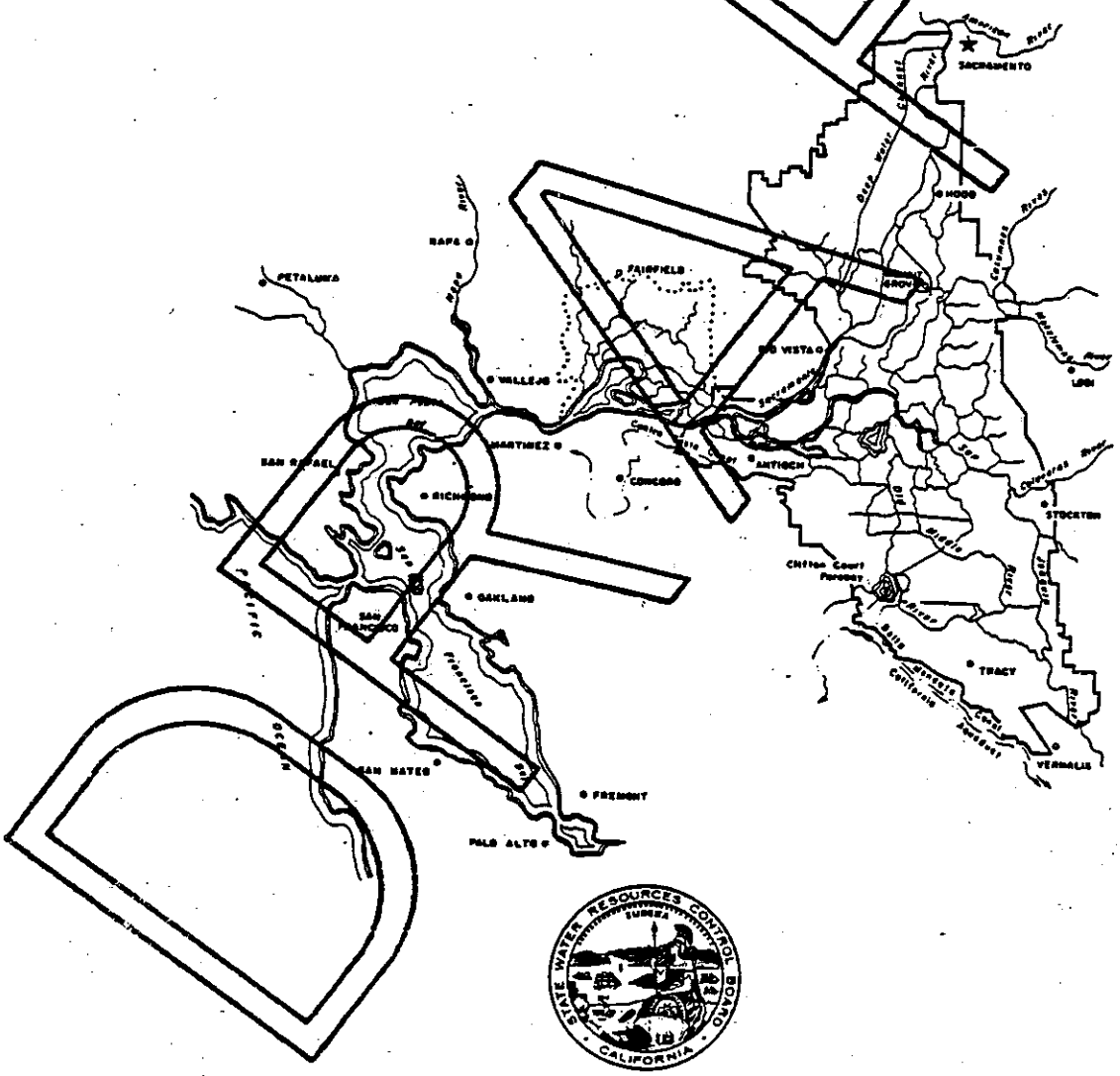
C-WIN 4

Water Quality Control Plan for Salinity

SAN FRANCISCO BAY/SACRAMENTO-SAN JOAQUIN DELTA ESTUARY



OCTOBER 1988

STATE WATER RESOURCES CONTROL BOARD

does not provide an equitable sharing of responsibilities to protect beneficial uses in the Bay-Delta Estuary.

7.3.2.5 Alternative 5

Alternative 5 offers the level of flows for protection of salmon as set forth under Alternative 3. However, outflow protection provided to striped bass is commensurate with that recommended by the DFG and the USFWS. Both the DFG and the USFWS recommended that some reduction in spring exports be achieved. However, neither made specific recommendations. Under this alternative, in April-July exports are established to reflect the conditions that occurred during a time when both striped bass and salmon populations were in much healthier conditions, prior to the increased export of the SWP (1953-1967 - see Figure 4.5.1.2-4). Reducing exports to the period before the SWP does not always provide the positive downstream flow in Old and Middle rivers sought by many fishery groups. Under this alternative, positive flows occur only about 20 percent of the time during April-July. It does reduce the magnitude of reverse flows compared to present conditions. A safe level of exports is not known. However, pre-SWP spring export rates appears to be a reasonable interim goal until a safe level of exports is found.

@ 70,000 AF impact on exports in spring

The average impact on existing and planned spring exports is a decrease of about 0.67 MAF. Compared to the last 15 years of spring exports, they would be reduced by about 0.2 MAF. In order to make up for this decrease in spring exports the CVP and SWP could increase exports in fall and winter months above today's levels as planned in their 1990 operations study. This is possible with existing facilities as shown in DWR's 1990 operations study. These actions would in effect freeze existing total annual exports at about the 1985 levels. The 1985 level of exports is the highest to date and 16 percent higher than the average level of exports since implementation of the 1978 Delta Plan. However, as shown in Chapter 6, this level of Delta supply is sufficient to meet reasonable water demands south and west of the Delta through the year 2010.

7.3.2.6 Alternative 6

Alternative 6 is the no action alternative. As stated previously, continuation of this alternative is expected to result in a decrease in April-June flows in both the San Joaquin River and the Sacramento River at Rio Vista. Exports in the October-April period will increase by at least 0.6 MAF above the highest levels experienced to date. All this will take place while the natural population of salmon continues to decline and the index of young striped bass is at its lowest levels ever recorded. In addition, the southern Delta will continue to receive inadequate protection.

In the face of these decreases in Estuary beneficial use protection and the benefits received by the water use community, the no action alternative appears to be inequitable.

and what actions should be taken; and (2) which factors were considered the most influential on adult and/or young salmon survival and production. Only the fishery agencies and environmental groups advocated levels of protection essentially different from those of the 1978 Delta Plan.

The positions taken by the parties at Phase I of the hearing on Chinook salmon are summarized below and in Tables 5.3.4.2-1 through 5.3.4.2-4:

- SWC (SWC,201,22-27;T,LIX,170:7-173:13)
  - Existing Delta Plan striped bass flow standards should be maintained as the salmon flow objectives until adequate data are available to determine whether changes are required.

Table 5.3.4.2-1 shows what the striped bass flows would be from May 6 through June under the 1978 Delta Plan and represents an estimate of the levels of protection advocated by the SWC, USBR, and DWR. USFWS data were used to calculate the estimated smolt survival index under these flows to compare with levels of protection advocated by other parties. For comparison, Table 5.3.4.1-3 gives an estimate of controlling flows during the entire April through June smolt emigration period.

- DWR (T,XLIII,219:2-221:8)
  - The existing striped bass standards should be the salmon standards.
  - Recent historical levels of catch and escapement are already being maintained.
- USBR (T,LXI,120:24-131:6)
  - Natural salmon production should be increased.
  - A system-wide management plan that addresses conditions in all salmon habitats should be developed.
  - Structural solutions, such as screens, to improve Delta survival would be preferred to flow increases since they would minimize impacts on other beneficial uses.
  - Continue interagency studies and refine monitoring to determine effectiveness of new programs.
  - Allow operational flexibility to respond to recommendations of the five-agency salmon group, composed of the USFWS, DFG, NMFS, DWR and USBR, recently formed to reduce or solve salmon problems identified in the Phase I hearings.

