 1985, 1987, 1988 and 1990, flows were lowest from November through March and highest from June through August. Runoff in 1986 was above average, but the maximum discharge in the American River was confined to the periods mid–January through April and June through August.

It is noteworthy that two of the three water years under review by the team were critically dry years and the third year was below normal. In the CV, under its current configuration, low flow conditions (e.g., droughts) equate to elevated water temperatures during spring outmigration for juveniles, and reduced habitat availability, increased susceptibility to pollutants, and entrainment in diversions caused by early onset of the irrigation season for adults returning in the fall. Also, predation is probably higher because of reduced living space and clear water conditions.

Water Deliveries

There are about 2,000 water diversions along Sacramento Basin waterways and in the Sacramento–San Joaquin Estuary, including the state and CVP diversions in the south delta. These facilities are known to divert juvenile SRFC into canals and fields from which the fish cannot regain access to the ocean.

During water years 1988–1990, CV diversions and pumps had the potential to take a large toll on salmon because of reduced runoff coupled with high water demand. Screens were in place on the larger diversions, but they were ineffective for small fish. Pre–screening loss of juvenile salmon at the state diversion through Clifton Court Forebay has been greater than 75 percent with an additional 15 percent loss at the screens (Terry Tillman, CDFG, personal communication).

Annual SWP deliveries during 1988–1990 averaged about 2.6 MAF, an all–time high for any three consecutive years since delivery started in 1967 (Figure 4). Most of the water was diverted at the state pumps in the south delta and delivered to the San Joaquin Valley or southern California. Above average delivery of about 5.7 MAF annually also was provided by the CVP (Figure 5). Here again, much of the water was diverted in the south delta (at federal pumps) for distribution to the south. Collectively, these two delivery systems probably affected most of the runoff from the Sacramento and San Joaquin river systems during water years 1988–1990.

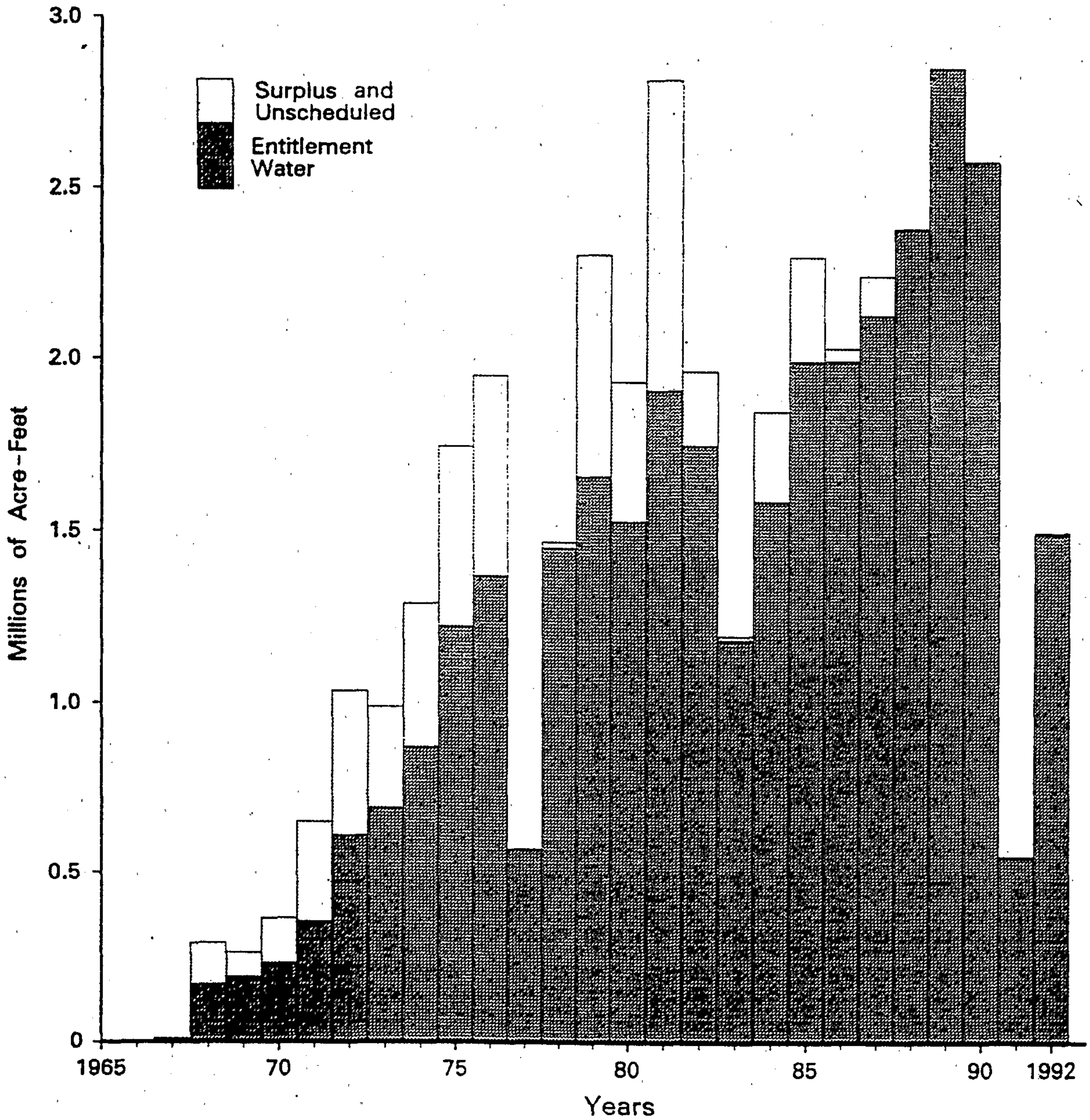


FIGURE 4. State Water Project deliveries, 1967–1992.

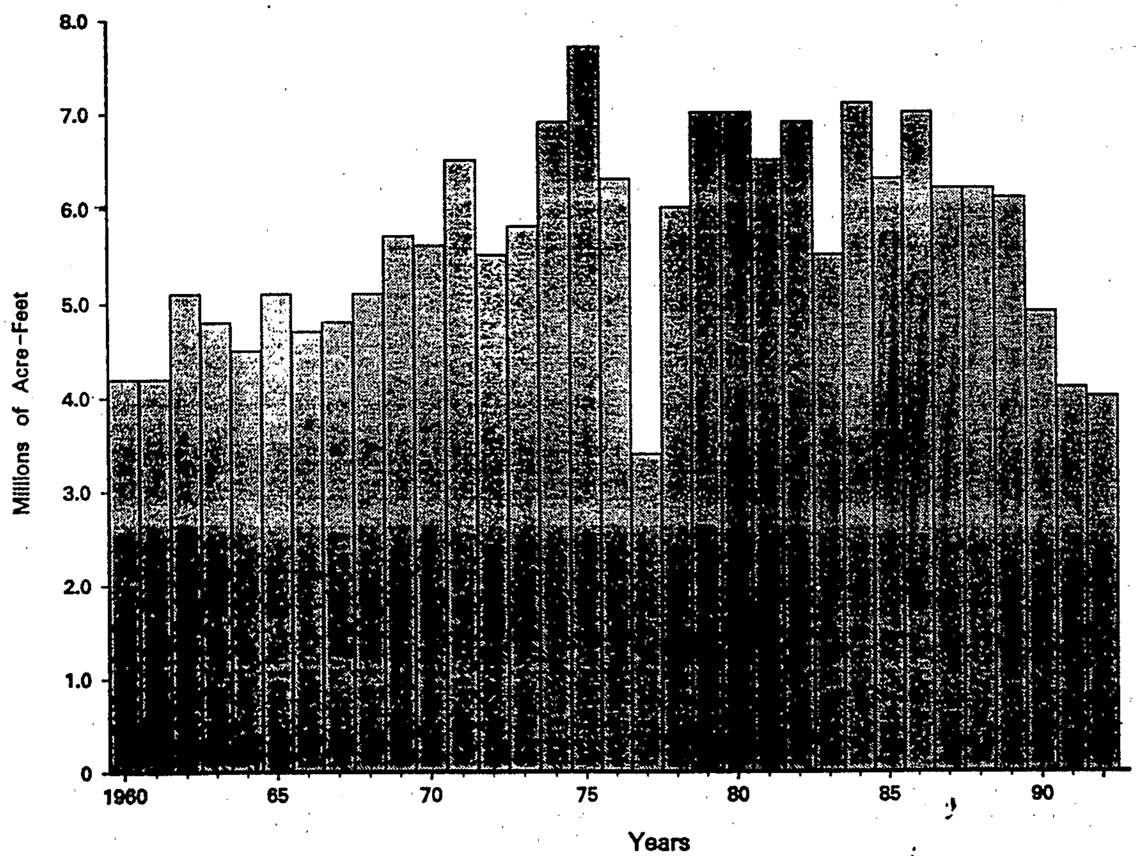


FIGURE 5. Central Valley Project deliveries, 1960–1992.

Most diversions in the basin are located in the delta and include unscreened pumps and syphons. However, indirect losses stemming from south delta pumping are suspected to cause greater mortality than entrainment at the pumps themselves. These losses are attributable to mortality associated with forced migration through the inner delta where predator impacts are high and environmental conditions less suitable than in the mainstem Sacramento River.

OTHER FACTORS IN THE ENVIRONMENT

Other than water quantity, myriad factors in the environment can affect the production and survival of SRFC. Degradation or change in status of these other factors, either singly or in combination, can adversely affect the survival and production of SRFC. Some of these factors include quantity and quality of available spawning gravel, availability of suitable cover for young fish, presence or absence of toxic substances in the water, presence of impediments or barriers to migration, status of predatory fishes and habitability of the marine environment.

A lack of data and time to prepare this report made it difficult to evaluate many of these factors. The overall assessment of the team was that these other factors have been generally static or improving with the exception of the marine environment, which is discussed in a separate section.

An example of an improved situation during 1988–1990 in the upper Sacramento Basin was the operation of RBDD during the juvenile outmigration period (Table 1). Conditions at RBDD for outmigrating fall chinook salmon of the 1987–1989 broods were much improved when compared to the pre–1987 broods. The dam gates at RBDD were opened for an average of about 25 percent during the outmigration period (December 15 through June 15) for the 1987–1989 broods. Except for the 1986 brood, pre–1987 broods were usually subjected to year–round gate closures. Unscreened pumped diversions did occur during the gates–up operations, but were limited by pumping capacity (less than 60 cubic feet per second) and averaged less than 1 percent of the river flow. Prior closed–gate operations included higher diversions (usually greater than 400 cubic feet per second) through the old inefficient louver screens.

TABLE 1. RBDD gates–up operations during the outmigration period[a/] for fall chinook salmon.

Brood Year	Water Year	Period of Gates–up Operations	Gates–up Operation During the Fall Chinook Outmigration Period	
			Number of Days	Percent
Pre–1986	Pre–1986/1987	Intermittent during flood flows only	Near 0	Near 0
1986	1986/1987	12/02/86 to 01/23/87 02/09/87 to 04/02/87 04/03/87 to 04/03/87	43	24
1987	1987/1988	12/02/87 to 02/16/88 03/05/88 to 03/09/88	19	10
1988	1988/1989	12/02/88 to 02/04/89 02/13/89 to 04/10/89	59	32
1989	1989/1990	12/02/89 to 04/01/90	59	32

a/ December 15 through June 15.

The two most important natural predators of SRFC in inland areas are striped bass in the estuary and Sacramento squawfish below RBDD. Counts of squawfish at RBDD are available for all years since 1980. Counts of these fish during 1988–1990 were within or below the range of those observed over the previous period of record (Figure 6). The low counts in 1989 and 1990 were probably partially attributable to the lifting of the RBDD gates during the upstream migration of winter chinook (which began in 1987). Adult striped bass abundance during 1988–1990 was estimated to be at a record low level, based on annual adult population estimates available since 1969 (Figure 7). Thus, squawfish and striped bass abundance probably was not a major factor in the reduced production and survival of SRFC of the 1987–1989 broods.

Upon reaching the ocean, numerous species of fish (including larger salmon), birds and marine mammals prey upon young salmon. Overall survival of cohorts of salmon is generally believed to be determined during their first summer in the ocean.

The team did not attempt an extensive examination of the natural impact other marine animals may have had on SRFC of the 1987–1989 broods. We also did not look into details of the physical quality or well-being of the marine environment during the period of SRFC ocean residency, including such factors as temperature, salinity or upwelling.

HATCHERY PRODUCTION

Five CV hatcheries (Figure 2) produced fall chinook of the 1987–1989 broods. The Mokelumne and Merced facilities are located in the east delta and the San Joaquin Basin, respectively, and are included in this analysis because strays from their operations frequently appear in the Sacramento Basin.

Hatchery releases of fall chinook of the 1987–1989 broods ranged from 30 to 37 million and averaged 35 million, 58 percent greater than the average for the previous 21 broods of 22 million fish (Figure 8). Average size of fish at release for the 1987–1989 broods was 0.26 ounces (61 per pound), 13 percent smaller than the average for the previous 21 broods (Figure 9).

The release strategy for nearly all hatchery chinook produced at state facilities since the 1980s has been to truck them and release them at sites at or below Rio Vista in order to bypass instream hazards. Coleman fish have always been released in the upper river (above river–mile [RM] 240) except for the 1989 brood, most of which were trucked and released at or downstream from Princeton Ferry (RM 164) because of drought conditions.

The team did not examine the potentially negative interactions between hatchery and naturally produced fish stemming from hatchery trucking practices. Trucking results in increased straying of returning adults and potentially high concentrations of hatchery fish in some natural spawning areas. If this has been a problem, however, it has been a long–standing one and not unique to the 1987–1989 broods.

There were no discernable disease problems affecting any CV hatchery chinook, including Coleman Hatchery fish, of the 1987–1989 broods (W. Wingfield, CDFG pathologist, personal communication). The team, therefore, did not find anything in hatchery planting records to explain the cause of spawning escapement shortfalls for SRFC in 1990–1992.

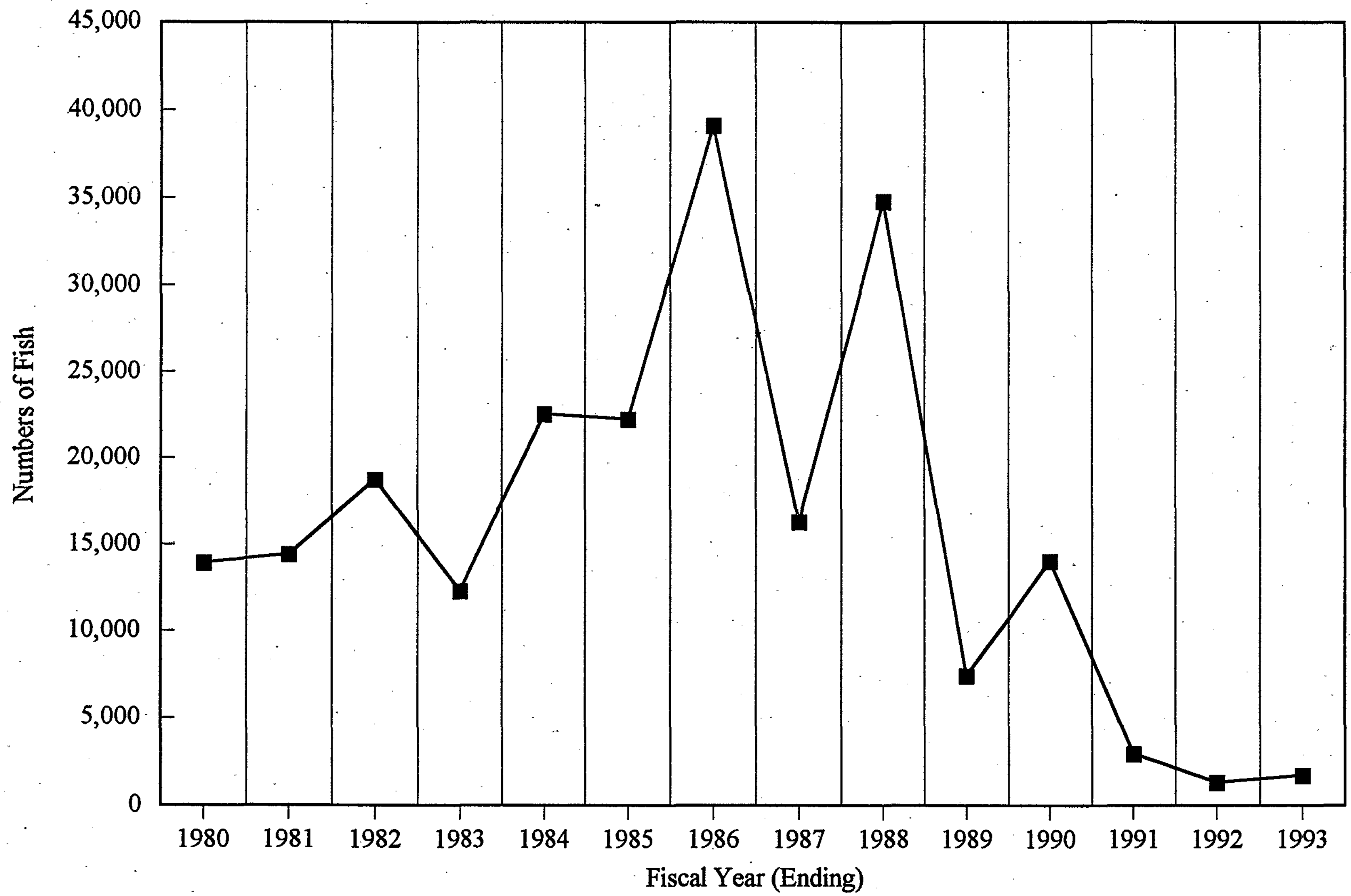


FIGURE 6. Red Bluff Diversion Dam squawfish counts by fiscal years 1980-1993.