Table 5.3.4.2-1--Recommended Salmon Flow Standards with present Delta Plan Delta Outflows for Striped Bass (SWC, USBR, DWR). (USFWS survival index values are shown in parentheses).

Period	Water Year Type					
	Wet	Ab. Norm.	B. Norm.	Subnormal Snowmelt	Dry[1/]	Dry or Critical[2/]
	Flow in cfs					
May 6-31	14,000 (0.53)	14,000 (0.53)	11,400 (0.38)	6,500 (0.11)	4,300 (0.0)	3,300 (0.0)
June	14,000 (0.53)	10,700 (0.34)	9,500 (0.27)	5,400 (0.04)	3,600 (0.0)	3,100 (0.0)

[1/] Dry year following a wet, above normal or below normal year, from D-1485 Table 2

[2/] Dry year following a dry or critical year

- Do not change existing standards until the recommendations of the five-agency salmon group can be evaluated.

- DTAC, TID/MID (TID/MID,Brief,9-14)

  - The smolt survival index should not be used as a standard.

- USFWS (USFWS,31,31d-j and 47)

  - Sacramento Basin fall run smolts should be protected April 1 through June 30 and San Joaquin Basin smolts from April 1 through June 15.

  - Sacramento River flows at Rio Vista, depending on water year type, should range from 21,500-10,000 cfs and provide smolt survival indices at the 1940's level, ranging from 0.95 in wet years to 0.30 in critical years.

  - San Joaquin River flows at Vernalis should range from 12,000-4,000 cfs, depending on water year type.

  - Eliminate reverse flows during smolt emigration.

  - Prevent delays to adult migrants, maintain unobstructed migration route, and maintain DO above 5 mg/l between Stockton and Turner Cut in the fall.

  - Survival goals could be achieved by a combination of flow, operational and physical modifications.

  Table 5.3.4.2-2 summarizes the protection levels recommended by USFWS and other fishery advocates.

- NMFS (T,LXI,22:24-28:4)

  - In the Sacramento River system, Delta smolt survival for all four races should be that which occurred under 1940 levels of water development (see Table 5.3.4.2-2).

  - The Water Quality Control Plan should contain a blend of physical and operational management measures as well as some increment of flow increase to improve smolt survival.

  - Interim standards should be established for the San Joaquin River system to improve salmon production.

- DFG (T,XLIII,76:24-80:24;DFG,64, and DFG,30)

  - Survival of each race in the Delta should be based on 1940 historical levels (see Table 5.3.4.2-2).

Table 5.3.4.2-2--Recommended Objectives for Chinook Salmon (USFWS,DFG,NMFS) (from USFWS,31d-i and 47)

Water Year Type	Sacramento Basin Smolts: April - June Survival Index	Sacramento Basin Smolts: April - June Rio Vista Flow (CFS)
Wet	0.95	21,500
Above Normal	0.85	20,000
Below Normal	0.75	18,000
Dry	0.65	16,000
Critical	0.30	10,000

1. Keep smolts out of central Delta.
2. Keep temperatures below 66 degrees F.
3. Keep smolts out of upper Old River.
4. Positive net flow in the San Joaquin, Old, and Middle rivers.

San Joaquin Basin Smolts

1. Same survival levels as for the Sacramento Basin.
2. Vernalis in flows ranging from 12,000 cfs in wet water years to 4,000 in critical water years.

Central Valley Adults

1. Maintain unobstructed migration route.
2. Dissolved oxygen $\geq$ 5 mg/1 between Stockton and Turner Cut on the San Joaquin River.

- Survival rate for Sacramento Basin fall run salmon should based on the USFWS flow-to-survival relationship in Exhibit 31.

- Eliminate flow reversals by 1995 in the San Joaquin River and in Old and Middle rivers.

- Survival levels in the San Joaquin River should also be based on historical levels but these still need to be defined.

- Physical and operational measures should be considered to achieve protection.

- EDF (EDF,23)

  - USFWS flows recommended for Sacramento Basin smolt migration should be adopted.

  - Vernalis flows should range from 11,000-5,000 cfs depending on water year type.

  - Delta outflows should range from 31,000-10,000 cfs, depending on water year type.

  Table 5.3.4.2-3 summarizes the flow conditions recommended by EDF.

- BISF (BISF,Brief,85-86 and 93-98)

  - The spring Delta outflows at Chipps Island, measured as a combination of Sacramento and San Joaquin River flows, should not be less than 38,500 cfs averaged over three to five year periods.

  - Outflows could be reduced in dry years provided compensating flows are available in other years.

  - There should be objectives for wet, median and dry year spring flows at levels greater than D-1485.

  - Endorses other measures proposed by USFWS.

  Table 5.3.4.2-4 summarizes the standards recommended by BISF.

5.3.4.3 Optimal Levels of Protection

Evidence presented in Phase I of the hearing indicates that Delta Plan objectives do not fully protect all the different life stages of Chinook salmon using the Estuary. The parties presenting evidence at the hearing reviewed much of the same data and generally agreed that under existing conditions the Delta is a source of significant mortality for smolts emigrating from upstream areas. This section summarizes available information on the factors contributing to reduced

Table 5.3.4.2-3--Recommended April-June Salmon Smolt Migration Standards (EDF)
(from EDF,23)

Water Year Type	Annual Survival Index Goal	Sacramento R. Rio Vista (cfs)	Sacramento R. Freeport (cfs)	Diversion[1/] Above RV (cfs)	San Joaquin R. at Vernalis (cfs)	Total River (Freeport + Vernalis)	Estimated[4/] Export + Ch. Depl.- E. Side (cfs)	Estimated Delta Outflow (cfs)
Wet	0.95	22,000	26,000	4,000[2/]	11,000	37,000	6,000	31,000
Above N.	0.86	20,000	24,000	4,000[2/]	10,000	34,000	7,000	27,000
Below N.	0.75	18,000	22,000	4,000[2/]	9,000	31,000	8,000	23,000
Dry	0.65	16,000	20,000	4,000[2/]	8,000	28,000	9,000	19,000
Critical	0.30	10,000	15,000	5,000[3/]	5,000	20,000	10,000	10,000

1/ From DWR Exhibit 50
2/ Cross Channel closed, Georgiana Slough only
3/ Cross Channel and Georgiana Slough
4/ Based on recent historic DAYFLOW records

Table 5.3.4.2-4--Recommended Salmon Smolt Protection Levels (BISF)
(BISF,Brief,85-86 and 93-98)

Controlling Year Type	Period	Protection Level (Delta Outflow in cfs)[1/]	Beneficial Use
Wet Years (wettest 10%)	Apr-Jun	38,500-42,000	salmon smolts, striped bass, shad
Median Years (years between wet and dry)	Apr-Jun	38,500-42,000	salmon smolts
Dry Years (driest 10%)	Apr-Jun	10,000	salmon smolts

1/ Combined Sacramento and San Joaquin River flows to meet outflow

To address this problem in the San Joaquin River, an agreement was reached in 1969 among the USBR, DWR, and DFG (an agreement still in effect although not incorporated into the 1978 Delta Plan conditions) under which DWR monitors DO levels in the San Joaquin River between Stockton and Turner Cut (Stockton Ship Channel) during the fall migration. If DO drops below 6 mg/l, a temporary rock barrier is installed across the head of Old River to increase San Joaquin River flows past Stockton thus improving DO levels (T,XXXVII,85:4-22). Better treatment of cannery wastes since 1978 (reducing the biochemical oxygen demand) and improved flows and water quality from New Melones Reservoir operations were reported to have helped alleviate this problem (USFWS,31,94). Since then, the Old River barrier has been installed in the fall of 1979, 1981, 1984 and 1987 (H. Proctor,DWR,pers.comm).

- Recommendation: For the protection of adult Chinook salmon migration in the Estuary, there should be downstream flows in the Sacramento River equal to or greater than those required under the 1978 Delta Plan for salmon migration. Minimum flows in the San Joaquin River past Stockton should be 500 cfs from July through November for protection of fall run upstream migration. DO should not fall below 6 mg/l in the San Joaquin River between Stockton and Turner Cut during these months.

  The theoretical objectives which would provide optimal protection for salmon in the Estuary are summarized in Table 5.3.4.3-5.

5.3.5 Striped Bass

5.3.5.1 No Action Alternative:

Striped bass are included specifically in the beneficial uses protected under the Delta Plan (Table VI-1, pp. VI-31-33,35). Included are specific electrical conductivity and flow standards as well as certain operational constraints required of the SWP and CVP. These standards evolved out of negotiations conducted among DFG, DWR, USFWS, and USBR prior to the Delta Plan hearing as part of a draft Four-Agency agreement; this agreement was never implemented (DFG,25,133). These standards have not accomplished the intended goal of maintaining the actual Striped Bass Index (SBI) at a long-term average of 79 (the so called "Without Project" conditions). Based on a mathematical relationship (predicted SBI; see below) developed by DFG, the actual SBI under the Delta Plan (1979-1985) should have averaged about 65 (corrected from DFG,25,134-136 after consultation with DFG staff). In fact, during those years (excluding 1986, in which the index reached predicted levels), the actual SBI averaged 22.4, about one third of the predicted SBI (corrected from DFG,25,136). In 1988, the actual SBI reached an all-time low of 4.6.

Table 5.3.4.3-5--Optimal Levels of Protection for Salmon

Time Period	Location	Objective/Action	Use Protected
July 1-November 30	San Joaquin River between Stockton and Turner Cut	Maintain DO $\geq$ 6 mg/1	Adult Migration (fall run)
July 1-November 30	San Joaquin River at Stockton	500 cfs flow	(fall run)
All Year	Sacramento River	flows $\geq$ Delta Plan	(all runs)
January-1 April-30	Delta Cross Channel	Close gates under below normal, dry, and critical water years	Fry Rearing (fall run)
April-1 June-30	Delta Cross Channel	Close gates	Smolt Emigration (fall run)
April-1 June-30	Sacramento R. at Rio Vista	22,500 cfs flow	Smolt Emigration (fall run)
April-1 June-30	San Joaquin R. at Vernalis	20,00 cfs flow	Smolt Emigration (fall run)
April-June-30	Delta pumping plants	No exports	Emigration/ Rearing (fall run)

The actual SBI is a value obtained after extensive field sampling and measuring of larval striped bass each summer. This value is a measure of the relative abundance of young striped bass in the Estuary when their average length is 38 mm (1.5 inches). It is called an index because it is a relative value and is not directly translatable into an absolute value of the number of larvae in the Estuary. However, it is a legitimate and relatively sensitive measure of the change in abundance of larvae between years. The actual SBI tends to underestimate the larval abundance in very high outflow years (such as 1983) because many of the larvae are carried downstream beyond the DFG sampling stations. The actual SBI has been measured every year since 1959, except 1966.

The actual SBI is not the only measurement of striped bass populations. A variety of sampling programs are employed in monitoring various components of the striped bass population (Table 5.3.5.1-1). While the decline rates and patterns may vary somewhat, all programs measuring striped bass abundance show large declines from the levels measured in the 1960's (DFG,25,6:25,9).

Table 5.3.5.1-1--Methods to Assess Population Levels of Striped Bass

ADULTS

1. Petersen Estimate--Mark and recapture method; 1969 to present; in Delta and Sacramento River; statistical analysis of number of fish recaptured which were marked in previous years.

2. Catch Per Unit Effort (CPUE) Index--Index of population based on number of fish caught per standardized unit of time; same locations as for Petersen estimate; 1969 to present except 1977, 1978, and 1981; possibly more reliable than Petersen estimate (DFG,25,Appendix 1).

3. Tag Returns--1958 to present, except 1962-1964 and 1967-1968; analysis of tags returned by fisherman; provides basis for comparison of fishing vs. "natural" mortality.

4. Party Boat Census--Annual reports submitted by party boat operators; provides information on numbers of fish caught, number of angler-days, and related information.

5. Creel Census--Informal surveys of shorelines, piers and private boats to examine catch rates, fish sizes and other information for other than party boat operations; done sporadically, with reduced effort in recent years.

EGGS, LARVAE AND JUVENILES

1. Petersen Fecundity Estimate--Annual since 1977; combines Petersen population estimate with fecundity (egg number) data from Striped Bass Health Monitoring Program, with certain correction factors (age and number of fish spawning) to estimate total number of eggs produced.

2. CPUE Fecundity Index--Uses same procedure as above except that uses catch per unit effort (CPUE) index value for number of spawing females rather than Petersen estimate.

3. Egg and Larva Survey--Area sampled variable but standardized in recent years to Suisun Bay, central and western Delta, and Sacramento River to Colusa; 1966-1973, 1975, 1977, 1984-1986; intensive sampling at 75 stations in spring to monitor number, growth, movement and mortality of larvae up to about 14 mm in length; Sacramento River stations also monitor egg abundance and movement.

4. Tow Net Survey--1959 to present except 1966; Delta and Suisun Bay; biweekly sampling at 30-40 stations in summer until average length of larvae exceeds 38 mm length; provides index of abundance (actual Striped Bass Index, or SBI) and distributional information.

5. Midwater Trawl--Throughout Bay-Delta Estuary up to Rio Vista and Clifton Court Forebay; 1967 to present except 1974 and 1979; typically monthly tows between September and December at a variable number of stations; gives measure of young-of-the-year abundance; more variable than SBI.

Table 5.3.5.1-1 (Continued)

RELATED SURVEYS

1. Salvage Records--Provides numbers of fish salvaged from Skinner Fish Protective Facility in Clifton Court Forebay; annual from about 1970 to present; provides general estimate of population trends and densities based on number salvaged over time.

2. Striped Bass Health Monitoring Program--1978 to present, not all years; 1984 to present under consistent format; analysis of tissues of 40 prespawning adult female fish from Rio Vista and Antioch; provides samples for fecundity data.

3. Other--Various other special purpose studies which provide special information on striped bass (Export Curtailment Study, gut content analysis, spring die-off monitoring, etc.).

There has been considerable confusion in the testimony concerning whether the SBI in the Delta Plan has "worked" or "failed." This is because the Delta Plan set standards based on a predicted SBI, a mathematical formula based on the relationship of the historical record of larval abundance (actual SBI) to spring Delta outflow and exports. This formula provided a prediction of what the SBI ought to be, given certain flow and export conditions, and it was used to develop the export and outflow standards in the Delta Plan. The discrepancy between the actual and the predicted SBI is the reason that some participants stated that "the SBI has failed". However, the actual SBI has not failed. It continues to provide a comparative measure among years. In fact, the actual SBI simply reflects the fact that the Delta Plan standards have been inadequate to maintain striped bass at 1975 levels, much less restore them to "without project" levels.

The actual SBI is the sum of two separate indices: The Suisun Bay index and the Delta index (Table 5.3.5.1-2). Throughout the 1960's, the Delta index has been the major contributor to the overall actual SBI (Figure 5.3.5.1-1). Generally in the 1970's and 1980's the actual SBI declined, in large part because of the decline in the Delta index (Figure 5.3.5.1-2). As shown in Table 5.3.5.1-2, during the period 1959-1970 (except 1966) the Delta index was greater than 60 percent of the total actual SBI in five of eleven years, and was less than 40 percent of the total actual SBI in only one year (1967). By contrast, during the 18-year period 1971-1988, during which a significant increase in Delta exports had occurred (see section 5.3.5.3), the Delta index was greater than 60 percent of the total actual SBI in only two years (1977 and 1988, both critically dry years with very low outflow and low SBI's), and was less than 40 percent of the total actual SBI in 12 of 18 years. For the ten-year period in which the Delta Plan standards were in effect (1979-1988), the Delta index was greater than 60 percent of the total actual SBI only in 1988, and was less than 40 percent in seven of the ten years. These results indicate a substantial shift in the survival patterns of striped bass larvae in recent years. The probable reasons for this shift are discussed in Section 5.3.5.3.