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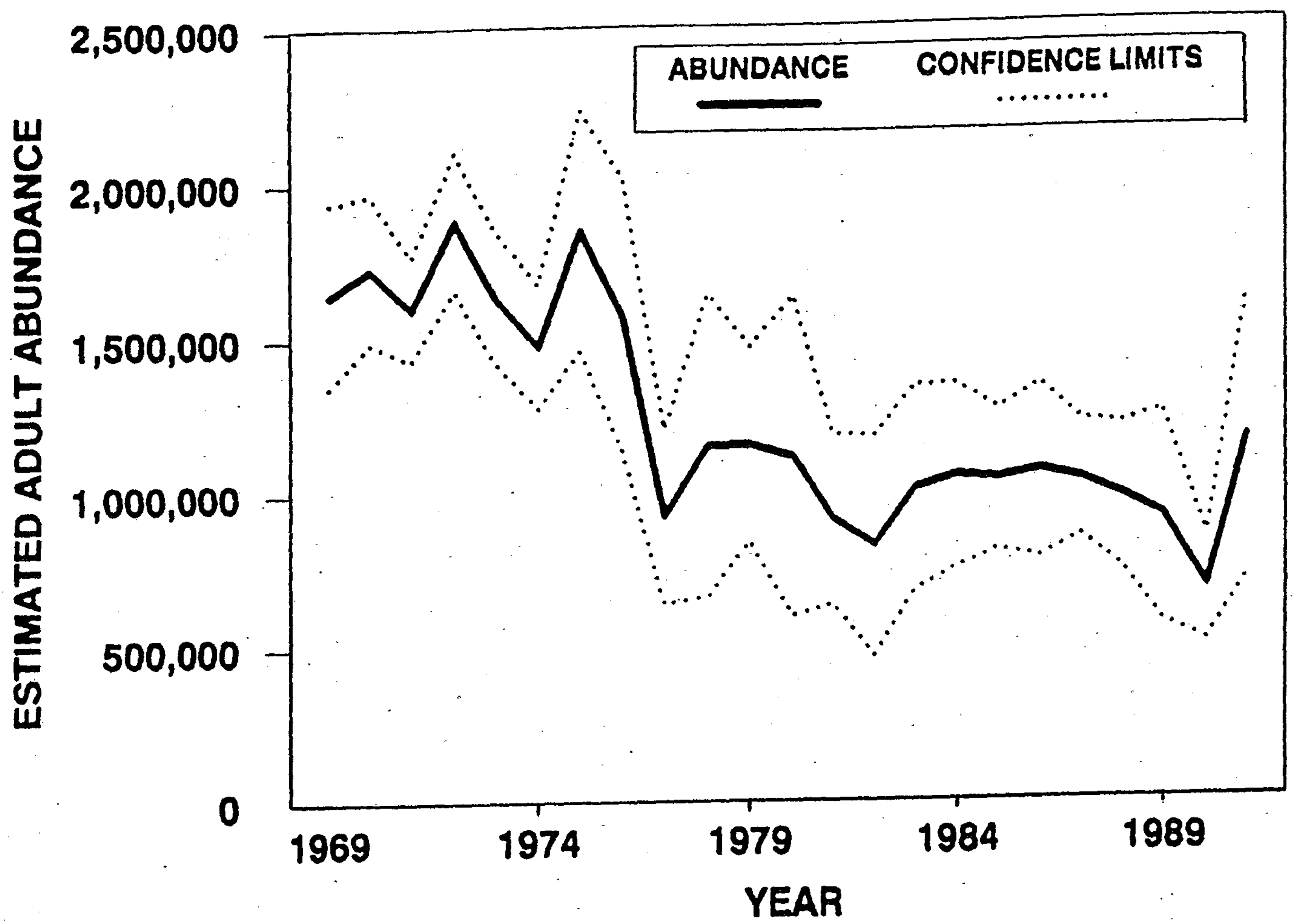

FIGURE 7. Trend in mark-recapture estimates of adult striped bass abundance in the Sacramento-San Joaquin Estuary, 1969-1991.

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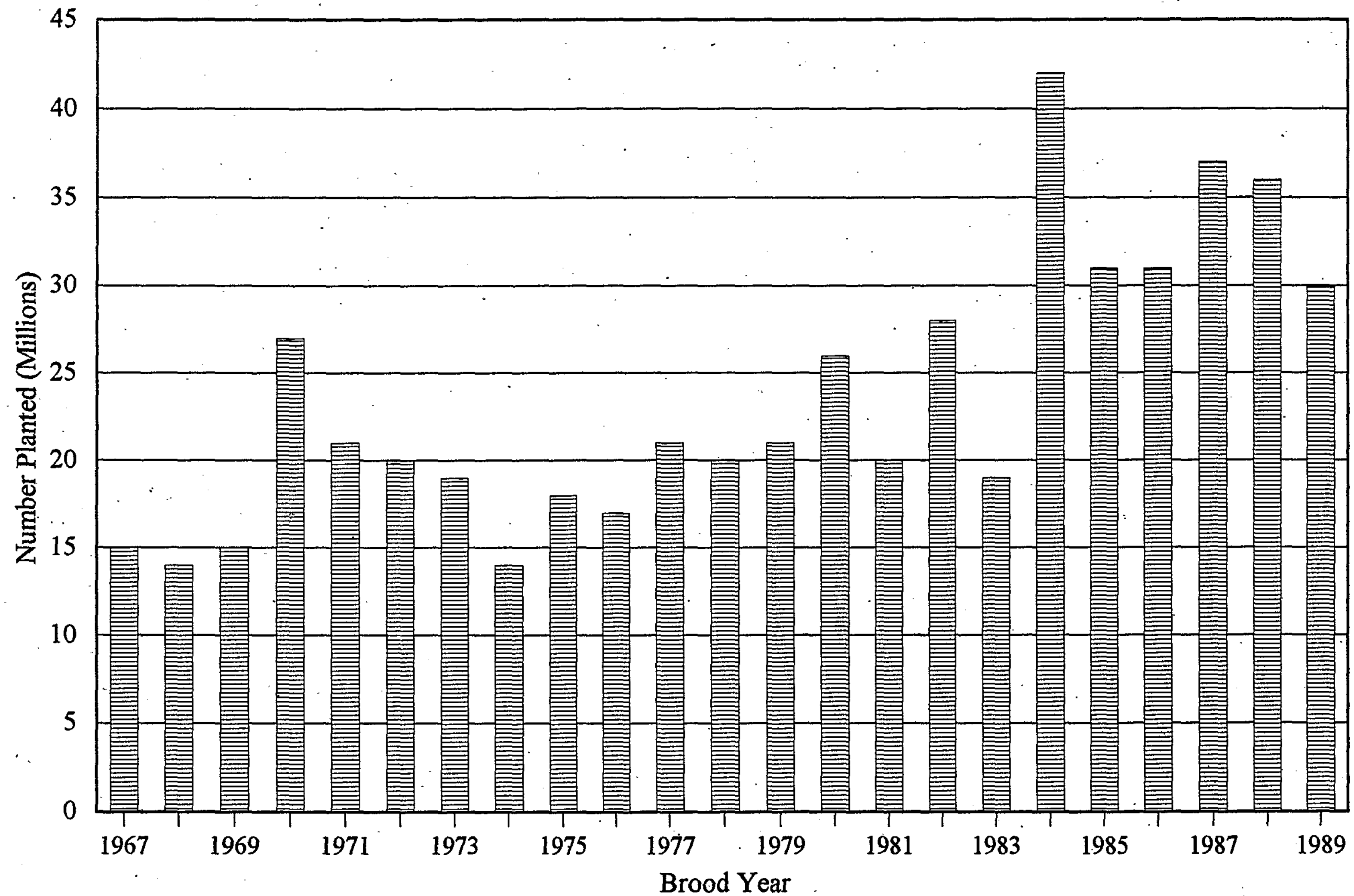

FIGURE 8. Central Valley fall chinook numbers, 1967-1989.

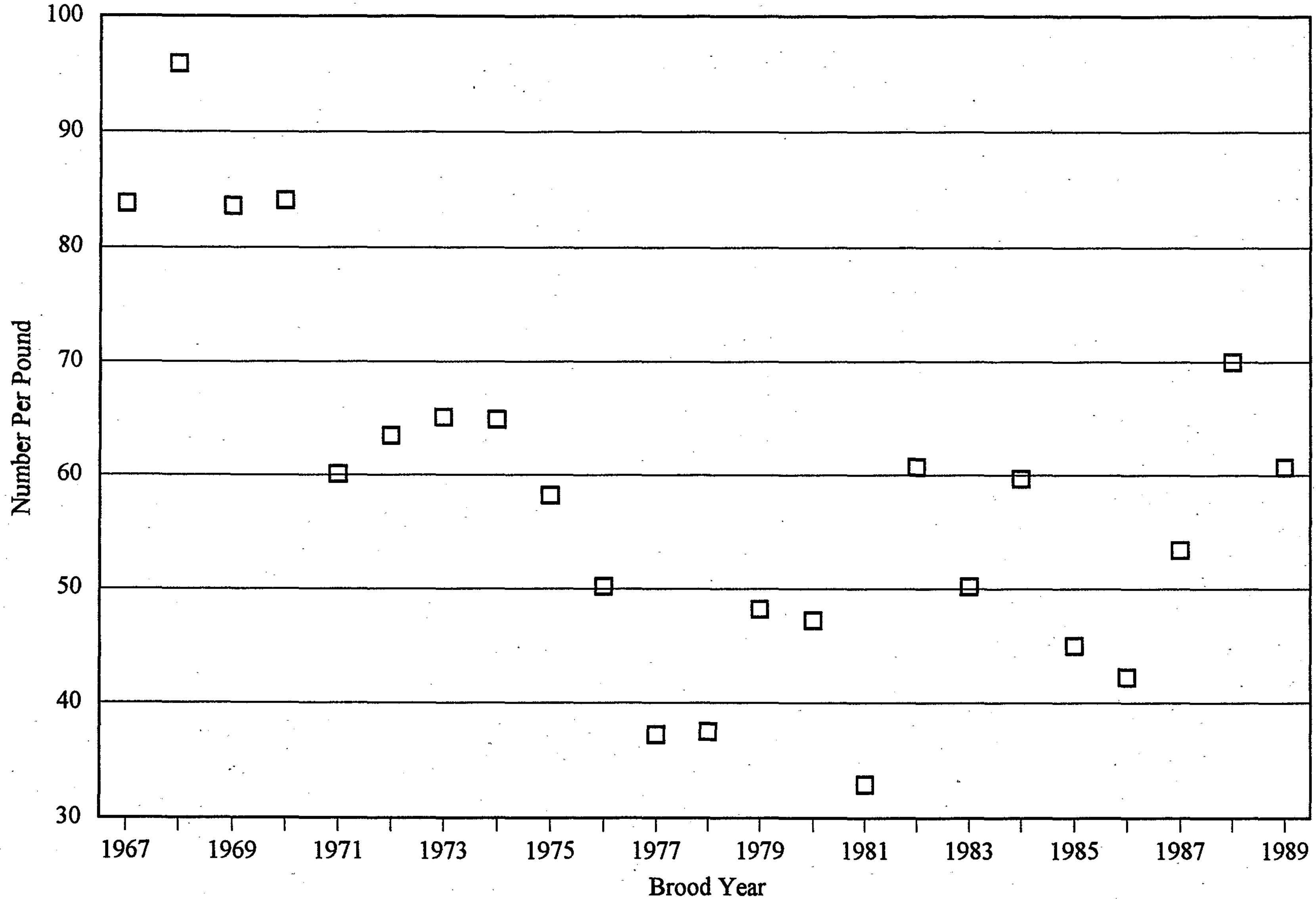

FIGURE 9. Central Valley fall chinook size at release, 1967-1989.

EVIDENCE OF PRODUCTION AND SURVIVAL

Smolt Index

An index of abundance of naturally produced and Coleman Hatchery SRFC is available for the years 1978–1992. It is exclusive of hatchery production from Nimbus and Feather River hatcheries and is based on standardized mid-water trawling in the vicinity of Chipps Island (Figure 10), below the Sacramento–San Joaquin Delta, during the months April through June.

The index for 1978–1987 ranged from 10.1 to 44.2 smolts and averaged 22.0 smolts per 20 minute trawl. During the springs of 1988–1990, the index ranged from 11.7 to 19.9 and averaged 16.6 smolts (Figure 11).

Delta and Ocean Survival Rates

An index of annual survival of juvenile chinook migrating through the delta is estimated for this report beginning with the 1977 brood year. It is based on releases of hatchery chinook bearing coded-wire tags (CWT) and is computed as the ocean recovery rate for CWTs released above the delta (Courtland, Ryde, Isleton or Sacramento) as a proportion of the ocean recovery rate for comparable CWT groups released below the delta (Benicia or Port Chicago, Table 2). Averages were computed for broods for which more than one survival rate comparison was available.

Delta survival rate indices for the 1987–1989 broods are generally in the mid-range, with indices lower than those observed for the 1981–1985 broods but greater than those observed for the 1977–1980 broods (Figure 12).

CWT data was also analyzed for evidence of low ocean survival for the 1987–1989 broods. This analysis used ocean fishery return rates for CWTs released below the delta (Benicia or Port Chicago) for the 1977–1989 broods (Table 2 and Appendix 1). The assumption here was that the lower river releases would better reflect brood year survival rate in the ocean because inriver or delta mortalities would be excluded.

Data for releases downstream of the delta show low ocean return rates for the 1988–1989 broods, with the only lower return shown during the period of record for the 1982 brood (Figure 13). The 1987 brood year return was in the mid-range of the rates observed since brood year 1977.

Other Indications of Ocean Survival

Available data indicate poor ocean survival rates in recent years for salmon stocks that commingle in the ocean with SRFC. These include Oregon coho salmon and Klamath fall chinook.

Marine survival of Oregon coho is correlated with ocean upwelling, which was weak throughout the period 1975–1990. Oregon coho are abundant off California north of Point Arena, particularly early in the year (May through June). This weak upwelling situation for Oregon coho has contributed to depressed production of naturally produced coho on the Oregon coast and triggered a review for that stock, comparable to the one presented here (Council 1992).

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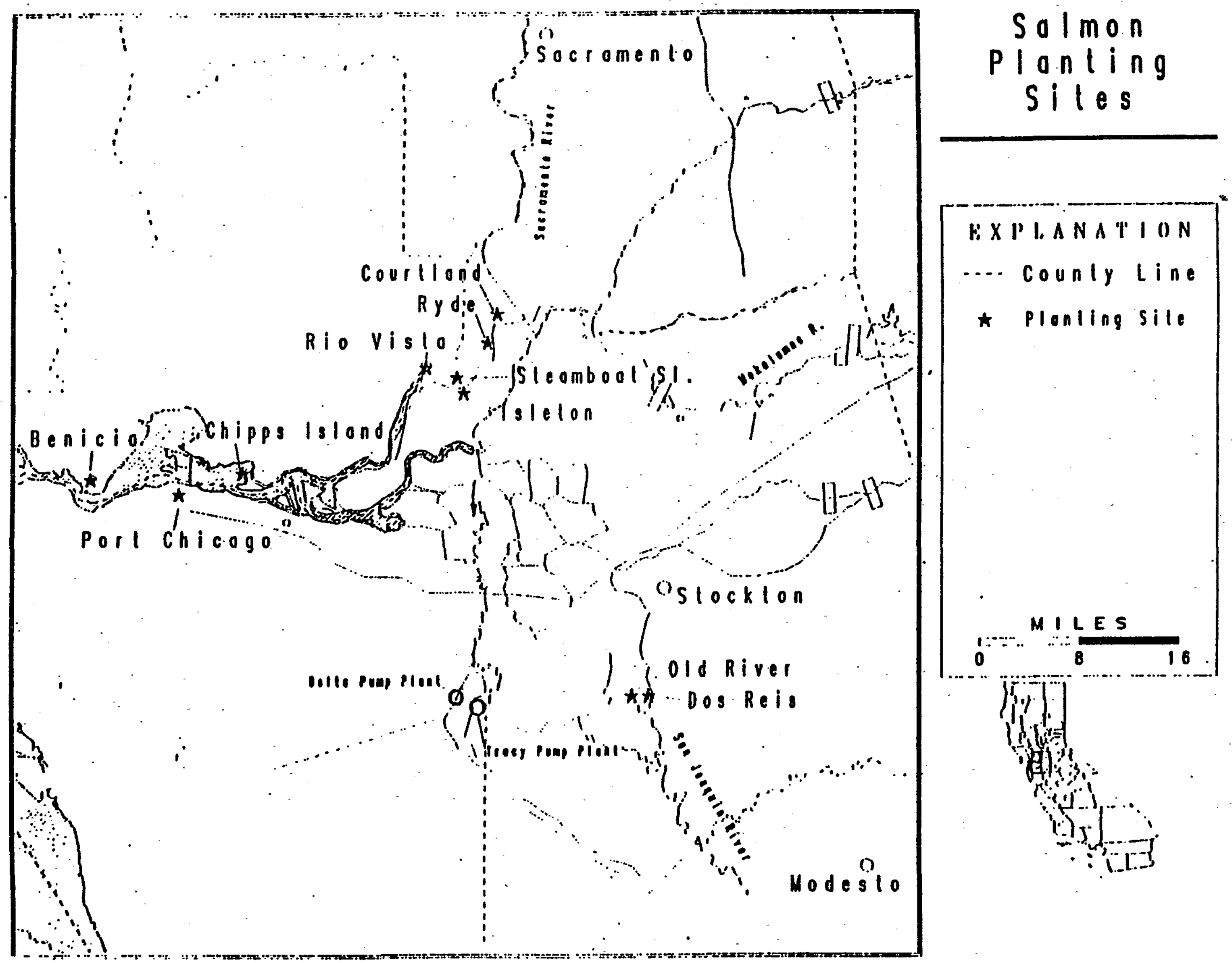

FIGURE 10. Salmon planting sites.

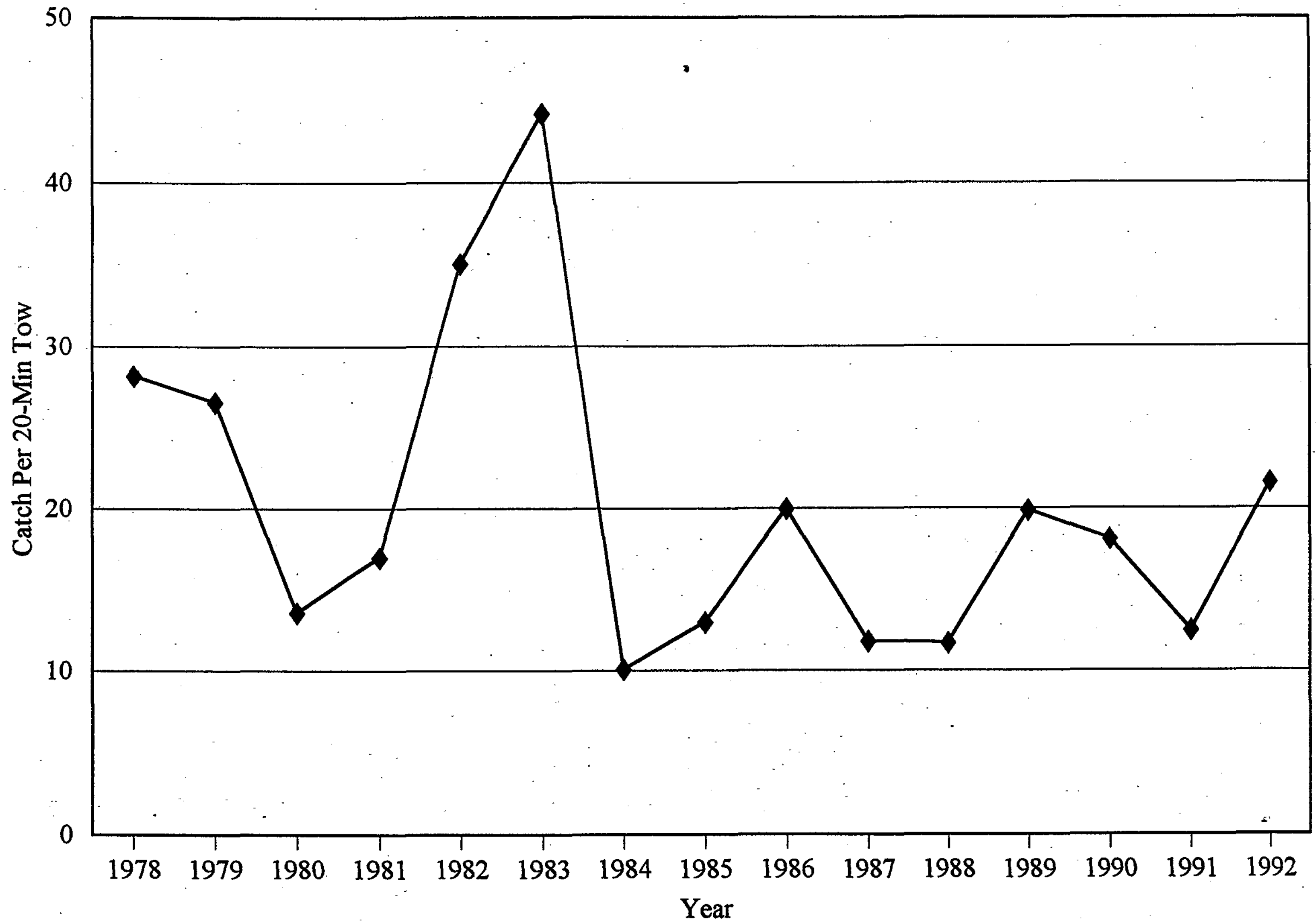

FIGURE 11. Chipps Island smolt index, 1978-1992.

TABLE 2. Ocean recovery rates and estimates of upper Sacramento River and delta survival for smolts emigrating in 1978–1990.

Outmigration Year	Release Site	Release Date	Ocean Recovery Rate	Upper River Survival	Delta Survival	Ocean Survival
1990 (BY89)	Battle Creek	5/11	0.0004895	0.24		
	Red Bluff	5/12	0.0003492	0.17		
	Princeton	5/14	0.000192	0.09		
	Benicia	5/22	0.003699			0.003699
	Sacramento	5/7	0.00208		0.56	
	Ryde	5/9	0.00262		0.71	
	Ryde	5/31	0.00342		0.925	
1989 (BY88)	Battle Creek	5/8	0.0016	0.33		
	Red Bluff DD		0.00172	0.36		
	Princeton		0.00175	0.36		
	Benicia		0.00495			0.00495
	Courtland	5/2	0.00484			
	Ryde		0.00814			
	Sacramento	6/1	0.00154		0.453	
	Courtland		0.00083		0.244	
	Ryde		0.00162		0.48	
	Port Chicago		0.00340		–	0.00340
	Sacramento	6/14	0.00074		0.11	
	Courtland		0.00089		0.13	
	Ryde		0.00020		0.03	
	Port Chicago		0.00695		–	0.00695
1988 (BY87)	Battle Creek	5/9	0.0076	0.70		
	Red Bluff DD		0.0088	0.81		
	Princeton		0.0079	0.73		
	Benicia	5/17	0.0064			0.0064
	Sacramento	5/5	0.0108		0.57[a/]	
	Courtland (gates closed)		0.0114			
	Courtland (gates open)		0.0091			
	Ryde (gates open)	5/7	0.0249			
	Ryde (gates closed)		0.0202			0.0249
	Sacramento	6/23	0.00146		0.08	
	Courtland (gates closed)		0.01341		0.71	
	Courtland (gates open)		0.0007		0.04	
	Ryde (gates closed)		0.00461		0.24	
	Ryde (gates open)		0.00528		0.28	
	Port Chicago		0.01890			0.01890
1987 (BY86)	Battle Creek		0.0088	0.62		
	Red Bluff DD		0.0071	0.50		
	Princeton		0.0034	0.24		
	Courtland		0.0142			
	Ryde		0.0201		0.50	0.0201

TABLE 2. Ocean recovery rates and estimates of upper Sacramento River and delta survival for smolts emigrating in 1978–1990.

Outmigration Year	Release Site	Release Date	Ocean Recovery Rate	Upper River Survival	Delta Survival	Ocean Survival
1986 (BY85)	Courtland		0.0169		0.60	
	Ryde		0.0194		0.68	
	Port Chicago		0.0284			0.0284
1985 (BY84)	Courtland		0.0039		0.39	
	Ryde		0.0085		0.85	
	Port Chicago		0.0100			0.0100
1984 (BY83)	Courtland		0.0058		0.84	
	Ryde		0.0042		0.61	
	Port Chicago		0.0069			0.0069
1983 (BY82)	Courtland		0.0039		1.30	
	Iselton		0.0038		1.27	
	Port Chicago		0.0030			0.0030
1982 (BY81)	Sacramento		0.0135		1.5	
	Port Chicago		0.0090			0.0090
	Sacramento		0.0065		1.1	
	Port Chicago		0.0058			0.0058
1981 (BY80)	Sacramento		0.00033		0.011	
	Port Chicago		0.0279			0.0279
1980 (BY79)	Sacramento		0.0100		0.41	
	Port Chicago		0.0243			0.0243
1979 (BY78)	Sacramento		0.0006		0.08	
	Port Chicago		0.0077			0.0077
1978 (BY77)	Sacramento		0.0004		0.012	
	Port Chicago		0.0330			0.0330

a/ Ryde (gates opened) released on 5/7 used as the denominator to estimate delta survival.

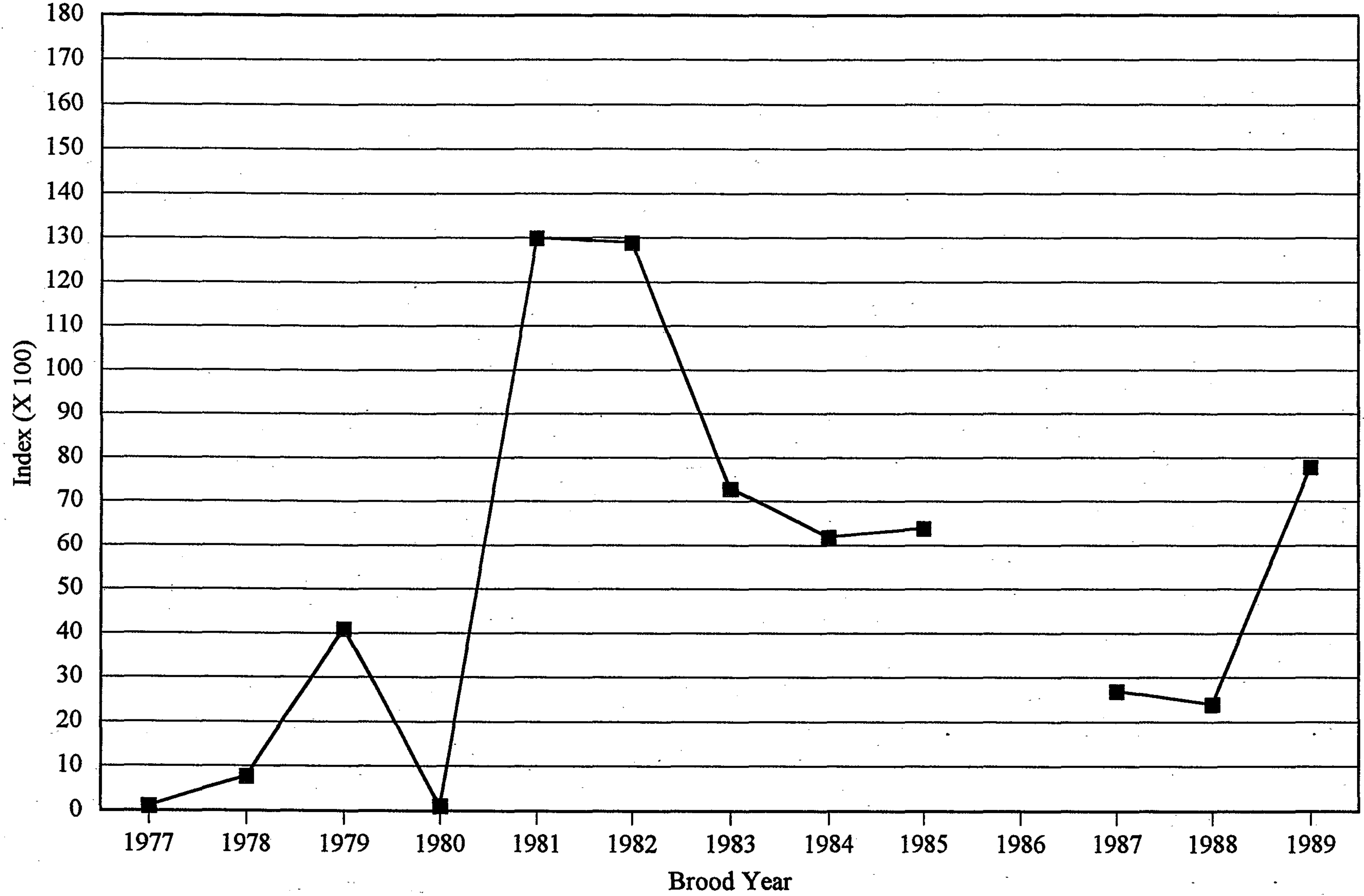

FIGURE 12. Index of delta survival, 1977-1989.

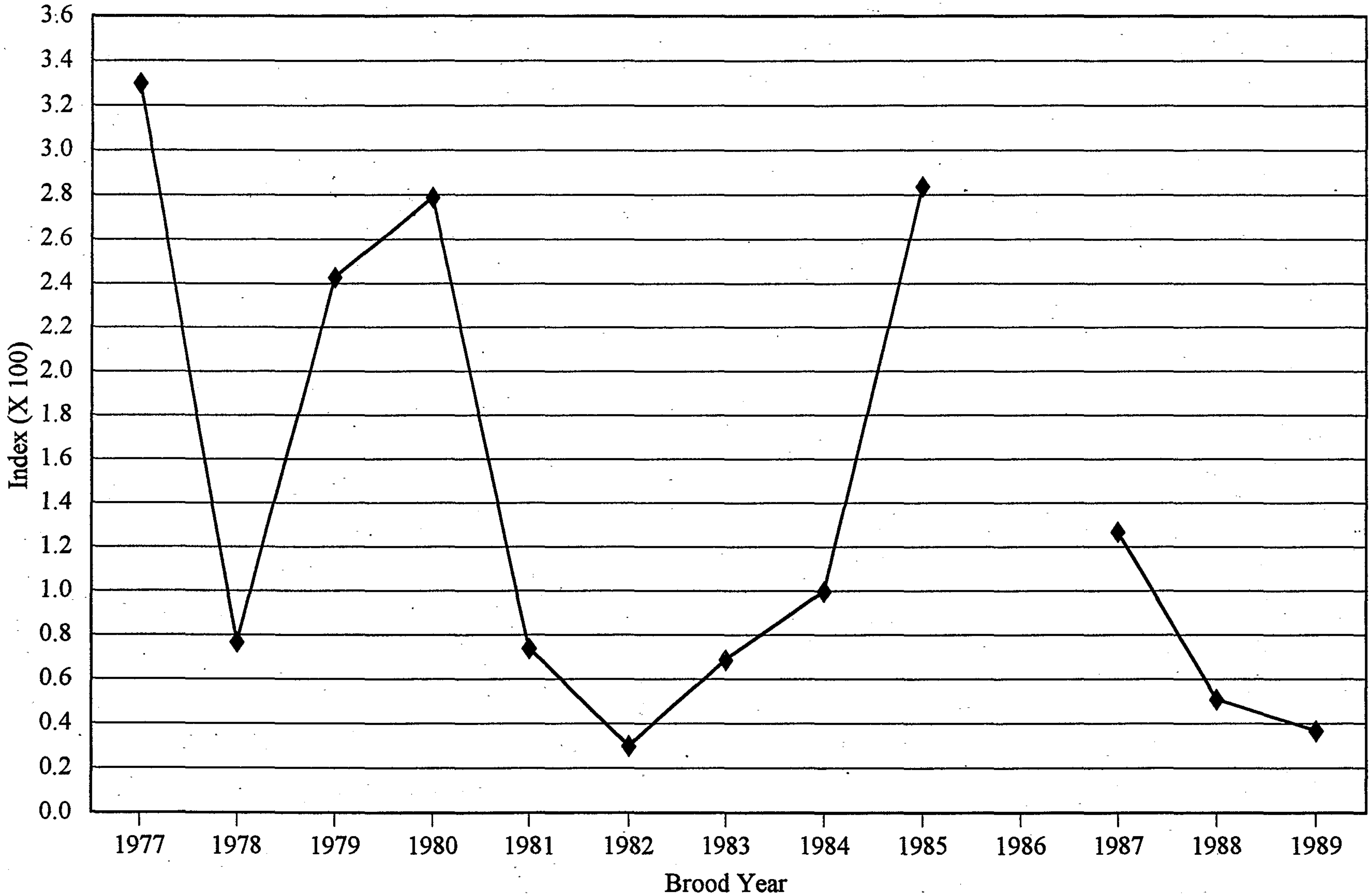

FIGURE 13. Index of ocean survival, 1977-1989.

Data for Klamath fall chinook, which are most available for the ocean fisheries between Point Arena and Florence, Oregon, also indicate reduced ocean survival rates during the late 1980s. Age–2 survival estimates for yearling fish of the 1987–1988 broods released from the two basin hatcheries were half or less of recent historic survival rate levels, excluding the 1980 and 1981 broods (Figure 14). Yearling fish were used in this analysis because they migrate very quickly following release to the ocean. The 1980 and 1981 broods were omitted from the analysis because of El Niño impacts affecting those broods.

Contribution of Naturally Produced and Hatchery Fish

The number of juvenile SRFC entering the ocean, both naturally spawning and hatchery fish, and the ocean survival rate of those fish, will determine adult abundance. These two variables do not necessarily vary in conjunction with one another, but they both significantly influence abundance. For example, juvenile abundance of the 1987–1989 broods was average or slightly above average because of increased releases of Feather River and Nimbus hatchery juveniles (Figures 8 and 11), but ocean survival was generally poor (Figure 13). Thus, low abundance was recorded for all three broods, three years later.

The contribution of hatchery and naturally produced fish to the CVI is believed to be heavily weighted in most years by hatchery fish. Reliable estimates of hatchery fish contributions are not available because representative marking of the hatchery releases has not been conducted at all hatcheries in the same years.

Inability to separate hatchery and natural fish contributions to the fisheries and spawning escapements contributes to the team's lack of statistical correlation between the available indices of production and survival of CV juvenile salmon and the CVI.

RIVER SPORT FISHERY HARVEST

River sport fishing for SRFC takes place on the mainstem Sacramento River from about Rio Vista to Keswick Dam, and in the lower Feather and American rivers, below barrier dams (Figure 2). Fall chinook are taken as early as July and as late as December, with October being the peak month for landings.

Basin–wide sampling of the river sport fishery was not conducted prior to 1990. Basin–wide estimates of SRFC catch since 1990 ranged from 21,500 to 33,900 and averaged 28,200 fish (Table 3).

The longest time–series of river harvest estimates of SRFC is for the fishery above RBDD. This sampling has been conducted in conjunction with upper river spawning stock surveys and data are available for all years since 1967 (Table 4).

The upper river harvest rate was estimated on an annual basis for this report to determine if the harvest rate in the river sport fishery has been increasing. It was computed as Catch/(Catch+Escapement).