5.3.5.2 Advocated Levels of Protection

The extensive testimony and exhibits presented on striped bass emphasize the point that, despite years of study, there is no consensus on the causes of the striped bass decline. As a result, two main and highly divergent approaches to the problem evolved during Phase I of the hearing. These approaches may be summarized as follows:

TABLE 5.3.5.1-2 STRIPED BASS INDEX DATA

YEAR	YEAR TYPE (1)	YEAR TYPE (2)	DATE SET	JULIAN DATE	DELTA INDEX	SUISUN INDEX	TOTAL INDEX	5-YEAR RUNNING AVERAGE	DELTA % OF TOTAL	PRED. INDEX	ACTUAL % OF PRED.
1959	D	D	JULY 12	193	30.7	3.0	33.7	-	91.1	34.1	98.8
1960	BN-SNSM	D	JULY 17	199	32.0	13.6	45.6	-	70.2	55.1	82.8
1961	D	D	JULY 21	202	25.2	6.4	31.6	-	79.7	45.5	69.5
1962	BN	BN	JULY 26	207	46.8	32.1	78.9	-	59.3	79.1	99.7
1963	W	W	AUG 03	215	38.2	43.5	81.7	54.3	46.8	87.3	93.6
1964	D	D	AUG 02	215	54.7	20.7	75.4	62.6	72.5	63.3	119.1
1965	W	W	JULY 31	212	49.4	67.8	117.2	77.0	42.2	87.7	133.6
1966	BN-SNSM	BN	NOT DETERMINED						NOT DETERMINED		
1967	W	W	AUG 12	224	35.1	73.6	108.7	95.8	32.3	92.7	117.3
1968	BN-SNSM	D	JULY 19	201	39.6	17.7	57.3	89.7	69.1	44.5	128.8
1969	W	W	AUG 09	221	33.6	40.2	73.8	89.3	45.5	92.7	79.6
1970	W-SNSM	D	JULY 18	199	36.6	41.9	78.5	79.6	46.6	66.8	117.5
1971	W	W	AUG 11	223	24.6	45.0	69.6	77.6	35.3	83.4	83.5
1972	BN-SNSM	BN	JULY 25	207	13.4	21.1	34.5	62.7	38.8	33.7	102.4
1973	W	BN	JULY 15	196	15.6	47.1	62.7	63.8	24.9	53.8	116.5
1974	W	W	JULY 22	203	17.4	63.4	80.8	65.2	21.5	63.1	128.1
1975	AN	W	JULY 30	211	23.4	42.1	65.5	62.6	35.7	83.8	78.2
1976	C	C	JULY 16	198	21.1	14.8	35.9	55.9	58.8	45.6	78.7
1977	C	C	JULY 24	205	8.3	0.7	9.0	50.8	92.2	47.5	18.9
1978	W	AN	JULY 23	204	16.5	13.1	29.6	44.2	55.7	65.1	45.5
1979	D	BN	JULY 19	200	5.4	11.5	16.9	31.4	32.0	54.9	30.8
1980	W	BN	JULY 15	197	2.8	11.2	14.0	21.1	20.0	80.5	17.4
1981	D	C	JULY 02	183	15.4	13.7	29.1	19.7	52.9	58.0	50.2
1982	W	W	JULY 30	211	9.5	39.2	48.7	27.7	19.5	79.3	61.4
1983	W	W	AUG 05	217	1.2	14.2	15.4	24.8	7.8	78.3	19.7
1984	W-SNSM	BN	JULY 13	195	6.3	20.0	26.3	26.7	24.0	68.6	38.3
1985	D	D	JULY 16	197	2.2	4.1	6.3	25.2	34.9	34.1	18.5
1986	W-SNSM	BN	JULY 09	190	23.8	41.1	64.9	32.3	36.7	65.1	99.7
1987	C	C	JUNE 22	173	7.3	5.3	12.6	25.1	57.9	43.5	29.0
1988	C	C	JULY 24	206	3.9	0.7	4.6	22.9	84.8	N.D.	N.D.

NOTES:

1. WATER YEAR TYPE (1) = BASED ON 1978 DELTA PLAN STANDARDS
2. WATER YEAR TYPE (2) = BASED ON PROPOSED SACRAMENTO VALLEY APRIL - JULY FORMAT
3. WATER YEAR TYPE CODE: W=WET; AN=ABOVE NORMAL; BN=BELOW NORMAL; D=DRY; C=CRITICAL; SNSM=SUBNORMAL SNOWMELT
4. 5 YEAR RUNNING AVERAGE INCLUDES 4 YEARS ONLY FOR 1967 - 1970
5. N.D. = NOT DETERMINED

FIGURE 5.3.5.1-1 STRIPED BASS INDEX

(NO SAMPLE IN 1966)