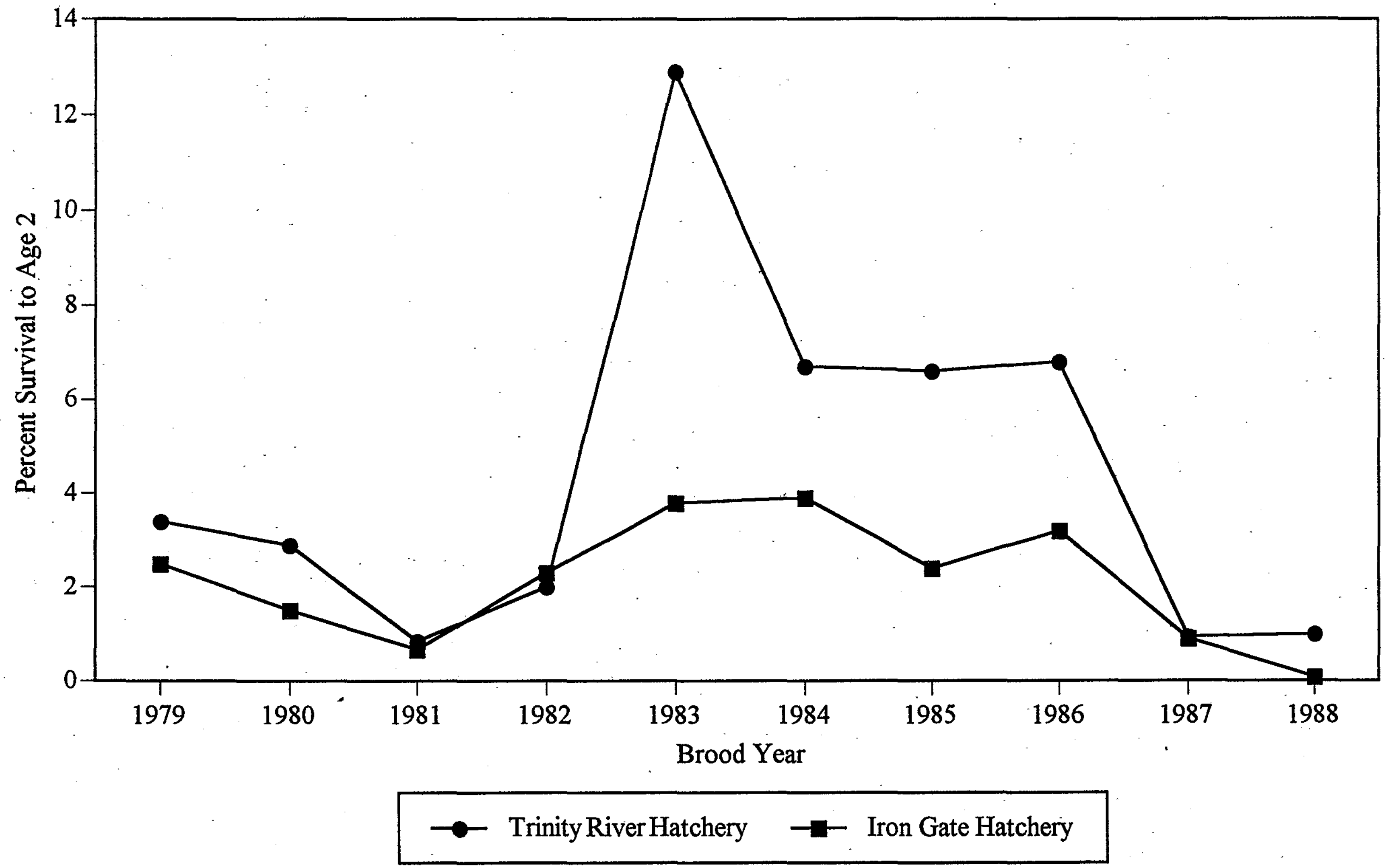

FIGURE 14. Survival rates from release to age-2 for yearling fall chinook salmon released from the Trinity River Hatchery and the Iron Gate Hatchery in the Klamath River system. Survival rates are equal to total estimated recoveries divided by release group size, but include no adjustment for ocean natural mortality.

TABLE 3. Sacramento River angler survey estimates of chinook salmon harvest. (Page 1 of 2)

		Sacramento River[a/]				American River[b/]	Feather River[c/]	Yuba River[d/]	Totals	Cumulative Total
		I	II	III	IV					
1991	Jan	0	0	0	84	0	0		84	84
	Feb	0	0	0	0	0	0		0	84
	Mar	0	0	0	0	0	0		0	84
	Apr	0	0	0	0	0	0		0	84
	May	0	0	0	0	0	0		0	84
	Jun	0	0	0	0	0	747		747	831
	Jul	298	22	234	22	1,010	302		1,888	2,719
	Aug	243	360	490	1,641	4,401	1,462		8,597	11,316
	Sep	256	468	1,004	1,920	1,972	3,517		9,137	20,453
	Oct	884	852	508	1,888	1,961	3,834		9,927	30,380
	Nov	153	230	43	201	3,086	49		3,762	34,142
	Dec	0	147	113	186	104	0		550	34,692
	Total	1,834	2,079	2,392	5,942	12,534	9,911	0	34,692	
1992	Jan	0	0	44	51	0	0		95	95
	Feb	0	0	0	0	0	0		0	95
	Mar	0	0	0	0	0	0		0	95
	Apr	0	0	0	0	0	0		0	95
	May	0	0	0	0	0	43		43	138
	Jun	0	43	0	0	501	0		544	682
	Jul	70	209	30	0	442	0		751	1433
	Aug	85	29	72	388	1,020	48		1,642	3,075
	Sep	593	382	1,365	1,379	194	2,148		6,061	9,136
	Oct	1,428	624	764	769	726	2,271		6,582	15,718
	Nov	554	371	105	465	2,933	197		4,625	20,343
	Dec	0	29	127	353	1,211	0		1,720	22,063
	Total	2,730	1,687	2,507	3,405	7,027	4,707	0	22,063	

TABLE 3. Sacramento River angler survey estimates of chinook salmon harvest. (Page 2 of 2)

		Sacramento River[a/]				American River[b/]	Feather River[c/]	Yuba River[d/]	Totals	Cumulative Total
		I	II	III	IV					
1993	Jan	0	0	0	125	0	0	0	125	125
	Feb	0	0	0	0	0	0	0	0	125
	Mar	0	0	0	0	0	0	0	0	125
	Apr	0	0	0	0	0	0	0	0	125
	May	0	0	0	0	0	56	0	56	181
	Jun	0	0	0	0	59	328	16	403	584
	Jul	62	0	27	0	193	625	0	907	1,493
	Aug	58	344	1,004	136	488	1,473	0	3,503	4,994
	Sep	420	672	1,152	1,006	1,359	2,237	0	6,846	11,840
	Oct	2,596	1,002	931	1,663	2,977	3,022	92	12,283	24,123
	Nov	426	118	378	397	4,171	50	0	5,540	29,663
	Dec								0	29,663
		3,562	2,136	3,492	3,327	9,247	7,791	108	29,663	

Description of areas sampled by angler survey:

a/ Sacramento River:
- I = Carquinez Bridge to Sacramento
- II = Sacramento to Colusa
- III = Colusa to Red Bluff Diversion Dam
- IV = Red Bluff Diversion Dam to Redding (ACID Dam)

b/ American River: Discovery Park to Nimbus Dam

c/ Feather River: Verona to Oroville Fish Barrier Dam

d/ Yuba River: (sampling began January 1993)
Marysville to 1 mile upstream of Highway 20 Bridge

TABLE 4. Salmon counts and estimated catches upstream of RBDD, 1967–1992.

	Late Fall Run		Winter Run		Spring Run		Fall Run	
Year	Spawner	Catch	Spawner	Catch	Spawner	Catch	Spawner	Catch
1967	37,208		57,306		23,514		89,220	821
1968	34,733	668	84,414	5,631	14,864	239	122,095	354
1969	38,752	207	117,808	3,628	26,505	571	133,815	1,712
1970	25,310	16	40,409	2,080	3,652	416	80,935	3,110
1971	16,741	435	43,089	3,484	5,830	148	63,918	3,139
1972	32,651	1,092	37,133	1,204	7,346	308	42,503	2,022
1973	23,010	1,229	24,079	1,428	7,762	587	53,891	2,136
1974	7,855	217	21,897	580	3,933	132	54,952	1,804
1975	19,659	398	23,430	851	10,703	469	63,091	3,132
1976	16,198	290	35,096	2,067	25,983	888	60,719	3,307
1977	10,602	478	17,214	744	13,730	277	40,444	825
1978	12,586	107	24,862	127	5,903	234	39,826	674
1979	10,398	114	2,364	25	2,900	43	62,108	1,128
1980	9,481	120	1,156	14	9,696	333	37,610	1,031
1981	6,807	89	20,041	246	21,025	370	53,744	299
1982	4,913	14	1,242	9	23,438	282	48,431	1,069
1983	15,190	101	1,831	4	3,931	77	42,096	737
1984	7,163	23	2,663	1	8,147	324	73,254	1,556
1985	8,436	120	3,962	275	10,747	547	97,707	5,079
1986	8,286	1,331	2,464	43	16,691	867	104,873	5,681
1987	16,049	307	1,997	20	11,204	233	103,063	2,856
1988	11,597	221	2,094	21	9,781	203	139,966	3,878
1989	11,639	223	533	5	5,255	109	84,057	2,329
1990	7,305	77	441	4	3,922	65	55,710	1,598
1991	7,039	209	191	0	773	22	44,937	5,655
1992	10,370	353	1,180	0	431	1	41,376	2,981

Source: Inland Fisheries Division, Red Bluff

Available data for the upper river indicate a highly variable level of harvest of SRFC with no trend indicated in the harvest rate through 1990 (Figure 15). In 1991 and 1992, harvest rate increased substantially, but the overall rate was still low (under 12 percent) compared to the ocean fisheries, as discussed in the next section.

OCEAN FISHERY MANAGEMENT

The methodology used to estimate ocean fishery impacts and spawning escapement of SRFC has been generally the same since 1984. In 1984, an index of abundance of CV chinook was developed for use in projecting the following year's escapement of SRFC. The CVI is the annual sum of ocean fishery landings south of Point Arena and spawning escapement of adult CV chinook stocks in the same year (Table 5). The CV chinook are the major contributor to ocean fisheries south of Point Arena as shown in ocean tagging studies (Fry and Hughes 1952) and protein analysis (Gall et al. 1989). SRFC comprise the large majority of chinook stocks in the CV.

METHODOLOGIES

Estimation of Recruitment

Prior to 1989, the CVI was projected based on CVI levels in recent years with general consideration given for brood year natural escapements, hatchery releases and the previous year's jack run. During 1989–1990, three predictors were evaluated and used for projecting the CVI: (1) pounds of juvenile chinook released from CV hatcheries, (2) numbers of juvenile chinook released from these same facilities and (3) the CV jack estimate for the previous year. Since 1991, the previous year's jack estimate has been used to project the CVI (Figure 16).

Estimation of Harvest and Escapement

Spawning escapement of SRFC is estimated as

Escapement = CVI * (1 – Harvest Rate Index) * Percent SRFC.

The annual harvest rate index for CV chinook is the ocean harvest landed south of Point Arena expressed as a percent of the CVI (Table 5, column 9). Since 1970, the ocean harvest rate index has been slowly increasing, and since 1987 it has averaged 75 percent (Figure 17). Although not an actual harvest rate, the increasing trend may indicate a level of harvest too high to sustain.

The ocean harvest rate index was projected during 1990–1992 based on the expectation of harvest rate for SRFC compared to recent years' rates. The adopted regulations were compared to recent years' regulations and the index was projected based on the relative number of days of fishing to be permitted by time, area and fishery. Except for 1992, the regulations south of Point Arena were essentially the same as they had been since 1980. The 1992 regulations were more

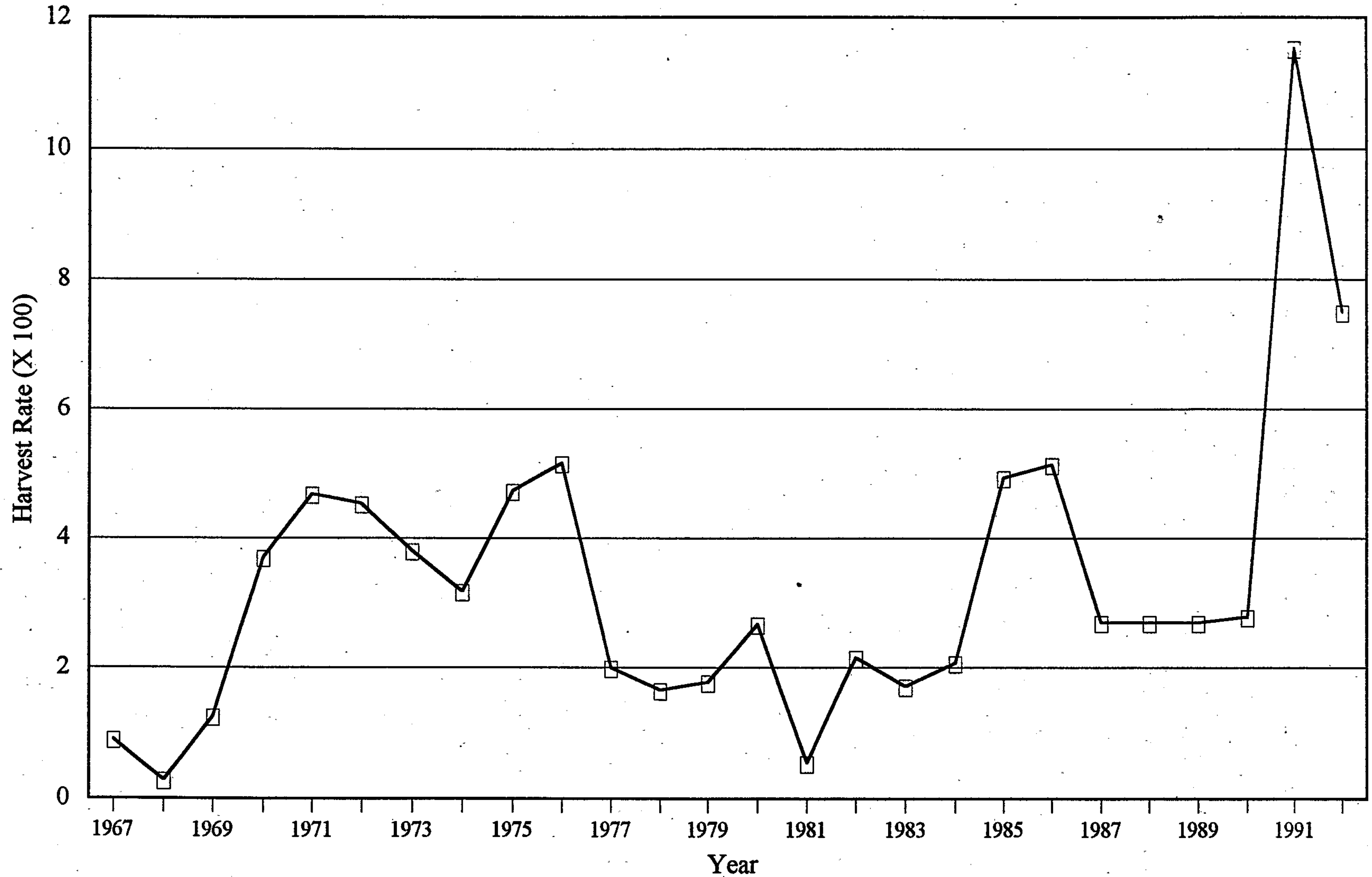

FIGURE 15. Upper Sacramento River harvest rate for Sacramento River fall chinook, 1967-1992.

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TABLE 5. Indices of annual abundance and ocean fishery impacts on California Central Valley chinook in thousands of fish. (Page 1 of 1)

Year	Ocean Chinook Landings South of Pt. Arena			Hatchery and Natural Escapements of Central Valley Adults			Abundance Index (Ocean + River Totals)	Ocean Exploitation Rate Index (Percent)[a]
	Troll	Sport	Total	Fall	Other[b]	Total		
1970	226.8	111.1	337.9	190.5	55.6[c]	246.1	584.0	58
1971	150.7	166.3	317.0	190.6	62.0	252.6	569.6	56
1972	229.8	187.6	417.4	99.6	46.1	145.7	563.1	74
1973	422.5	180.9	603.4	227.1	27.1	254.2	857.6	70
1974	282.7	141.6	424.3	205.6	35.7	241.3	665.6	64
1975	234.4	92.7	327.1	159.2	47.6	206.8	533.9	61
1976	237.9	68.6	306.4	168.8	43.8	212.6	519.0	59
1977	263.8	76.6	340.4	148.7	42.8	191.5	531.9	64
1978	291.0	65.9	356.9	136.9	17.1	154.0	510.9	70
1979	234.1	108.5	342.6	167.9	11.3	179.2	521.8	66
1980	294.3	77.1	371.4	155.9	31.6	187.5	558.9	66
1981	289.9	73.8	363.7	189.3	18.7	208.0	571.7	64
1982	418.4	122.5	540.9	177.2	36.8	214.0	754.9	72
1983	178.2	53.0	231.2	121.0	14.2	135.2	366.4	63
1984	221.7	78.7	300.3	197.5	17.6	215.1	515.4	58
1985	212.3	121.8	334.1	308.9	19.0	327.9	662.0	50
1986	502.5	114.8	617.3	259.0	30.3	289.3	906.6	68
1987	446.8	152.8	599.7	188.0	25.2	213.2	812.9	74
1988	830.5	130.4	960.9	244.9	23.3	268.2	1,229.1	78
1989	363.8	130.9	494.7	149.6	16.4	166.0	660.7	75
1990	336.2	112.6	448.8	108.3	13.5	121.8	570.6	79
1991	254.6	62.1	316.7	112.3	15.1	127.4	444.1	72
1992	163.5	66.7	230.2	85.3	12.8	98.1	328.3	70
1993[d]	249.6	97.7	347.3	131.4	14.9[e]	146.3	493.6	70

a/ Ocean harvest landed south of Pt. Arena as a percent of the abundance index.
b/ Spring run of the current calendar year and late fall and winter runs of the following calendar year.
c/ Percent of adults in 1970 spring run assumed the same as 1971 (72 percent, 5,500 total).
d/ Preliminary.
e/ Winter run assumed to be the same as previous year.

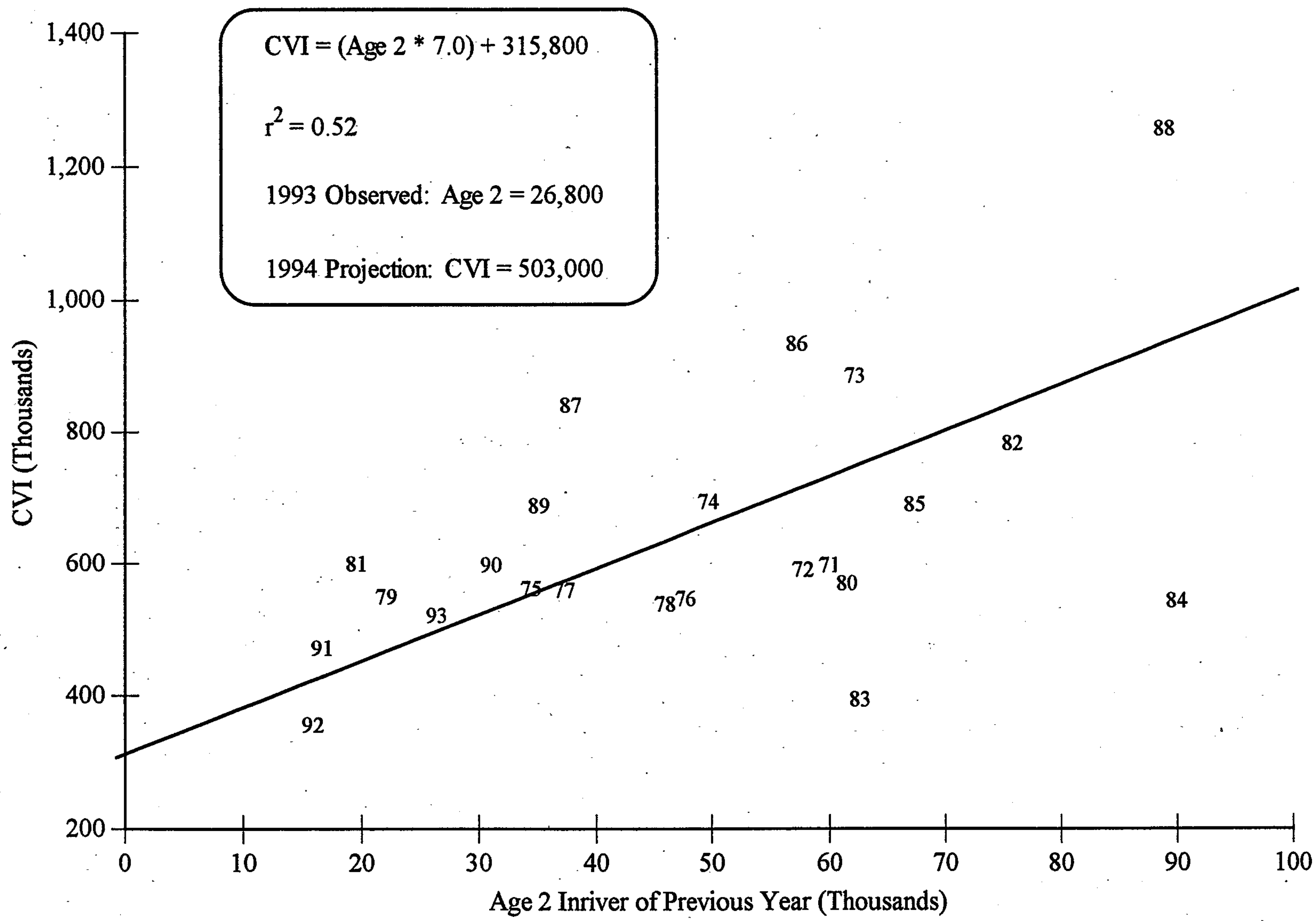

FIGURE 16. Linear regression of Central Valley Index on inriver age-2 Central Valley chinook of the previous year, 1971-1993. (Years shown are CVI year; 1983 and 1984 omitted.)

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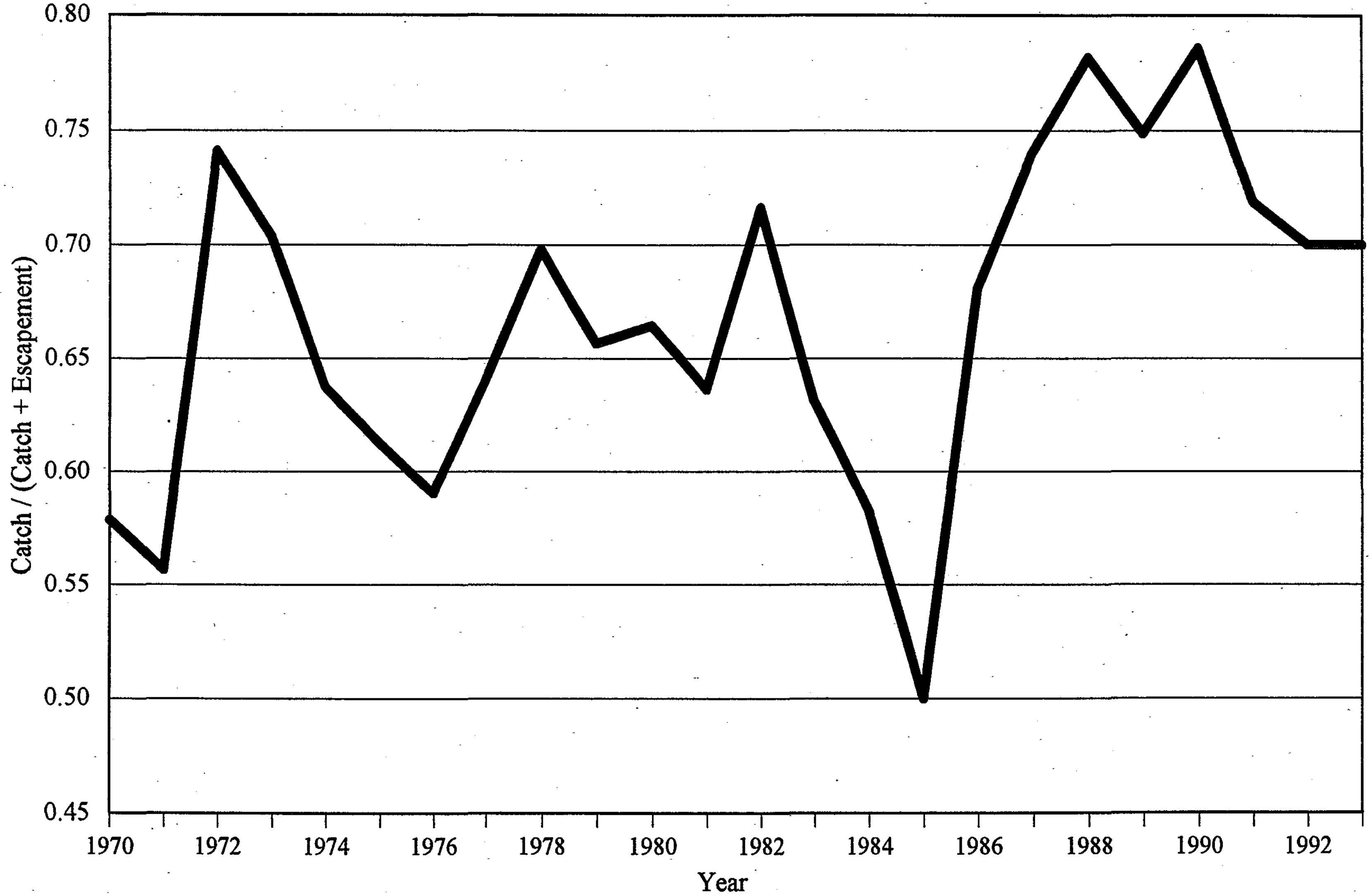

FIGURE 17. Central Valley chinook salmon harvest rate index, 1970-1993.

restrictive south of Point Arena in order to protect Klamath River fall chinook. During 1990–1991, the recent four–year average harvest rate index was used for estimating ocean escapement of SRFC; for 1992, the index was projected to be 34 percent, about half of the recent four–year average.

The proportion of SRFC in CV escapements has been gradually increasing since 1970, but has been stable in recent years at about 90 percent of the combined escapements. The proportion of SRFC in the CV escapement during 1990–1992 was projected based on the recent four–year average.

Deviations from Predictions

Each year during 1990–1992, the escapement goal range for SRFC was expected to be met. However, the actual escapements were well below the goal range of 122,000 adult spawners in all years. In 1992, the actual escapement was less than one–third of the preseason projection (Table 6).

The preseason point projection for the CVI during 1985–1988 ranged from 58 to 79 percent, and averaged 68 percent, of the postseason CVI estimates (Table 7). Prior to the El Niño years of 1983–1984, the CVI had been relatively stable. However, during 1985–1988, the CVI increased significantly, then began a sharp decline (Figure 18).

The relatively poor relationship between the various predictors and past CVI stems from variations in CV chinook stock contributions to the ocean fisheries south of Point Arena, varying hatchery release strategies and variable maturity schedules that are not accounted for in the predictors for CV chinook stocks. Predictors based on hatchery numbers or pounds released have been particularly disappointing. The jack–to–CVI fit was also influenced by difficulties in identifying jacks caused by variations in lengths of age–2 and older spawning fish (CV jacks have been estimated based on sample criteria involving length of fish rather than on scale analysis). Since 1991, the Council's Salmon Technical Team has used the CV jack estimate for the prior year as the best indicator of CVI abundance.

Projections of ocean harvest rate index and escapement percentage of SRFC were within 6 percentage points or less of the postseason estimates for these parameters during 1990–1992, except that the preseason harvest rate index was only about half the postseason estimate in 1992 (Table 8). In 1992, while the regulations were more restrictive, the harvest rate index was the same as in previous years. This might reflect a failure to anticipate the magnitude of the shift of effort from more northerly areas or a higher availability of fish in nearshore areas. While some higher than anticipated harvest can be absorbed in higher abundance situations, when combined with the overestimate of stock size in 1992, low escapements occurred.

TABLE 6. Comparisons of preseason and postseason estimates of SRFC spawning escapement, 1990–1992, in thousands of adult fish (this table is based on preseason report III for the preseason projections of escapement and actual escapement estimates for SRFC updated through 1992).

Year	Preseason	Postseason	Preseason/Postseason
1990	160.0	107.3	149%
1991	158.3	109.5	145%
1992	269.0	82.4	326%

TABLE 7. Comparisons of preseason and postseason estimates of chinook salmon for the CVI (in thousands of fish).

Year or Average	Preseason	Postseason	Preseason/ Postseason
1985–1988	–	–	0.68
1985	524.8	662.0	0.79
1986	546.5	906.6	0.60
1987	592.9	812.9	0.73
1988	707.1	1,229.1	0.58
1989	625–885	660.7	0.95–1.34
1990	500–900	570.6	0.88–1.58
1991	466	444.1	1.05
1992	452	328.3	1.38
1993	501	493.6	1.01

TABLE 8. Comparisons of preseason and postseason estimates of the ocean harvest rate index for CV chinook and the percent SRFC in the CV spawning escapements, 1990–1992 seasons.

	Harvest Rate Index for CV Chinook			Percent SRFC in CV Spawning Escapement		
Year	Preseason	Postseason	Pre/Post	Preseason	Postseason	Pre/Post
1990	0.74	0.79	94%	90	89	101%
1991	0.72	0.72	100%	90	88	102%
1992	0.34	0.70	49%	90	84	107%

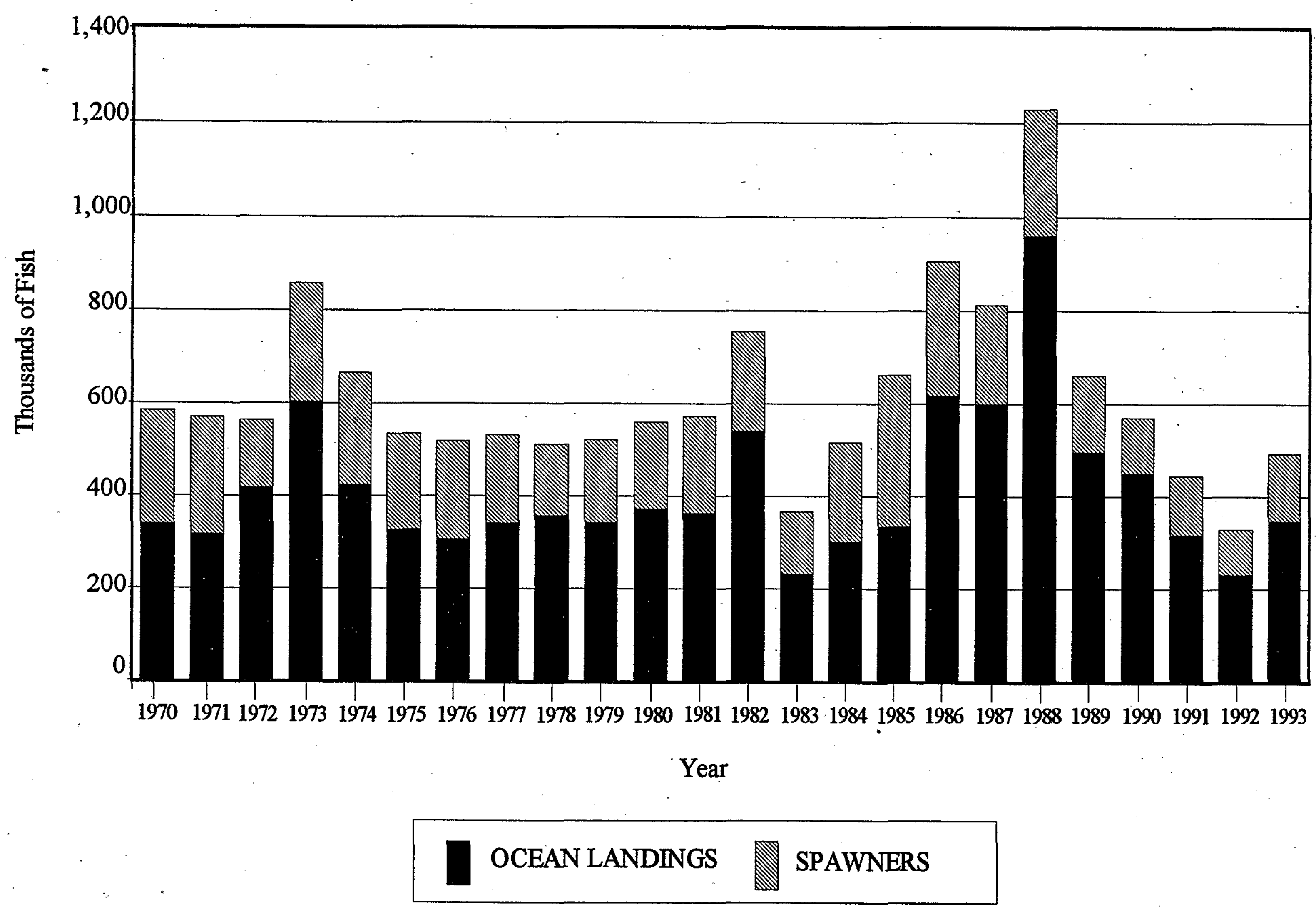

FIGURE 18. Central Valley chinook salmon annual abundance index, 1970-1993.

MARINE MAMMAL INTERACTIONS

Marine mammal interactions with ocean salmon fisheries have probably been increasing off Washington, Oregon and California because of increasing populations of California sea lions and Pacific harbor seals. This conclusion is based on the experiences of knowledgeable team members, coupled with the population trends for both species (Figures 19 and 20). These interactions result in the underestimation of ocean fishery impacts caused by depredation of marine mammal pinnipeds on hooked or released fish.

Harbor seals can be a year–round problem in local areas where the animals may live their entire lives. Harbor seals are not known to make extensive oceanic migrations (Hanan 1993).

Sea lions generally are a seasonal problem because they breed and pup on various islands off southern California and Baja California, and in the Gulf of California. Breeding takes place from May through July and involves mature males that live the rest of the year from British Columbia south, including Puget Sound (Lowry et al. 1992). Because of this, salmon fishery interactions with sea lions are lowest during the sea lion breeding season. Conversely, there is likely a period of intense feeding and increasing salmon fishery interactions as the males return to more northern climes during August through September.

CDFG, in a recent study (unpublished) of shaker catches in the California charter boat fishery, recorded losses of sport–caught salmon to marine pinnipeds. Sampling was conducted from March through October of 1993 and involved 87 charter boat trips out of ports between Crescent City and Morro Bay, with most of the trips (55) out of San Francisco.

A total of 1,051 salmon (mostly chinook) were observed hooked in the CDFG study and 15 (1.4 percent) were observed lost to pinnipeds. The incidence of marine mammal encounters was highest in the Monterey area (8 salmon in 25 trips), followed by the San Francisco area (7 salmon in 55 trips).

Dockside interviews with charter and private boat anglers by CDFG in 1993 indicated a salmon loss rate to pinnipeds over the entire season in all areas of about 1.65 percent of the catch. A rough estimate of the loss of salmon to pinnipeds in the 1993 sport salmon fishery off California is 2,000 fish, compared to a landed catch of 140,000.

Pinniped depredation data are unavailable for the commercial fishery. Data for the sport fishery probably are not representative of the commercial fishery because trollers generally fish in different areas and hook many more salmon per unit of effort and in total.