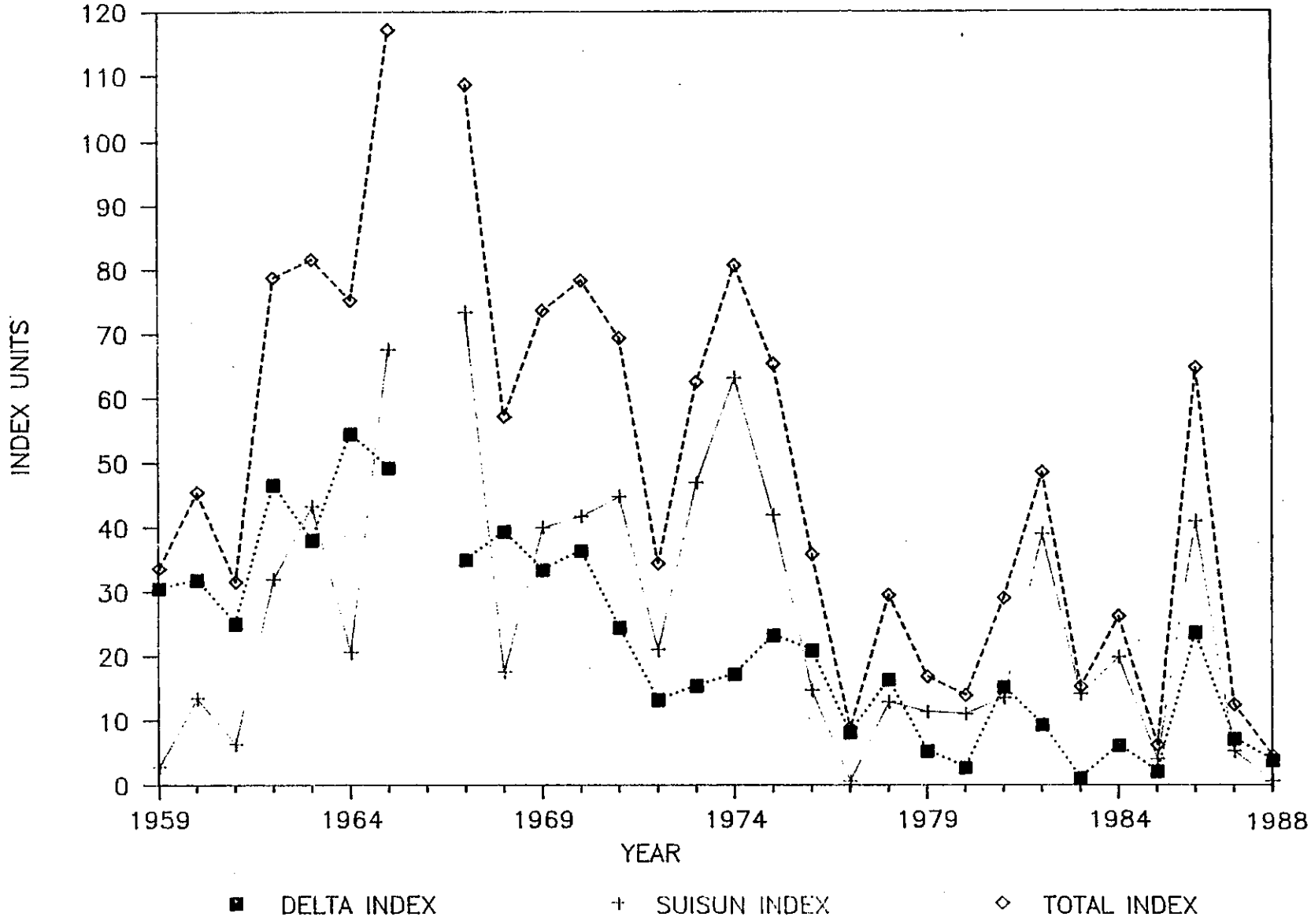
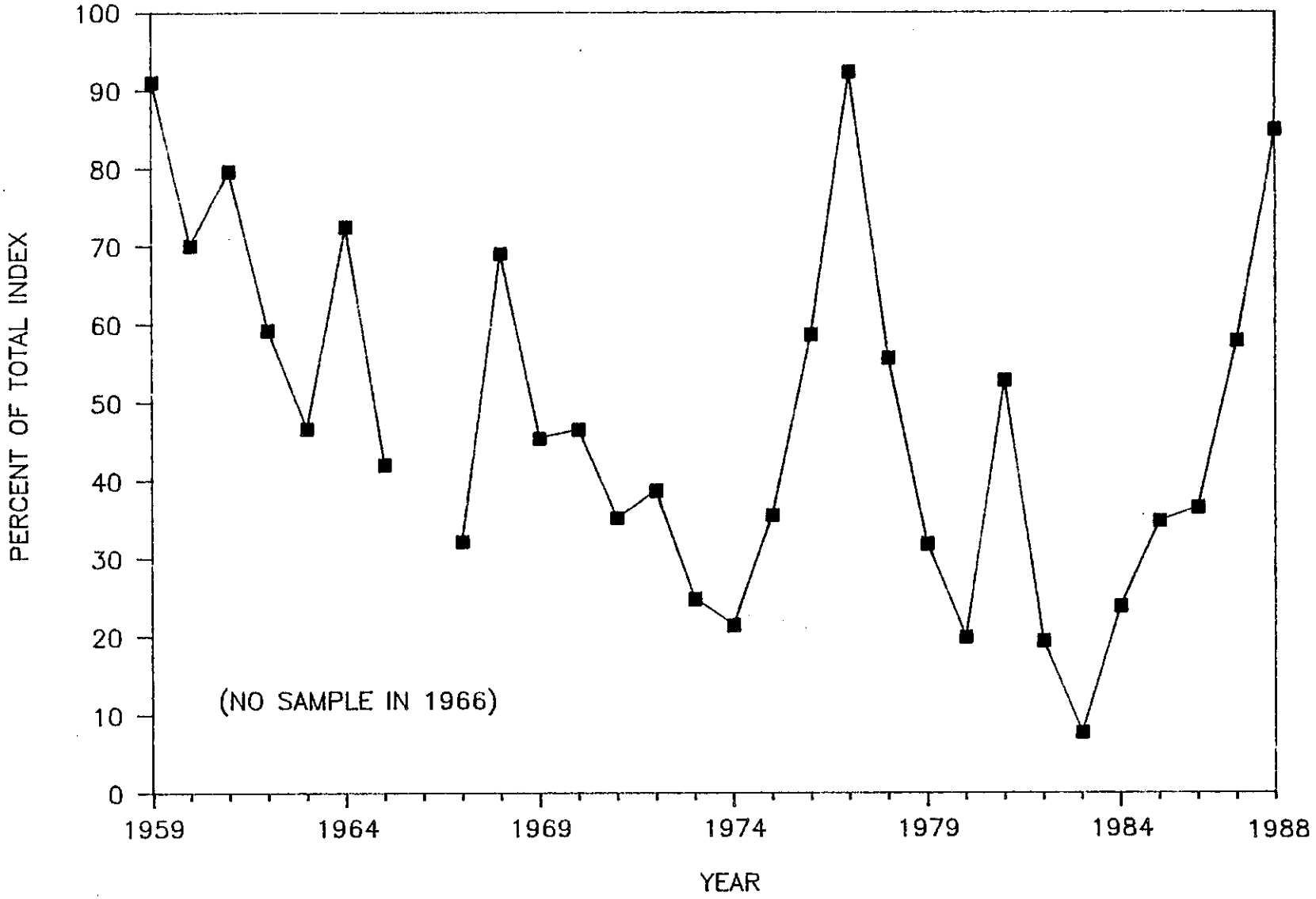


FIGURE 5.3.5.1-2 DELTA STRIPED BASS INDEX

AS PER CENT OF TOTAL ACTUAL STRIPED BASS INDEX



- Retain Present Standards

  Because there is no agreement on what to do about striped bass, it was suggested that the present Delta Plan standards be retained for the most part until "cause and effect" relationships have been determined. This position was advocated by SWC, DWR, and others (SWC,203,4;DWR,602,2). SWC proposed five major hypotheses for the possible decline of striped bass (SWC,203,22). Four of these involve the effects of water export either directly or indirectly. The SWC, among others, advocate an extensive series of experiments to test these various hypotheses; but in the meantime, the current standards should be retained except to facilitate performing these tests. This approach is discussed further in Section 5.3.5.3.

- Change the Delta Plan Standards to Attempt to Provide Additional Protection

  This position was advocated by DFG, USFWS, EDF and others. The main argument here is that striped bass are not being protected by the Delta Plan standards, and the population is in serious decline. Therefore, something must be done now, even if all the reasons for the decline are not known; enough is known to at least proceed in some areas.

  The major proposal for changed objectives was put forth by DFG (DFG,64,6-12) with support from USFWS in their own recommendations (USFWS,47,5-6). Both agencies called for short-term measures, primarily in the form of greatly increased outflow and changes in the operation of the Delta Cross Channel gates. Long-term proposals included recommendations for eliminating reverse flows in the San Joaquin River by 1995, examination of new Delta water transfer facilities, possible operational changes, and evaluation of current research and monitoring programs required by the Delta Plan (DFG,64,14-19).

  The overall goal of DFG was to achieve an annual production of young striped bass equal to a long-term average actual SBI of 106, which they determined was the "historical level" (DFG,64,6). DFG believes this is not a realistic objective in the near future (DFG,64,6) and cannot be achieved with their present state of knowledge about striped bass (T,LX,102:24-103:16). In fact, DFG estimated that their increased flow recommendations and other changes would, on average, increase the SBI only to 28, which is six points, i.e., 25 percent, higher than the average of the 1979-1985 period (T,LX,102:3-21). The proposed flow objectives do not call for increased flow beyond the levels presently required under the Delta Plan for critical years, or for dry years following dry or critical years (DFG,64,6; T,LX,82:2-4). No changes in exports are proposed except that a limit of 5,000 cfs total diversions would be imposed in May and June, rather than the present 6,000 cfs, when water is being withdrawn from storage for export (DFG,25,7;T,LX,82:11-15).

A larger percentage of total Delta inflow is exported under low flow conditions in the Delta; this provision would somewhat reduce impacts on striped bass larvae. DFG also proposed expansion of the provision for closure of the Delta Cross Channel gates to include the ability to request closures when the Delta Outflow Index is less than 12,000 cfs. Under the Delta Plan, DFG can request closure of the gates only when the Delta Outflow Index is greater than 12,000 cfs. DFG did not recommend any change in the length of the period during which such requests can be made (April 16--May 31 in all years). All other Delta Plan standards would remain in effect (DFG,25,7).