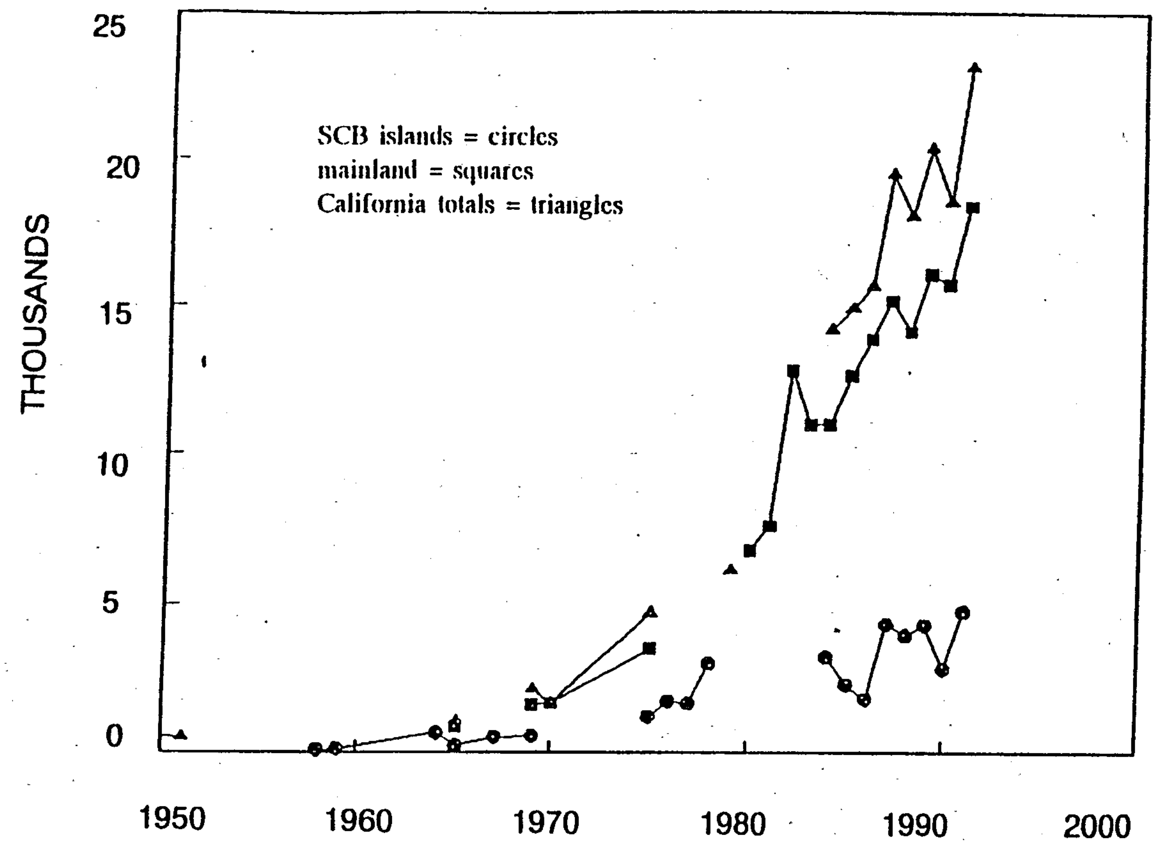

FIGURE 19. Harbor seal counts and estimates, 1950–1991.

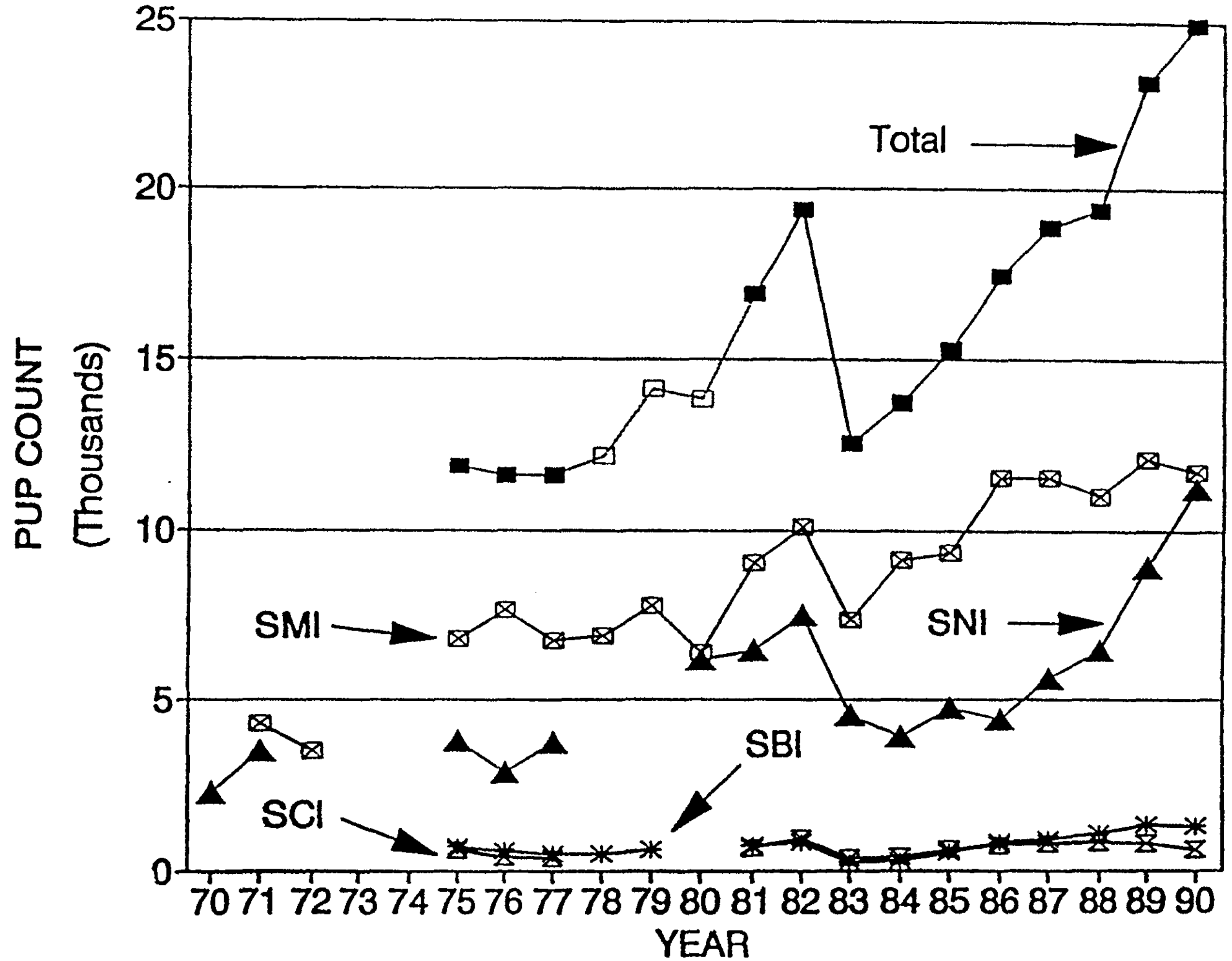

FIGURE 20. Counts of California sea lion pups at San Miguel Island (SMI: index counts), San Nicolas Island (SNI), San Clemente Island (SCI) and Santa Barbara Island (SBI). The total count is shown for years in which counts were available for all four rookeries (solid squares). The total estimated count is shown for years in which counts were not available for all rookeries, but were estimated (open squares). The average of multiple counts was used when more than one count was available.

CONCLUSIONS FOR SHORTFALLS

The following conclusions were reached regarding conditions affecting the production and survival of SRFC of the 1987–1989 broods.

1. Drought conditions during 1987–1990 resulted in lower than normal water releases from basin storage facilities during the salmon spawning and rearing period. The early spawning adults were confronted with warm, low water releases below the dams, and the young fish were confronted with reduced quantity and lower quality rearing habitat. Water diversions decreased the survival of outmigrating juveniles by causing reduced streamflows coupled with record–high water delivery rates, particularly at the pumps in the south delta, and early onset of the irrigation season. Average production of naturally produced juveniles and slightly above average production of hatchery smolts entering the ocean, coupled with low ocean survival rate, resulted in low production of adult SRFC as measured by the CVI.

2. Overestimation of the CVI and underestimation of ocean harvest rate contributed to the escapement shortfalls in all three years. The failure of regulations to adequately restrict harvest levels in 1992, and the overestimation of the CVI (particularly in 1992), resulted in escapement shortfalls.

CURRENT PLANS FOR RESTORING BASIN PRODUCTIVITY

CENTRAL VALLEY PROJECT IMPROVEMENT ACT

Congress recently passed Public Law 102–575, Title 34, the Central Valley Project Improvement Act (CVPIA). This statute is aimed, in large part, at reversing the declining trend in anadromous fish populations in the CV. The U.S. Fish and Wildlife Service (USFWS) and U.S. Bureau of Reclamation (USBR) are responsible for its implementation. Some of the major provisions of the CVPIA as they pertain to SRFC are as follows:

1. Amends federal statute to include protection and mitigation of fish and wildlife as an objective of the federal CVP

2. Establishes a goal of doubling the anadromous fish populations

3. Provides a base of 800,000 acre–feet of water for fish and wildlife, with provision to acquire additional water

4. Addresses the need to minimize fish passage problems at RBDD

5. Establishes a restoration fund and provides authorization to collect assessments from beneficiaries of CVP water and power

6. Authorizes funding for up to 75 percent of the cost of projects, activities, or studies aimed at meeting the intent of the CVPIA

STATE OF CALIFORNIA RESTORATION ACTIVITIES

At the direction of California Governor Pete Wilson, CDFG has recently developed a plan to restore and enhance aquatic habitats for salmon and steelhead trout in the CV above the estuary (CDFG 1993). The plan gives details of proposed projects that are listed in priority, beginning with those that will benefit threatened or endangered species, followed by those that will contribute to doubling the salmon and steelhead runs. It also identifies administrative actions that need to be undertaken and studies that need to be conducted by the various entities in California responsible for fish and wildlife management or protection of their habitats. Summaries of the proposed projects, administrative actions and study needs are included as appendices 2 through 4 of this document.

Governor Wilson has also remarked that the Sacramento–San Joaquin Delta "is broken" and initiated a three–year comprehensive planning effort "to protect and enhance the San Francisco Bay/Sacramento–San Joaquin Delta Estuary by addressing water quality concerns, effective design and operation of water export systems, maintenance of delta levees and channels, and guarantees for protection of the bay–delta estuary and its fish and wildlife resources." The Governor established the Bay–Delta Oversight Council (BDOC), a 22–member public advisory body, to develop recommended actions to address the areas of concern. CDFG is working with BDOC in that effort and expects it to define the actions needed in the estuary to compliment the measures described in CDFG's habitat restoration and enhancement plan for the CV above the estuary.

The estuary planning effort is expected to be the most difficult element of the CV recovery planning process. This is because of the technical difficulty of meeting an objective of increased water delivery for agricultural and municipal uses south of the delta, while at the same time providing for an improved delta environment for fish and wildlife.

FOUR–PUMPS AGREEMENT

In December 1986, the California departments of Water Resources and Fish and Game signed an agreement to offset the direct losses of chinook salmon, steelhead and striped bass at the delta intake to the California Aqueduct (The "Four–Pumps Agreement"). This agreement funds projects that will offset salmon losses at the pumps by increasing natural production through habitat improvement. There is also a $15 million account to fund projects that appear to have significant but unquantifiable benefits to salmon.

Although the agreement focuses on San Joaquin stocks, projects on the Sacramento River are also considered. For example, the $15 million account was used to fund a 100,000 cubic yard gravel restoration project on the Sacramento River near Redding and a conjunctive use project on Mill Creek, a Sacramento River tributary. Additional projects developed through CDFG's anadromous fisheries restoration efforts, the CVPIA fish doubling plan or other sources will be considered for funding.

ENDANGERED SPECIES MEASURES

Measures implemented to protect the listed winter chinook and delta smelt may benefit SRFC as well. In February 1993, the National Marine Fisheries Service issued its biological opinion on the effects of SWP and CVP operations on winter chinook. The opinion concluded that project operation would jeopardize the winter run's existence and specified reasonable and prudent operational measures and an incidental take permit to avoid jeopardy. These measures included closure of the Delta Cross Channel from February 1 through April 30 in all years, and no reverse flow in the lower San Joaquin River during the same period. These actions should improve survival of the other three races (fall, late-fall and spring chinook) during their outmigration. The opinion also included temperature objectives in the upper Sacramento River and a carryover storage objective for Shasta Reservoir. An operational plan is needed to ensure that measures implemented to protect winter chinook do not adversely affect the other races.

USFWS released its delta smelt biological opinion on SWP/CVP operations on February 4, 1994. Outflow and incidental take provisions in this jeopardy opinion may result in higher delta outflows and less project pumping in the drier years. These conditions should increase juvenile salmon survival through the delta.

SAN FRANCISCO ESTUARY PROJECT

This has been a five-year cooperative effort to promote more effective management of the San Francisco Bay-Delta Estuary and to restore and maintain the estuary's water quality and natural resources. Its recently completed Comprehensive Conservation and Management Plan (CCMP) was signed by U.S. Environmental Protection Agency administrator and by Governor Pete Wilson. The CCMP contains specific goals and actions to restore California's salmon runs.

RECOMMENDATIONS FOR ASSURING FUTURE PRODUCTIVITY

1. Develop and implement measures under state and federal delta mitigation agreements to improve salmon survival through the delta; USFWS and USBR must continue their efforts toward the timely implementation of the CVPIA, including collection of CVP beneficiary assessments required to fund much needed habitat restoration projects and resource studies; implement the salmon studies, administrative modifications and restoration projects recommended by CDFG for the CV above the delta; BDOC must continue its deliberations aimed at the development of a comprehensive plan for the protection and enhancement of the fish and wildlife resources of the San Francisco Bay-Delta Estuary while providing for the efficient and reasonable use of CV water resources; and the action plans of the recently completed San Francisco Estuary Project must be carried out by the responsible parties listed in the plan. Federal water quality standards may soon be promulgated that will further protect SRFC juveniles as they pass through the Sacramento-San Joaquin Delta.

2. The SRFC escapement goal range of 122,000 to 180,000 adult fish must be retained and met in all years.

3. SRFC regulatory models should be reexamined to prevent overestimation of ocean abundance of CV chinook and underestimation of impacts of proposed fishing regulations.

4. Representative marking of all CV hatchery chinook stocks should be undertaken to estimate contribution rates of hatchery and naturally produced populations to the fisheries and spawning escapements.

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APPENDIX 1
CODED-WIRE TAGGED SMOLT RELEASE AND RECOVERY INFORMATION FOR DELTA SURVIVAL ESTIMATES USING EXPANDED OCEAN TAG RECOVERIES

Coded-wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a/]. (Page 1 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age			Total Recoveries (Expanded)	Recovery Rate
			2	3	≥4		
1978							
Sacramento 6-62-2	162253	6/6	24	35	0	59	.0004
Port Chicago 6-62-3	164766	6/5	881	4549	87	5517	.0330
1979							
Sacramento 6-62-5	160151	6/5	1	80	20	101	.0006
Port Chicago 6-62-6	110122	6/6	53	713	89	855	.0077
1980							
Sacramento 6-62-8	98586	6/2&3	112	922	24	1058	.0107
Sacramento 6-62-11	84642	6/4&5	54	701	21	775	.0092
Port Chicago 6-62-9	88700	6/10	266	1746	47	2059	.0232
Port Chicago 6-62-12	79443	6/13	291	1687	32	2010	.0253
1981							
Sacramento 6-62-14	71932	6/2	21	4	0	25	.00034
Sacramento 6-62-17	68138	6/5	4	15	3	22	.00032
Port Chicago 6-62-15	78339	6/8	318	1827	42	2186	.0279

Coded-wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a/]. (Page 2 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age 2	3	≥4	Total Recoveries (Expanded)	Recovery Rate
1982							
Sacramento 6-62-18 (CNFH)[b/]	89780	5/12	25	770	279	1076	.0120
Sacramento 6-62-20	85885	5/11	26	1065	182	1284	.0150
Port Chicago 6-62-19 (CNFH)	86877	5/17	21	467	285	777	.0090
Sacramento 6-62-21	60822	6/5	7	277	112	396	.0065
Port Chicago 6-62-22	63221	6/8	5	273	90	368	.0058
San Joaquin River 6-46-28	48227	4/24	18	380	148	546	.0113
1983							
Courtland 6-62-24	96706	5/16	20	320	39	379	.0039
Port Chicago 6-62-30	43374	5/23	18	90	21	129	.0030
Isleton 6-62-23	92693	5/20	9	289	57	355	.0038
Lower Mokelumne 6-62-25	83435	5/19	0	220	51	271	.0032
Lower Old River 6-62-26	89500	5/17	0	77	17	95	.0011
1984							
Courtland 6-62-27	62604	6/11	46	293	27	366	.0058
Port Chicago 6-62-37	23558	6/29	34	159	14	207	.0089

Coded-wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a/]. (Page 3 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age			Total Recoveries (Expanded)	Recovery Rate
			2	3	≥4		
Port Chicago 6-62-31	18442 42000	6/29	18	57	7	82 289	.0004 .0069
SF Mokelumne 6-62-28							
SF Mokelumne 6-42-08	41371	6/12	22	195	39	256	.0062
Ryde 6-62-29	44818	6/13	15	142	24	181	.0040
Ryde 6-42-09	15180 59998	6/13	3	64	2	69 250	.0045 .0042
NF Mokelumne 6-62-32	59808	6/14	10	213	9	232	.0039
Lower Old River 6-62-33	64896	6/15	0	13	5	36	.0006
Golden Gate 6-54-52	48677	7/25	70	949	304	1323	.0271
Port Chicago 6-54-51	50152	7/23	74	772	214	1060	.0211
<u>1985</u>							
Courtland 6-62-40	10901	5/10	19	26	5	50	.0046
Courtland 6-62-39	14753	5/10	3	24	0	27	.0018
Courtland 6-62-38	54457	5/10	61	168	0	230	.0042
Courtland 6-62-41	20550 100661	5/10	10	74	0	84 390	.0041 .0039
SF Mokelumne 6-62-34	100386	5/7	29	281	5	315	.0032
Ryde 6-62-35	107161	5/11	139	746	26	911	.0085

Coded-wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a/]. (Page 4 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age			Total Recoveries (Expanded)	Recovery Rate
			2	3	≥4		
NF Mokelumne 6-62-35	101237	5/9	90	473	0	563	.0056
Lower Old River 6-62-42	105289	5/8	39	161	31	231	.0022
Golden Gate 6-62-44	47518	5/14	70	433	34	537	.0113
Port Chicago 6-62-45	48143	5/13	58	404	1	463	.0100
CNFH 5-6-16	10209	5/31	0	0	0	0	0
<u>1986</u>							
Courtland 6-62-43	98866	5/27	127	1414	134	1675	.0169
Ryde 6-62-48	101320	5/30	166	1635	165	1966	.0194
NF Mokelumne 6-6-2-47	101949	5/29	88	1028	162	1278	.0125
SF Mokelumne 6-62-46	102965	5/28	95	796	96	987	.0096
Lower Old River 6-62-49	98869	5/31	23	572	49	644	.0065
Port Chicago 6-62-51	47995	6/2	116	1108	141	1365	.0284
Golden Gate 6-62-52	49583	6/3	78	1555	153	1786	.360
Upper Old River 6-46-59	107215	5/30	36	524	17	577	.0054
Dos Reis 6-46-58	91040	5/29	133	831	83	1046	.0114
<u>1987</u>							

Coded–wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a]. (Page 5 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age			Total Recoveries (Expanded)	Recovery Rate
			2	3	≥4		
Courtland (gates closed) 6–62–53	49781	4/28	50	864	69	983	.0197
Courtland (gates closed) 6–62–54	50521 100302	4/28	90	836	57	983 1966	.0195 .0196
Ryde 6–62–55	51103	4/29	124	1318	153	1595	.0312
Courtland E (gates open) 6–62–56	49083	5/1	44	645	47	736	.0150
Courtland W (gates open) 6–62–57	51836 100919	5/1	46	601	46	693 1429	.0134 .0142
Ryde 6–62–58	51008	5/2	89	840	96	1025	.0201
CNFH 5–18–39	51706	5/12	13	408	36	457	.0088
RBDD3[c] 5–18–40	51807	5/13	16	341	9	365	.0071
Princeton 5–18–41	51271	5/14	2	154	19	176	.0034
Upper Old River 6–45–3, 4 and 5	90952	4/27	48	410	37	495	.0054
Dos Reis 6–45–6, 7 and 8	92721	4/27	55	1050	98	1203	.0129
<u>1988</u>							
Miller Park B6–14–06	51005	5/5	87	477	9	573	.0112
Miller Park B6–14–07	51753 102758	5/5	85	439	16	540 1113	.0104 .0108

Coded–wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a/]. (Page 6 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age: 2	3	≥4	Total Recoveries (Expanded)	Recovery Rate
Courtland (gates closed) B6–14–03	51388	5/3	88	495	7	590	.0115
Courtland (gates closed) B6–14–04	55861 107249	5/3	82	545	8	635 1225	.0114 .0114
Courtland (gates open) B6–14–05	51274	5/6	62	348	2	412	.0080
Courtland (gates open) 6–31–1	51206 102480	5/6	65	450	7	521 933	.0102 .0091
Ryde (gates closed) 6–31–1	52741	5/3	99	952	16	1068	.0202
Ryde (gates open) 6–31–2	53238	5/6	149	1151	25	1325	.0249
CNFH 5–19–40	51923	5/9	40	342	12	393	.0076
Princeton 5–19–41	52771	5/11	59	353	5	416	.0079
Benecia 5–18–42	51651	5/17	34	291	8	333	.0064
Miller Park 6–62–61	49245	6/23	7	70	2	80	.00162
Miller Park 6–62–62	48647 97892	6/23	4	51	7	63 143	.00130 .00146
Courtland (gates closed) 6–62–59	54997	6/21	30	494	26	550	.01000
Courtland (gates closed) 6–62–60	51904 106901	6/21	38	428	18	484 1434	.00932 .01341

Coded–wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a/]. (Page 7 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age 2	3	≥4	Total Recoveries (Expanded)	Recovery Rate
Courtland (gates open) 6–62–50	99827	6/24	10	60	0	70	.00070
Ryde (gates closed) 6–31–3	53961	6/22	30	210	8	249	.00461
Ryde (gates open) 6–31–3	53942	6/25	21	246	18	285	.0058
Steamboat Slough 6–31–5	49342	6/24	7	171	4	182	.00369
Steamboat Slough 6–31–6	47975 97317	6/24	12	183	12	206 388	.00429 .00399
Port Chicago 6–31–4	54151	6/29	96	916	12	1024	.01890
<u>1989</u>							
Dos Reis 6–31–14	52962	4/20	8	26		34	.00064
Upper Old River 6–31–13	51972	4/21	11	27		38	.00073
Jersey Point 6–1–11–1–11	27758	4/24	3	77	3	83	.00295
Jersey Point 6–1–11–1–12	29058 56816	4/24	11	73	12	84 179	.00330 .00315
Dos Reis 6–1–11–1–7	25089	5/2	7	17	4	28	.00111
Courtland 6–31–11	51211	5/2	72	177	0	249	.00486
Upper Old River 6–1–11–1–6	24782	5/3	9	2	0	11	.00044

Coded–wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a]. (Page 8 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age 2	3	≥4	Total Recoveries (Expanded)	Recovery Rate
Ryde 6–31–12	51046	5/3	127	269	21	417	.00817
Jersey Point 6–1–11–1–9	27525	5/5	8	124	6	138	.00501
Jersey Point 6–1–11–1–10	28708 56233	5/5	15	119	7	141 279	.00491 .00496
CNFH 5–20–37	51074	5/8	34	41	9	84	.00160
RBDD[d] 5–20–38	52677	5/9	25	62	4	91	.00172
Princeton 5–20–39	50842	5/10	11	73	5	89	.00175
Benecia 5–20–40	39379	5/15	2	168	25	195	.00495
Miller Park 6–31–10	52612	6/1	18	59	4	81	.00159
Courtland 6–31–8	50659	6/2	5	37	0	42	.00083
Ryde 6–31–7	50601	6/2	27	55	0	82	.00162
Port Chicago 6–31–9	51760	6/5	23	153	0	176	.00340
Sutter Slough 6–31–16	49762	6/13	18	116	17	151	.00303
Steamboat Slough 6–1–14–1–1	51237	6/13	7	52	12	70	.00136
Miller Park 6–31–15	44695	6/14	10	23	0	33	.00074
Courtland 6–1–14–1–3	52907	6/15	10	37	0	47	.00089
Port Chicago 6–1–14–1–4	48329	6/19	62	273	16	352	.00728

Coded–wire tagged smolt release and recovery information for delta survival estimates using expanded ocean tag recoveries[a/]. (Page 9 of 9)

Year Released, Location and Tag Code	Number Released	Date of Release	Number of Expanded Recoveries in Ocean by Age			Total Recoveries (Expanded)	Recovery Rate
			2	3	≥4		
Ryde 6–1–14–1–2	51134	6/16	10	0	0	10	.00020
1990							
Battle Creek 5–20–55	51069	5/11	25	32	0	57	.00111
Red Bluff 5–20–56	51533	5/12	19	9	0	28	.00054
Princeton 5–20–57	52077	5/14	12	0	0	12	.00023
Benecia 5–20–58	52446	5/22	5	200	52	257	.00490
Sacramento 6–31–18	48390	5/7	7	100	8	115	.00237
Ryde 6–31–20	51878	5/9	8	133	39	180	.00346
Ryde 6–31–22	50837	5/31	8	176	30	214	.00421

a/ All CWT salmon used in this experiment were from Feather River Hatchery (FRH) unless noted otherwise.
b/ Coleman National Fish Hatchery (CNFH)
c/ Fish released above Red Bluff Diversion Dam (RBDD)
d/ Fish released below RBDD

APPENDIX 2
CENTRAL VALLEY ACTION PLAN: ANADROMOUS FISH HABITAT RESTORATION ACTIONS

Anadromous fish habitat restoration actions listed in order of priority. (Page 1 of 4)

Priority	Anadromous Fish Habitat Restoration Action	Cost
A-1	Install and operate permanent structural temperature control devices at Shasta and Whiskeytown dams and develop and implement modifications in Central Valley Project (CVP) operations as needed to assist the Secretary of Interior's efforts to control water temperatures in the upper Sacramento River.	$105,000,000
A-1	Develop and implement permanent measures to minimize fish passage problems for adult and juvenile anadromous fish at the Red Bluff Diversion Dam in a manner that provides for the use of associated CVP conveyance facilities for delivery of water to the Sacramento Valley National Wildlife Refuge complex.	52,000,000
A-1	Resolve entrainment problems at the Glenn-Colusa Irrigation District's Hamilton City Pumping Plant on the Sacramento River.	45,000,000
A-1	Control effluent from Iron Mt. Mine Superfund site until Basin Plan objectives are met.	No Estimate
A-1	Remove Clough Dam on Mill Creek and move the existing diversion to allow salmon and steelhead unimpaired access to spawning areas.	No Estimate
A-1	Relocate the M&T diversion in Big Chico Creek to the Sacramento River and install fish screens.	2,500,000
A-1	Establish and maintain a Sacramento River meander belt and limit future bank protection to preserve instream and riparian habitat.	No Estimate
A-1	Acquire Butte Creek water rights from willing sellers.	500,000
A-1	Identify and correct fish passage problems at diversions in Butte Creek through dam removal or improvements to existing fish ladders.	475,000
A-1	Install fish screens on 11 agricultural diversions in Butte Creek that range in capacity from 70 to 1,100 cfs.	14,589,000
A-1	Provide flows from Whiskeytown Dam on Clear Creek to allow adequate spawning, incubation, rearing and emigration habitat for salmon and steelhead.	No Estimate
A-1	Restore spawning gravel in Clear Creek for salmon and steelhead.	500,000
A-1	Repair or rebuild the water control structures in Big Chico Creek at Five Mile Dam and Lindo Channel following completion of the hydrologic study.	100,000
A-1	Inspect and repair existing fish ladders in Big Chico Creek.	100,000

Anadromous fish habitat restoration actions listed in order of priority. (Page 2 of 4)

Priority	Anadromous Fish Habitat Restoration Action	Cost
A-1	Install a fish screen in the Yuba River on Browns Valley Irrigation District diversion.	No Estimate
A-1	Replace screens in the Yuba River on South Yuba-Brophy and the Hallwood-Cordua diversions.	No Estimate
A-1	Install and operate a temporary fish barrier on the San Joaquin River at the Merced River confluence each fall to prevent adult salmon from straying into irrigation canals. The barrier should be operated until a decision is made regarding restoration of chinook salmon in the upper San Joaquin River below Friant Dam.	50,000 per year
A-1	Install a fish protective device in the San Joaquin River at Banta-Carbona Irrigation District diversion, or provide alternate water supplies to the district.	1,245,000
A-1	Install a fish protective device in the San Joaquin River at West Stanislaus Irrigation District diversion, or provide alternate water supplies to the district.	1,245,000
A-1	Install a fish protective device in the San Joaquin River at Patterson Irrigation District diversion, or provide alternate water supplies to the district.	1,245,000
A-1	Install a fish protective device in the San Joaquin River at El Solyo Irrigation District diversion.	400,000
A-1	Upgrade screens on four medium-sized riparian diversion in the Merced River (diversion capacities [cfs] 20, 25, 27, 52) and upgrade fish bypasses on two additional diversions.	620,000
A-1	Restore habitat for salmon migration, spawning and rearing in the Merced River by rehabilitating riffle areas, repairing or constructing levees and channels, and isolating mining pit areas from active channel.	4,000,000
A-1	Restore habitat for salmon migration, spawning and rearing on the Tuolumne River at 17 sites by renovating spawning gravel and riffle areas, increasing side channel diversity, recontouring channels and isolating predator habitat.	2,000,000
A-1	Restore habitat for salmon migration, spawning and rearing on the Stanislaus River by renovating approximately 11,400 square yards of spawning and rearing habitat and modifying approximately 14,600 linear feet of channel.	1,925,000
A-1	Construct an effective escape channel in the west corner of the Keswick Dam stilling basin to protect salmon and steelhead.	No Estimate
A-1	Remove Sacramento River bank rip-rap and restore anadromous fish habitat.	No Estimate
A-1	Continue acquisition of land and conservation easements to protect the riparian corridor along the Sacramento River.	No Estimate

Anadromous fish habitat restoration actions listed in order of priority. (Page 3 of 4)

Priority	Anadromous Fish Habitat Restoration Action	Cost
A-1	Continue planting riparian vegetation along the banks of the Sacramento River.	No Estimate
A-1	In the absence of a water exchange program, install fish screens on the agricultural diversion in Battle Creek.	110,000
A-1	Improve fish passage at Eagle Canyon in Battle Creek.	5,000
A-1	Screen all unscreened hydropower diversions in Battle Creek.	900,000
A-2	Correct fish passage and flow fluctuation problems at Anderson-Cottonwood Irrigation District's diversion dam on the Sacramento River.	No Estimate
A-2	Screen the larger diversions along the Sacramento River.	No Estimate
A-2	Purchase land adjacent to Clear Creek to preserve remaining sources of spawning gravel.	1,000,000
A-2	Manage agricultural return flows from Colusa Drain and Sutter Slough to control water temperatures in the Sacramento River and install barriers to upstream migration.	No Estimate
A-2	Improve spawning and rearing habitat in Butte Creek.	200,000
A-2	Improve spawning and rearing habitat in the Yuba River.	1,000,000
A-2	Avoid peaking power operations at Oroville Reservoir when storage is at or below 1.7 million acre-feet.	No Estimate
B-1	Upgrade existing fish screens in the Mokelumne River at Woodbridge Irrigation District's diversion.	2,000,000
B-1	Improve upstream fish passage in the Mokelumne River at Woodbridge Irrigation District Dam.	100,000 to 700,000
B-1	Install fish screens in the Mokelumne River at North San Joaquin Water Conservation District diversions (north and south).	300,000
B-1	Improve spawning habitat on the Mokelumne River by addition of approximately 23,000 cubic yards of gravel.	500,000
B-2	Require stockpiling of spawning gravel from existing mining operations in Cottonwood Creek for subsequent placement in the Sacramento River.	100,000
B-3	Assist the City of Chico in eliminating siltation problems at One Mile Dam on Big Chico Creek.	50,000
B-3	Protect and manage riparian habitat along the Yuba River.	100,000 per year
C-1	Screen, as needed, any diversion on Cow Creek (each diversion <5 cfs) that entrains juvenile salmon or steelhead.	180,000
C-1	Install fish screens on all major water diversions in Bear Creek.	No Estimate

Anadromous fish habitat restoration actions listed in order of priority. (Page 4 of 4)

Priority	Anadromous Fish Habitat Restoration Action	Cost
C-1	Construct fish passage facilities in the Calaveras River at Bollota Weir (Mormon Slough Diversion), Clements Dam (Clements Road Bridge), and Cherryland Dam, unless sufficient flow is obtained for adult salmon passage.	150,000
C-2	Fence riparian corridors to exclude livestock from Cow Creek.	800,000
C-2	Construct a fish passage structure over the Corning Canal siphon in Elder Creek.	250,000
C-2	Replenish gravel on reconstructed spawning riffles in Paynes Creek as needed.	3,000 per year
C-2	Renovate existing spawning gravel in Mill Creek.	100,000
C-2	Construct gravel detention structures in Mill Creek to provide new or additional spawning areas.	500,000
C-2	Restore spawning gravel in the North Fork of Battle Creek.	50,000
C-3	Construct a barrier at the mouth of Crowley Gulch on Cottonwood Creek to prevent entry of adult fish.	50,000
C-3	Restore spawning gravel in the lower reach of Deer Creek.	100,000
C-3	Dredge behind Saeltzer Dam on Clear Creek to provide a sediment trap.	50,000
TOTAL	**Total does not include actions where no estimate is listed under cost. Inclusion of actions where no estimate is provided will add substantially to the overall total.**	**$343,292,000**

APPENDIX 3
CENTRAL VALLEY ACTION PLAN: ADMINISTRATIVE ACTIONS REQUIRED FOR FULL RESTORATION OF ANADROMOUS FISH HABITAT

Administrative actions required for full restoration of anadromous fish habitat listed in order of priority. (Page 1 of 6)

Priority	Administrative Action to Improve Anadromous Fish Habitat	Agency
A-1	Meet flow standards, objectives and diversion limits set forth in all laws and judicial decisions that apply to Central Valley Project facilities.	USBR
A-1	Adopt instream flow, seasonal fluctuations and ramping rates for the Sacramento River as recommended by California Department of Fish and Game (CDFG) in the D-1630 hearings: Shasta Reservoir carryover storage < 2.8 million acre-feet (AF) October 1 through April 30 — 3,500 cfs May 1 through September 30 — 4,000 cfs Shasta Reservoir carryover storage > 2.8 million AF All Year — 4,500 cfs Ramping rate should not exceed 15 percent in a 12-hour period for flows above 6,000 cfs, 200 cfs per 24-hour period for flows between 4,500 and 6,000 cfs, and 100 cfs per night for flows less than 4,500 cfs.	SWRCB EPA
A-1	Implement Basin Plan objectives for the Sacramento River for all water quality parameters.	RWQCB
A-1	Through negotiations, obtain instream flows for salmon and steelhead in the lower reach of Deer Creek.	CDFG Water Districts
A-1	Continue to provide recommendations to USFS for developing land use policies to protect spring chinook salmon habitat in Mill Creek.	CDFG USFS
A-1	Obtain increased flow in Mill Creek to allow adult and juvenile salmon and steelhead unimpaired passage up and downstream.	CDFG/SWRCB Water Agencies
A-1	Prepare a multi-agency Comprehensive Resource Management Plan for Clear Creek to address excessive erosion in the watershed.	multi-agency
A-1	Obtain increased streamflow below Whiskeytown Dam on Clear Creek to improve migration, spawning and rearing habitat.	CDFG/USBR FERC/SWRCB
A-1	Prepare a salmon and steelhead management and habitat restoration plan for Butte Creek.	CDFG
A-1	Seek amendments to existing water rights and power licenses to provide additional Butte Creek flow for salmon and steelhead.	FERC SWRCB
A-1	Through FERC and water rights processes, obtain increase releases from PG&E power plant diversions in Battle Creek to provide for anadromous fish.	FERC SWRCB

Administrative actions required for full restoration of anadromous fish habitat listed in order of priority. (Page 2 of 6)