USFWS proposed flow objectives and operational changes similar to DFG as short-term measures, as well as similar long-term recommendations, such as elimination of reverse flows in the lower San Joaquin River (USFWS,47,5-6). However, they also proposed that outflow be not less than 10,000 cfs during the May through July period "to keep larvae and young-of-the-year [striped bass] in Suisun Bay and maintain the null zone (spring-summer) no further [upstream] than Honker Bay" (USFWS,47,5). This contradicts their own recommendation in support of the Delta Plan flow standards, per DFG, for critical years, and dry years following dry or critical years. No testimony was presented to resolve this contradiction.

EDF also proposed increased outflow standards (EDF,25). The recommendations are similar to, and are based on DFG recommendations, but include a multiplier factor of 1.5 in May, 1.0 in June, and 0.7 in July to the recommended May-June flow increases to adjust for the greater densities of eggs and larvae which are present in the earlier months (T,LVII,78:21-79:4). The recommended flow levels were expected to provide survival approaching "without project" levels. However, it was EDF's opinion that protection at "historic levels" would require higher levels than those recommended; EDF did not determine what those flow levels might be (T,LVII,79:5-18). In some years, the recommended flows would actually be greater than unimpaired flows (T,LVII,80:7-81:5).

5.3.5.3 Optimal Levels of Protection

The striped bass problem in the Estuary is very complicated, and there probably is no single answer to the problem. However, important steps could be taken to protect striped bass that are not being employed at present. Therefore, the recommendation by some participants that the present Delta Plan standards remain in effect is rejected. The striped bass population has declined too much (perhaps in excess of 70 percent since the 1950's) to take no definitive actions to provide additional protection. None of the participants disputed the fact that there is a problem with striped bass, even if they differed on what course to take. The record low 1988 SBI of 4.6 further emphasizes the need to take immediate action.

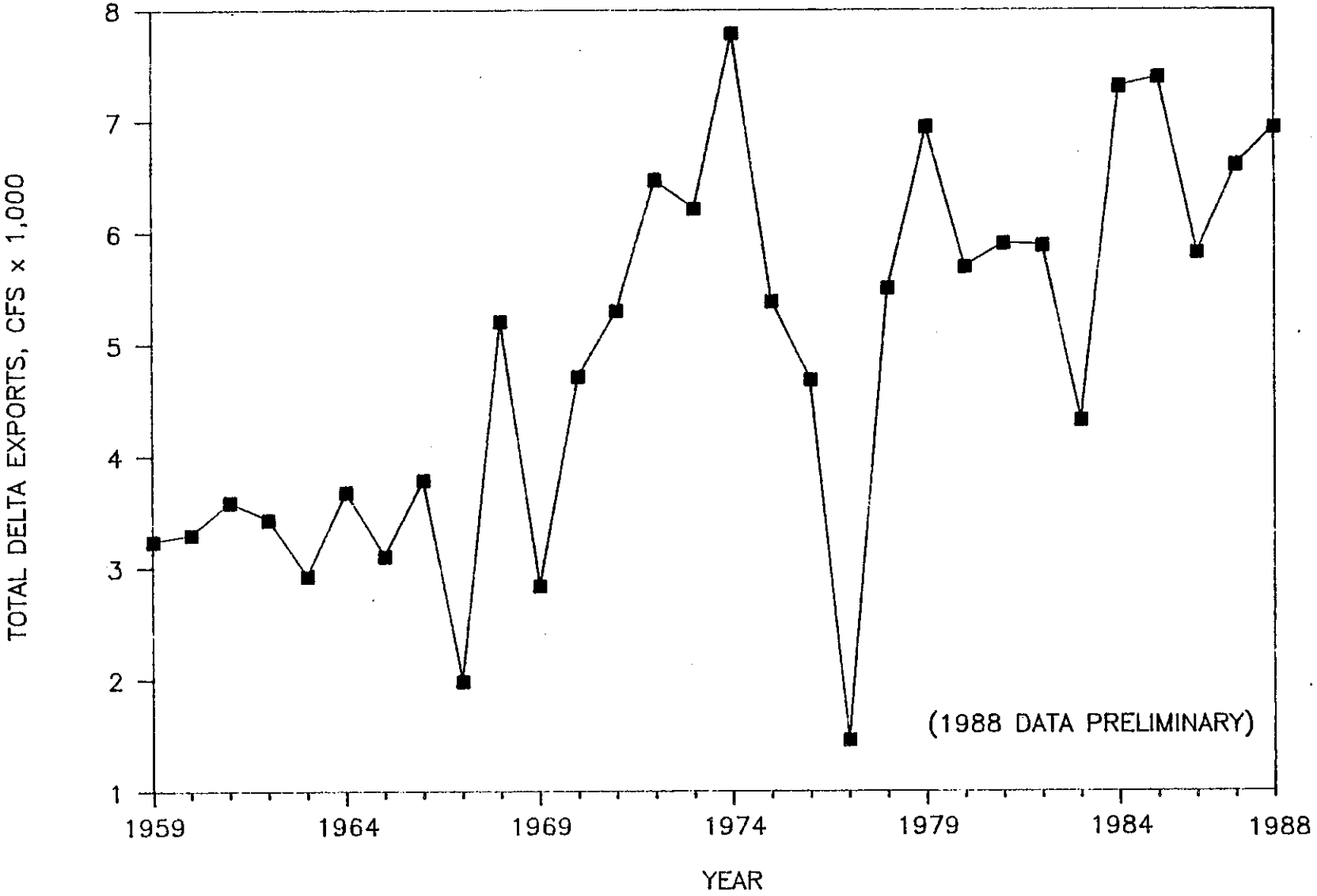
Changes in the Delta Plan are appropriate standards because they are not doing what they were intended to do i.e., provide reasonable protection for striped bass. This beneficial use is not being protected to the extent originally intended by the Board in the Delta Plan; therefore, steps must be taken to provide additional protection. Certain steps have been suggested which are not related to flow and salinity standards, or which are intended to provide "equivalent protection" for striped bass. In general, these proposed actions do not provide equivalent protection or are not relevant to actions included under this Plan. These alternative measures will be discussed in individual sections below as appropriate.

In rejecting continuation of the current Delta Plan standards, it is important to understand why those standards did not work. Spring flow and export standards have not worked because they were being applied to a situation in the Delta which was significantly different from the one under which the data used to develop the formulas for the predictive index were obtained. The original relationship among the predictive SBI, outflows and exports was based on data developed during the period 1959-1970. During this period, exports in the spring were primarily from the CVP, and certain major upstream storage projects (Oroville and New Melones) had not been completed or had not yet had a significant effect on the Delta. As shown in Figure 5.3.5.3-1, total Delta exports (SWP,CVP,and CCC) were relatively constant at about 3,500 cfs during the April through July period. However, during the 1971 through 1976 period, when the decline in the Delta portion of the SBI began to become apparent, total exports for the April through July period increased to an average of 6,000 cfs. When Delta Plan standards for striped bass were in effect (1979-1988), the average April through July total exports were about 6,300 cfs, or 80 percent higher than for the 1959-1970 period, and 45 percent higher than the 1959-1976 period (the period used for development of the predicted SBI in the Delta Plan).

The relationship for the May through July periods, on which the Delta Plan standards were set, shows a similar pattern. Average May through July total Delta exports for the period 1959-1970 were about 3,700 cfs. During the period 1971-1976, the average exports increased to 6,300 cfs. For the period that the Delta Plan standards were in effect (1979-1988), average May-July exports declined slightly from the 1971-1976 period to about 6,200 cfs, due to the export restrictions imposed by the Delta Plan. This restriction represents less than three percent reduction from the 1971-1976 period, when the Delta index was declining. In effect, the Delta Plan standards stabilized exports at post-1970 levels, but did nothing to provide protection comparable to that found under the original relationship from the 1959-1970 period. Under the Delta Plan, average total Delta exports in the months of May, June, and July are still 66 percent higher than the 1959-1970 period, and 34 percent higher than the 1959-1976 period (the period used as the basis for the predictive index).

FIGURE 5.3.5.3-1 TOTAL DELTA EXPORTS

COMBINED SWP, CVP, AND CCC; APRIL – JULY AVERAGE



The direct and indirect effects of these increased exports have most likely been the major factor in the recent decline of striped bass. As noted above, four of the five hypotheses proposed by the SWC are directly or indirectly related to flows and exports. All the participants acknowledge that exports and their attendant effects on flows in the Delta do have deleterious effects on striped bass. Below are presented the particular problems related to striped bass and the proposed recommendations to provide them optimal protection. These recommendations are summarized in Table 5.3.5.3-1. Acceptance or rejection of the proposed objectives of the participants will be discussed. As noted above, the proposal to retain the current standards is rejected.

TABLE 5.3.5.3-1
OPTIMAL LEVELS OF PROTECTION FOR STRIPED BASS

Time	Location	Recommendation	Protection
April 1--June 15 (all years)	San Joaquin R. Vernalis to Antioch Bridge	Maximum daily EC not to exceed 0.3 mmhos/cm	Adult striped bass migration and spawning
April 15--July 31 (all years)	Delta Cross Channel gates	Closed	Reduce translocation of eggs and larvae
April 1--July 31 (all years)	Statutory Delta channels	No withdrawals or exports (except for emergency)	Reduce egg and larva entrainment
April 1--May 31 (all years)	Chipps Island	Daily Delta outflow at least 33,900cfs	Move larvae to Suisun Bay nursery area and keep null zone at Honker Bay or downstream
June 1--June 30 (all years)	Chipps Island	Daily Delta outflow at least 32,400 cfs	Move larvae to Suisun Bay nursery area and keep null zone at Honker Bay or downstream
July 1--July 31 (all years)	Chipps Island	Daily Delta outflow at least 29,100 cfs	Move larvae to Suisun Bay nursery area and keep null zone at Honker Bay or downstream
April 1--July 31 (all years)	Vernalis	San Joaquin River component of Delta outflow equal to or greater than proportion under unimpaired flow	Maintain positive downstream flow in all Delta channels

- Problem 1: Adult Striped Bass Spawning is Affected by Limitations on the Spawning Area.

  DFG has testified that the formation of a salinity barrier in the mainstem San Joaquin River above Venice Island tends to restrict spawning runs and spawning activity in that area (T,XLI,68:1-69:10). DFG also testified, and other evidence shows, that historically striped bass did spawn above the Delta in the San Joaquin River system. Striped bass are not able, under Delta Plan standards, to fully use the historical spawning habitat.

  Current Delta Plan standards provide for a maximum of 0.550 mmhos/cm EC at Prisoners Point, on the San Joaquin River from April 1 to May 5. DFG data (DFG,25,44-46) (shows that striped bass will not migrate through the eastern Delta into areas where EC is greater than 0.55 mmhos/cm. In addition, the majority of striped bass spawn in water with EC less than 0.3 mmhos/cm. Thus, the Delta Plan standard effectively blocks upstream migration of striped bass in the San Joaquin River beyond Prisoners Point in drier years, and may have an impact on spawning as well. The short period of time (35 days) which is covered by the Delta Plan standards may also be inadequate to provide full use of the San Joaquin River migration and spawning habitat.

  There are two aspects to the solution of this problem: Sufficient flows must be provided to break up this salinity barrier, and water quality in the San Joaquin River must be appropriate to promote migration and spawning upstream. Both can be accomplished by providing water of sufficient quality and quantity at Vernalis, provided that exports are not too large to prevent adequate flow down the mainstem San Joaquin River below Mossdale, and that the protection period is of sufficient length to utilize the habitat fully.

  None of the participants proposed any objectives to solve this problem, other than general proposals for greatly increased outflows for striped bass larvae. However, since San Joaquin River flows were not stipulated in these recommendations, it is assumed that this problem was not being specifically addressed.

  Based on evidence received, there appears to be no particular problem for adult striped bass, relative to habitat, in the Sacramento River, or to temperature regimes in either the Sacramento or San Joaquin rivers, since spawning tends to be initiated by increasing temperatures. The effects of warmer water in recent years is discussed below in relation to periods of time in which the objectives should apply.

  - Recommendation 1: Electrical conductivity in the mainstem San Joaquin River from Vernalis downstream to the Antioch Bridge should not exceed a daily maximum of 0.300 mmhos/cm from April 1 to June 15 in all water year types.

- Problem 2: Eggs and Larvae are Translocated into the Central Delta through the Delta Cross Channel and Georgiana Slough.

  Eggs and small larvae of striped bass are carried passively down the Sacramento River and are transported into the central Delta through the Delta Cross Channel and Georgiana Slough. Translocation to the central Delta exposes the eggs and larvae to increased mortality (DFG,25,54). The Delta area is less suitable as a nursery habitat than the Suisun Bay area. Screening is not effective for these small eggs and larvae.

  Existing Delta Plan standards call for closing of the Delta Cross Channel gates when the Delta outflow index (DOI) is above 12,000 cfs, but various conditions apply: DFG must request a closure, the potential closure period is only from April 16 through May 31, the maximum number of days available for closure within this period is 20, and no more than two out of four days may be consecutive. DFG has proposed expanding this standard to include closure when the DOI is less than 12,000 cfs, but for only a total of ten days in the period, and no more than one day out of four. Closure periods should be determined by real-time monitoring (DFG,64,7). The USFWS called for closure of the Delta Cross Channel gates and for modification of export operations "when densities [of eggs and larvae] are high" (USFWS,47,5). This recommendation is broader than the DFG recommendation, in that it appears to allow for more flexibility in the closure period to accommodate differences between years in striped bass spawning, but "high densities" is undefined. Neither recommendation provides optimal protection, however, since neither seeks to isolate Sacramento River eggs and larvae from the central Delta entirely.

  Georgiana Slough has no gates on it at present. Georgiana Slough intercepts little more than about 13 percent of the Sacramento River flow at Freeport (DAYFLOW documentation). Given the other recommendations proposed below to enhance downstream flows in the central Delta, no recommendation for protection of striped bass passing into Georgiana Slough appears to be warranted. However, losses through the Delta Cross Channel are larger, and protection can be provided with present facilities. In the absence of proven technology to provide real time monitoring, and because of the need to provide full protection, the following recommendation is made.

  - Recommendation 2: The Delta Cross Channel gates should remain closed for the period April 15 through July 31 in all water year types.

The above sets of recommendations are all inadequate to protect striped bass eggs and larvae fully because none provide flows sufficient to move all larvae out of the central Delta into Suisun Bay nursery areas in all year types. In addition, none call for curtailment of exports to reduce reverse flows and entrainment. On the other hand, the EDF, recommendation for 38,000 cfs seems excessive since DFG believes that 33,900 cfs will move 100 percent of the eggs and larvae past Collinsville. Since no recommendations for April flows were received, the DFG standard will be applied to April as well as May. April standards are needed because significant spawning occurs in the Delta in April, and these eggs and larvae also require protection.

The outflow recommendations proposed will still not assure positive downstream flows in all Delta channels. In particular, exports from the Delta by the SWP and CVP can induce reverse flows in Old and Middle rivers. Eggs and larvae in the central Delta can be drawn into these channels and entrained in the export facilities and agricultural diversions, or be carried to areas of the Delta which are unsuited for their survival. In addition, if, as a result of removal of the salinity barrier on the San Joaquin River, spawning returns to the area around and above Vernalis, eggs and larvae produced upstream will be pulled into Old River and entrained into the export facilities. These factors represent additional mortality for young striped bass.