Priority	Administrative Action to Improve Anadromous Fish Habitat	Agency
A-1	Negotiate with the Los Molinos Mutual Water Company for additional flow in Antelope Creek for salmon and steelhead.	CDFG Water District
A-1	Establish a program to exchange Antelope Creek surface water for ground water with landowners with existing wells.	CDFG
A-1	Evaluate the benefit of drilling new wells to establish a water exchange program with private landowners who divert Antelope Creek water.	CDFG
A-1	Consider administrative or legal remedies to obtain streamflows in Antelope Creek to ensure restoration of habitat for salmon and steelhead.	CDFG SWRCB
A-1	Develop a comprehensive plan to address fish and wildlife on the San Joaquin River, including streamflow, channel and riparian habitat, and water quality improvements needed to reestablish naturally reproducing anadromous fisheries on the San Joaquin River below Friant Dam.	USFWS/CDFG NMFS/USBR DWR/COE
A-1	Establish interim basin outflow objectives, criteria or standards to protect juvenile salmon and steelhead from April 15 through May 15. The following minimum flow objectives should be adopted for Vernalis on the San Joaquin River April 15 through May 15 during a defined interim period: Water Year Type — Flow (cfs) Wet — 10,000 Above Normal — 8,000 Below Normal — 6,000 Dry — 4,000 Critical — 2,000	SWRCB EPA FERC
A-1	Establish interim basin outflow objectives, criteria or standards to protect upstream migration of adult salmon in the San Joaquin River.	SWRCB EPA
A-1	Establish water temperature protection objectives for the San Joaquin River at Vernalis (fall and spring).	SWRCB EPA
A-1	Require the following interim total annual instream flow releases (acre-feet) on the Merced River for fisheries: Water Year Type — Total Release (AF) Wet — 355,956 Above Normal — 320,514 Below Normal — 267,252 Dry — 218,445 Critical — 181,716	SWRCB EPA FERC
A-1	Require measurement of instream flow requirements at the Crocker-Huffman and Snelling stream gauges on the Merced River.	DWR

Administrative actions required for full restoration of anadromous fish habitat listed in order of priority. (Page 3 of 6)

Priority	Administrative Action to Improve Anadromous Fish Habitat	Agency
A-1	Establish the following water quality objectives on the Merced River for the protection of salmon spawning, rearing and emigration: 56°F maximum water temperature from October 15 through February 15 to protect egg incubation throughout the designated spawning reach from Crocker-Huffman Dam to Cressey. 65°F maximum surface water temperature from April 1 through May 31 to protect emigrating salmon throughout the lower Merced River.	SWRCB RWQCB EPA
A-1	Require adequate instream flow releases for the protection of salmon spawning, rearing and emigration on the Tuolumne River.	SWRCB FERC
A-1	Establish water quality objectives for the protection of salmon spawning, rearing and emigration on the Tuolumne River: 56°F maximum water temperature from October 15 through February 15 to protect spawning and egg incubation throughout the designated spawning reach from LaGrange Dam to Waterford. 65°F maximum surface water temperature from April 1 through May 31 throughout the lower Tuolumne River to protect emigrating smolts.	SWRCB RWQCB EPA
A-1	Require the following interim total annual instream flow releases on the Stanislaus River for fisheries (AF): <u>Water Year Type</u> — <u>Total Release (AF)</u> Wet — 381,498 Above Normal — 325,959 Below Normal — 269,034 Dry — 221,811 Critical — 185,280	SWRCB EPA FERC
A-1	Establish the following water quality objectives on the Stanislaus River for the protection of salmon spawning, rearing and emigration: 56°F maximum water temperature from October 15 through February 15 to protect spawning and egg incubation throughout the designated spawning reach from Goodwin Dam to Riverbank. 65°F maximum surface water temperature from April 1 through May 31 to protect emigrating smolts throughout the lower Stanlislaus River.	SWRCB RWQCB EPA
A-1	Ensure compliance with fish screening requirements in Fish and Game Code Section 6100 for diversions in the Yuba River.	CDFG

Administrative actions required for full restoration of anadromous fish habitat listed in order of priority. (Page 4 of 6)

Priority	Administrative Action to Improve Anadromous Fish Habitat	Agency
A-1	Require the following temperatures and streamflows to protect salmon and steelhead in the lower Yuba River: Maximum Temperature (°F) Period / @Daguerre / @Marysville Oct 1-Mar 31 / 56 / 57 Apr / 60 / 60 May / NR / 60 Jun / NR / 65 Jul-Aug / 65 / NR Sep / NR / 65 Streamflow (cfs) Period / @Marysville Oct-Mar / 700 Apr / 1,000 May / 2,000 Jun / 1,500 Jul-Sep / 450	SWRCB FERC Local Agencies
A-1	Maintain 1.5 million AF of carryover storage in Oroville Reservoir on October 1 of each year to preserve cold water for later release into the Feather River.	DWR
A-1	Adopt new flow release criteria for the Feather River following completion of the Department of Water Resources (DWR) instream flow study.	SWRCB
A-1	Require the following streamflow and temperature standards for the Feather River at the specified locations: At the riffle one mile below Thermolito Afterbay Outlet Period / Streamflow / Temperature (°F) Jan-Apr / 2,000 / 56 May 1-15 / 3,000 / 60 May 16-Jun 15 / 4,000 / 60 Jun 16-Oct 15 / 1,000 / NR Oct 16-Dec 31 / 1,700 / 56 At Shanghai Bend Period Jan-Mar / 2,700 / 56 Apr / 3,000 / 60 May 1-15 / 5,000 / 60 May 16-Jun 15 / 6,000 / 65 Jun 16-Oct 15 / 1,500 / NR Oct 16-Dec 31 / 2,200 / 56	SWRCB FERC DWR

Administrative actions required for full restoration of anadromous fish habitat listed in order of priority. (Page 5 of 6)

Priority	Administrative Action to Improve Anadromous Fish Habitat	Agency
A-1	Prepare and implement a comprehensive plan to restore habitat in Battle Creek for winter and spring chinook salmon and steelhead.	CDFG USFWS
A-1	Develop and implement a mechanism for real-time water projects operations coordination between the Central Valley Project (CVP) and the State Water Project in the Sacramento River Basin.	USBR DWR CDFG
A-1	Seek general plan amendments to establish protection zones for riparian vegetation throughout the Sacramento River Basin.	Local Gov'ts
A-2	Prepare a watershed management and restoration plan for Big Chico Creek.	CDFG/DWR RWQCB/Chico
A-2	Develop and implement a continuing program for the purpose of restoring and replenishing, as needed, spawning gravel lost due to the construction and operation of CVP dams, bank protection projects and other actions that have reduced the availability of spawning gravel and rearing habitat in the Stanislaus River downstream from Goodwin Dam.	USBR DWR CDFG COE
A-2	Develop and implement a continuing program for the purpose of restoring and replenishing, as needed, spawning gravel lost due to the construction and operation of CVP dams, bank protection projects and other actions that have reduced the availability of spawning gravel and rearing habitat in the upper Sacramento River from Keswick Dam to Red Bluff Diversion Dam.	USBR DWR CDFG COE
A-2	Prohibit dredging operations during late summer and fall in the Stockton Ship Channel to protect water quality for anadromous fish.	COE RWQCB
A-2	Develop a plan to increase rearing habitat for juvenile salmon and steelhead in the Yuba River.	CDFG
A-2	Provide additional law enforcement to protect the Stanislaus River salmon habitat through diligent enforcement of screening, water pollution and streambed alteration Fish and Game code sections.	CDFG
A-2	Provide additional law enforcement to protect the Tuolumne River salmon habitat through diligent enforcement of screening, water pollution and streambed alteration Fish and Game code sections.	CDFG
A-2	Provide additional law enforcement to protect the Merced River salmon habitat through diligent enforcement of screening, water pollution and streambed alteration Fish and Game code sections.	CDFG
B-1	Implement RWQCB waste discharge requirements for operation of the One Mile Recreation Area in Big Chico Creek.	Chico CDFG/RWQCB
B-1	Regulate gravel extraction to protect salmon and steelhead spawning areas in the Yuba River.	CDFG County

Administrative actions required for full restoration of anadromous fish habitat listed in order of priority. (Page 6 of 6)

Priority	Administrative Action to Improve Anadromous Fish Habitat	Agency
B-1	After installation of an effective water treatment system at CNFH, allow fall salmon to migrate past the hatchery to spawn naturally in Battle Creek.	USFWS
B-1	Require the following instream flow releases to the American River below Nimbus Dam: Period — Flow (cfs) Oct 15-Feb 28 — 1,750-4,000 Mar 1-Jun 30 — 3,000-6,000 Jul 1-Oct 14 — 1,500	Court SWRCB CDFG USBR
B-1	Establish minimum fall carryover storage at Folsom Reservoir to maintain suitable year-round temperatures in the American River.	SWRCB
B-1	Adopt ramping rate criteria to protect eggs and fry of anadromous fish in the American River.	CDFG USBR
B-1	Develop a coordinated multi-agency management plan for the lower American River.	CDFG/USFWS NMFS/COE USBR/County
C-1	Coordinate and implement an agreement with Anderson-Cottonwood Irrigation District for future canal operations affecting Westside streams.	CDFG ACID
C-1	Continue to coordinate with local agencies to develop and implement sediment control measures for Westside streams.	CDFG Local Gov'ts
C-1	Coordinate with local agencies to develop a program to improve water quality of runoff into Westside streams from urban areas.	CDFG/RWQCB Local Gov'ts
C-2	Require fish passage when issuing permits for the Tehama-Colusa and Corning Canal siphon crossing on Thomes Creek.	COE
C-2	Require all gravel extraction permit applications to provide protection for fish passage in Thomes Creek.	CDFG Tehama County
C-2	Institute an erosion control ordinance to protect salmon habitat in Thomes Creek.	Tehama County
C-2	Reduce sewage discharge into Churn Creek.	RWQCB CDFG
C-2	Institute an erosion control ordinance to minimize sediment input into Elder Creek.	Tehama County
C-2	Obtain increased flow in Paynes Creek to allow adult and juvenile salmon and steelhead unimpaired passage up and downstream.	CDFG/SWRCB Water Users
C-2	Coordinate with local agencies to develop stream overflow areas to attenuate storm water runoff into Westside streams from urban areas.	Local Gov'ts

ACRONYMS USED IN THIS TABLE

ACID	Anderson–Cottonwood Irrigation District
CDFG	California Department of Fish and Game
CNFH	Coleman National Fish Hatchery
COE	(United States Army) Corp of Engineers
DWR	(California) Department of Water Resources
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
NMFS	National Marine Fisheries Service
RWQCB	Regional Water Quality Control Board
SWRCB	State Water Resources Control Board
USBR	United States Bureau of Reclamation
USFS	United States Forestry Service
USFWS	United States Fish and Wildlife Service

APPENDIX 4
CENTRAL VALLEY ACTION PLAN: EVALUATION ACTIONS

Evaluation actions in order of priority. (Page 1 of 3)

Priority	Evaluation Action	Cost
A-1	Evaluate opportunities to reestablish spring salmon and increase late fall salmon and steelhead populations in the Stanislaus River Basin.	$100,000
A-1	Complete water temperature modeling study on the Stanislaus River.	50,000
A-1	Evaluate screening needs and set priorities in the San Joaquin River existing small (< 10 cfs) and medium sized (15 to 250 cfs) diversions.	25,000
A-1	Evaluate fish screening needs at 44 small riparian pump irrigation diversions on the Stanislaus River. Set priorities for installation of screens.	15,000
A-1	Evaluate fish screening needs at 68 small riparian pump irrigation diversions on the Tuolumne River. Set priorities for installation of screens.	15,000
A-1	Evaluate fish screening needs at 68 small riparian pump irrigation diversions on the Merced River. Set priorities for installation of screens.	15,000
A-1	Complete evaluation of spawning, rearing and migration habitat restoration needs on the Stanislaus River.	33,000
A-1	Complete evaluation of spawning, rearing and migration habitat restoration needs on the Tuolumne River.	33,000
A-1	Complete evaluation of spawning, rearing and migration habitat restoration needs on the Merced River.	33,000
A-1	Inventory all water diversions in the Yuba River drainage from Englebright Dam to the Feather River.	25,000
A-1	Conduct an instream flow study on Clear Creek.	300,000
A-1	Conduct a water quality study on Butte Creek.	100,000
A-1	Complete the instream flow study on the Feather River.	10,000
A-1	Complete the instream flow study on Battle Creek.	No Estimate
A-1	Monitor flow and temperatures at the hatchery to ensure Feather River temperature compliance from the Fish Barrier Dam to the Thermalito Afterbay Outlet.	10,000
A-1	Investigate developing a disease-free water supply for Coleman National Fish Hatchery on Battle Creek.	No Estimate
A-2	Evaluate fish passage problems throughout the Deer Creek drainage.	25,000
A-2	Monitor adult salmon and steelhead passage at Saeltzer Dam on Clear Creek.	10,000

Evaluation actions in order of priority. (Page 2 of 3)

Priority	Evaluation Action	Cost
A-2	Monitor fish passage on Butte Creek.	50,000
A-2	Conduct instream flow study on Butte Creek.	150,000
A-2	Develop hydrologic model for Butte Creek.	No Estimate
A-2	Monitor salmon and steelhead passage on Big Chico Creek.	50,000
A-2	Investigate flow/temperature relationship in Mill Creek.	25,000
A-2	Evaluate existing spring chinook salmon and steelhead holding, spawning and rearing habitat in Antelope Creek to identify opportunities for habitat restoration.	No Estimate
A-2	Conduct a fish passage problem survey in lower Antelope Creek.	15,000
A-2	Reestablish the abandoned USGS gauging station upstream of the existing agricultural diversion dam on Antelope Creek.	25,000
A-2	Conduct annual spring chinook salmon snorkel surveys in Antelope Creek.	10,000
A-2	Continue to install and monitor thermographs in the headwaters of Antelope Creek to record summer water temperatures in spring chinook salmon holding area.	5,000
A-2	Install and operate a thermograph and streamflow gauge near the mouth of Antelope Creek to determine flow/temperature relationships.	No Estimate
A-2	Conduct surveys in Antelope Creek for fall and late-fall chinook spawning habitat.	5,000
A-2	Reestablish the Upper Bidwell Park USGS streamflow gauge in Big Chico Creek.	25,000
A-2	Complete a sediment transport and hydrologic study for Big Chico Creek.	100,000
A-2	Install and monitor thermographs in Big Chico Creek.	10,000
A-2	Monitor flow and temperatures in the Feather River at the riffle one mile below the Thermalito Afterbay Outlet.	10,000
B-1	Evaluate opportunities for alternate methods of providing temperature control at New Melones Reservoir on the Stanislaus River (e.g., installation of a temperature curtain, removal of Old Melones Dam).	50,000
B-1	Complete instream flow studies on the lower American River and conduct monitoring as required by court order.	250,000
B-1	Evaluate screening needs at small riparian diversions in the Mokelumne River.	115,000
B-1	Evaluate establishing vegetative cover along the banks of the American River.	No Estimate
B-1	Evaluate the need for gravel restoration in the American River.	100,000

Evaluation actions in order of priority. (Page 3 of 3)

Priority	Evaluation Action	Cost
B–2	Monitor and evaluate spawning gravel quality and quantity in Clear Creek.	75,000
B–2	Conduct a temperature modeling study in Deer Creek below existing diversions.	20,000
B–2	Identify spawning gravel restoration sites in Big Chico Creek.	10,000
B–2	Conduct an inventory of diversions on the Bear River and identify those needing fish screens.	10,000
C–1	Conduct instream flow and stream temperature modeling studies to determine flow needs for spawning and rearing on the Calaveras River.	300,000
C–1	Determine the number and capacity of unscreened water diversions on the Calaveras River. Establish a priority for installing screens.	25,000
C–1	Conduct an instream flow study in Cow Creek to determine migration, spawning and rearing needs for fall and late–fall chinook salmon and steelhead.	No Estimate
C–2	Evaluate the effectiveness of Sacramento River spring pulse flows on the survival of juvenile anadromous fish.	No Estimate
C–2	Develop predictive methodology for Sacramento River hydrology, temperature, fish populations, fish harvest, water development and wetlands.	No Estimate
C–2	Conduct an annual review of gravel operations to ensure unimpaired fish migration in Thomes Creek.	25,000
C–2	Conduct a fish passage study in Thomes Creek.	10,000
C–2	Investigate the feasibility of developing alternate water supplies for diverters in Paynes Creek drainage.	25,000
C–2	Investigate the feasibility of obtaining adequate stream flows for salmon in Stony Creek.	No Estimate
C–2	Investigate the feasibility of constructing a siphon at the Glenn–Colusa Irrigation District canal crossing on Stony Creek.	No Estimate
C–2	Determine adequacy of fish screen at Granlees Diversion Dam on the Cosumnes River.	15,000
C–2	Conduct annual salmon spawning surveys in Bear Creek.	No Estimate
TOTAL	**Total does not include actions where no estimate is listed under cost. Inclusion of actions where no estimate is provided will add substantially to the overall total.**	**$2,999,000**

RIPARIAN HABITAT ACTION RECOMMENDATIONS

All state lands should be examined and existing or potential riparian habitats enhanced and permanently preserved. Federal and local agencies should be strongly encouraged to retain or acquire riparian lands for permanent preservation. Riparian lands suitable for maintenance and restoration should be acquired by fee purchase, easement or deed restriction throughout the Central Valley.

Accelerated regeneration of riparian plant communities should be undertaken on public and private lands , under long–term lease, to establish corridors along streams and wetlands to link riparian plant communities. Acquisition programs for protection or regeneration of riparian lands should target development of corridors to establish linkages between existing valley riparian tracts.

Specific actions recommended for immediate implementation to protect and restore riparian habitat include:

1. Examine all state–owned Central Valley lands and establish riparian areas for permanent restoration and preservation by the California Department of Fish and Game (CDFG) for fish and wildlife.
2. Conduct a fish and wildlife oriented survey of Central Valley streams to identify existing riparian wildlands and areas of high potential for restoration of riparian woodlands.
3. Allocate surface and ground water for restoration and maintenance of key riparian tracts and corridors.
4. Establish a state policy for preservation and restoration of riparian wildland communities as a high priority for all state agencies.
5. Develop and adopt a comprehensive state riparian habitat restoration, preservation and management policy and plan for the Central Valley administered by CDFG under the authority of the Secretary of Resources. Request the Legislature to enact the comprehensive policy.
6. Fully fund an accelerated riparian habitat acquisition program for lands to be administered for fish and wildlife by CDFG.
7. Maximize preservation and restoration of riparian habitats and streamside corridors to meet open space, greenbelt and other wildland and parkland objectives through mandated state and local land use planning and zoning programs.
8. Recognize plants, fish, wildlife and invertebrates with equal emphasis in riparian habitat acquisition, restoration and management programs.
9. Incorporate riparian habitat restoration into all state fish, wildlife, recreation and other land management and environmental restoration programs.
10. Amend the Forest Practices Act to include greater protection for riparian hardwoods through harvest, regeneration and conversion regulations similar to, or more restrictive than, those provided for other commercial species.