Based on the above discussion, a series of recommendations to address these interrelated problems are proposed:

To prevent entrainment of striped bass eggs and larvae in municipal, industrial, and agricultural diversions and export facilities in the Delta:

- Recommendation 3-1: No withdrawals or exports of water from the statutory Delta for any purposes other than for emergency conditions should be permitted for the period April 1 through July 31 in any water year type.

To assure movement of striped bass eggs and larvae into the Suisun Bay nursery area and to keep the entrapment zone west of Collinsville:

- Recommendation 3-2: Daily Delta outflow should be no less than the following in all water year types:

April 1 through May 31----------33,900 cfs
June 1 through June 30----------32,400 cfs
July 1 through July 31----------29,100 cfs

- Problem 3: Striped Bass Eggs and Larvae in the Central Delta are Lost in Large Numbers.

Considerable evidence has been presented by DFG and USBR, among others, to demonstrate that the central Delta is not an appropriate environment for survival of eggs and larvae of striped bass. The primary causes of these losses are entrainment in agricultural diversions, export facilities and M&I intakes. In addition, the reverse flows and longer residence times induced by the export pumps result in increased starvation of and predation on eggs and larvae. Flows are required to move the eggs and larvae down stream of Collinsville on the Sacramento River and into the Suisun Bay nursery area. Calculations developed by DFG (DFG,64,8) based on egg and larva sampling programs have determined that a Delta outflow of 33,900 cfs in May will move 100 percent of six mm striped bass larvae into the Estuary west of Collinsville. Equal protection in June would require 32,400 cfs, and in July (for seven mm fish, the smallest size class still present in that month) 29,100 cfs. The exhibit does not specify what export levels were present when the data to develop these calculations were collected. Nor does the exhibit present any indication of how the flow should be proportioned between the Sacramento and San Joaquin rivers. Despite evidence that spawning in the central Delta and the San Joaquin River occurs in April (DFG,64,9), no flow requirements or recommendations were presented for the month of April.

USFWS recommendations (USFWS,47,5) basically support those of DFG, but also recommend that Delta outflow be not less than 10,000 cfs during the May through July period, and that reverse flows be eliminated in the lower San Joaquin River at Jersey Point. No recommendations for Delta outflow in April, for required flows in the San Joaquin River, or for elimination of reverse flows in Old and Middle rivers were presented.

As discussed above (see section 5.3.5.2), EDF proposed Delta outflows based on the DFG data but weighted for the abundance of larvae in different months (more larvae present in May, fewer in July). EDF Exhibit 25 calls for flows of 38,000 for the period May 6 through May 31 in wet years, decreasing to 21,000 cfs in critical years. Lesser flows are proposed for the months of June and July. As with DFG and USFWS, no flow is apportioned to the San Joaquin River.

To assure that positive downstream flows are maintained in all Delta channels and to move eggs and larvae downstream from the San Joaquin River system:

- Recommendation 3-3: The contribution of the San Joaquin River to the total Delta outflow should be at least equal to that proportion of flow which would be present under unimpaired flow conditions.

- Problem 4: Disruptions of the Striped Bass Food Chain have occurred

  Striped bass may be starving because of loss of food from the central Delta. DFG presented evidence to indicate that zooplankton are becoming depleted, or the species composition of zooplankton has changed in the central Delta. This may have detrimental effects on striped bass when they first begin feeding (DFG,25,95-102).

- Recommendation 4: The above recommendations to maintain downstream flows in all Delta channels and to move the larvae rapidly into the Suisun Bay nursery area, where food of the appropriate species composition is available and more plentiful, should provide appropriate resolution of this problem. Should the other recommendations not be fully implemented such that the zooplankton food problem needs to be addressed, separate recommendations will be developed at that time. However, for the present, no recommendation for the protection of striped bass food supply is made.

- Problem 5: Pollutant Burdens

  Adult striped bass are burdened with a variety of pollutants which may affect their survival and reproductive potential. DFG and other participants have introduced evidence to indicate that adult striped bass are burdened with various organic and inorganic pollutants, which may affect their survival and their ability to reproduce, particularly through resorption of eggs in the ovaries. In addition, certain of these contaminants may pose a health risk to humans if striped bass are consumed too often. DFG fishing regulations include a precaution against consumption of too much striped bass because of mercury levels in their flesh.

- Recommendation 5:

  This subject is not directly relevant to Water Quality Control Plan standards. Actions proposed in the Pollutant Policy Document may have beneficial effects for striped bass. Other related recommendations are discussed in Chapter 8.

- Problem 6: Attraction to Effluents

  Evidence presented by DFG indicates that some striped bass may be attracted to certain components of industrial effluent streams and suffer deterioration and starvation. Laboratory tests indicate that the fish are attracted even when these chemicals are extremely diluted. The fish tend to remain in the effluent streams even though little or no food is available, and they undergo fin rot.

- Recommendation 6: Additional study of this phenomenon is warranted (see Chapter 8). Actions proposed in the Pollutant Policy Document may also have beneficial effects for striped bass.

- Other Problems and Considerations

  The above recommendations represent those levels of flow, salinity, and operational constraints which will, in theory, provide optimal protection for the striped bass beneficial use. Certain aspects of the problem of the decline of striped bass, such as pollutants, the Suisun Bay spring die-off, and effects of upstream diversions on survival of eggs and larvae, are beyond the scope of this Plan, in that they are not directly related to flow and salinity considerations in the Estuary.

- Hatcheries

  Certain other corrective or mitigative measures, such as hatcheries or grow-out facilities for fish salvaged at the export pumps, may be capable of providing some protection for striped bass. The question of hatchery production should not be considered at this time. Although there has been some recent success in producing striped bass in the hatchery, the fate of those fish in the Estuary (and ocean) and their recruitment to the fishery have not yet been determined. In addition, and most critically,even if some hatchery fish are recruited to the fishery and produce viable eggs and larvae, the purpose of that recruitment is lost if those eggs and larvae are subsequently lost to the fishery because of the various problems discussed above. Likewise, the question of other facilities cannot be addressed at this time, since no specific facilities have been proposed.

- Relationship of Recommended Outflows to Unimpaired Delta Outflow

  The Delta outflow recommendations proposed in Recommendation 5 above are as follows: 33,900 for April 1 through May 31; 32,400 for June 1 through June 30; and 29,100 for July 1 through July 31 in all years. Based on data developed for SWRCB exhibits, for unimpaired flow at Chipps Island for the years 1922-1978, the objective will be met with unimpaired flows as shown below:

Year Type	April	May	June	July
Wet	A	A	A	S
Above Normal	A	A	M	N
Below Normal	A	A	S	N
Dry	M	N	N	N
Critical	S	N	N	N

A = recommended flow level met in all years
M = recommended flow level met on average; met in most years
S = recommended flow level met in some years; not met on average
N = recommended flow level not met in any year

5.3.6 American Shad--Protection of Beneficial Uses

5.3.6.1 No Action Alternative

Under the Delta Plan there are essentially no standards to protect American shad. While the impacts of the Delta Plan on shad could not be quantified, it noted that the recommended plan for striped bass protection was expected to provide shad protection as well in wet, above normal, and dry water years, with a "definite lessening of protection" in critical years (Plan,V-39,VI-9).

The only specific standards for shad proposed in the Delta Plan (Table VI-1, pg.VI-35) concerned operation of the CVP's Tracy Fish Protective Facility. Certain secondary velocities and bypass ratios are required "to the extent possible" between June 1 and August 31 to increase screening efficiency for shad and other species. However, these standards are to be met "to the extent that they are compatible with export rates." Thus, shad protection is incidental to the operation of the CVP export pumps. There are no standards addressing shad for the SWP pumps.

5.3.6.2 Advocate Recommended Levels of Protection:

- WACOC

  WACOC recommended continuing the current practice of relating flow requirements for the protection of fish and wildlife to the variation of each year's runoff and storage conditions. Specifically, flow requirements "should be