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WRINT-DFG-Exhibit #8

Summary and Recommendations for the Department of Fish and Game's Testimony on the Sacramento-San Joaquin Estuary

SUMMARY OF PRESENT SITUATION

The Governor stated in his recent speech on water policy: "The Delta is broken". The testimony of the Department of Fish and Game (DFG) provides some of the specifics supporting that conclusion, not only for the Delta, but for the entire Estuary.

To summarize our testimony briefly, most fish species dependent on the Bay-Delta Estuary for food, nursery habitat, and as a migration corridor are in decline. The striped bass population has declined by 70%. The winter-run Chinook salmon population is down below 90% of its historical level. The spring-run Chinook is down 80% while fall-run is down 50%. Starry flounder and Bay shrimp are going downhill, and listings for the spring-run, longfin smelt, green sturgeon, and Sacramento splittail are actively being considered. The U.S. Fish and Wildlife Service has proposed listing the Delta smelt.

Most native fish species living within the brackish and freshwater portions of the Estuary exhibit a general pattern of increasing abundance in relation to the magnitude of Delta outflow during the winter and spring. The abundance of about 55 percent of the fish and large invertebrates using the Bay portion of the Estuary, however, does not change in relation to variations in freshwater flows. Most of the estuarine and anadromous fish species, however, are more abundant in wet than dry years. While some marine species are more abundant in dry than wet years, no substantial invasion of the Estuary by marine fishes occurs in dry years. In fact, as the current drought has progressed, the overall abundance of fish has generally declined,

ALTERNATIVE MEASURES

Fall Run Chinook Salmon

The Interagency Ecological Study Program, under the leadership of the Fish and Wildlife Service (USFWS), has extensively evaluated the environmental needs of fall run chinook salmon in the Estuary. The principal need is to improve the survival of downstream migrants during April, May, and June by minimizing their exposure to water exports and maintaining appropriate water temperatures. Our proposals focus on the former, since we have not identified any temperature measures appropriate for these proceedings.

Measures to protect fall run will help spring run salmon. In fact, the combined effect of measures for winter run and fall run chinook salmon will cover the whole period of spring run outmigration and be sufficient to protect the few remaining spring run fish.

DFG has relied on the USFWS to present the technical support for recommendations on fall run salmon. Based on that evidence, DFG provides 3 alternative sets of measures for improving survival of salmon in the Delta. These alternatives are listed below:

Alternative A

1. In order to reduce entrainment of Sacramento salmon smolts into the interior Delta,

    a. Close Delta Cross Channel Gates from 4/15 through 6/15 in all year types.

5. Limit exports at Banks (SWP) and Tracy (CVP) pumping facilities from 4/15 through 5/15 and establish minimum 14-day mean flows in the San Joaquin River as measured at Vernalis in various year types as follows:

Year Type	Export Limit	Flow Minimum
Critical	2,000 cfs	2,000 cfs
Dry	3,000 cfs	4,000 cfs
Below Normal	4,000 cfs	6,000 cfs
Above Normal	5,000 cfs	8,000 cfs
Wet	6,000 cfs	10,000 cfs

Alternative C

1. In order to reduce entrainment of Sacramento salmon smolts into the interior Delta,

   a. Close Delta Cross Channel Gates from 2/1 through 6/30 during all year types and

   b. Close Georgiana Slough from 2/1 through 6/30 during all year types.

2. In order to prevent the loss of San Joaquin River smolts to direct entrainment into Old River and the Clifton Court Forebay:

   Install a full barrier in Old River from 2/1 through 6/30 and 9/1 through 11/30 in all year types, providing that ongoing evaluation documents expected benefits and no unacceptable effects on winter-run salmon or other species.

3. Sacramento River flows at Rio Vista should be maintained at 6,000 cfs from 2/1 through 10/30 in all year types.

4. In order to prevent reverse flow on the San Joaquin River when the Delta Cross Channel and Georgiana Slough are closed, maintain 14-day mean flows at Jersey Point from 4/1 through 6/30 as follows:

Critical	1,000 cfs
Dry	1,500 cfs
Below Normal	2,000 cfs
Above Normal	2,500 cfs
Wet	3,000 cfs

5. Limit exports at Banks (SWP) and Tracy (CVP) pumping facilities from 4/1 through 6/30 and establish minimum 14-day mean flows in the San Joaquin River as measured at Vernalis in various year types as follows:

Year Type	Export Limit	Flow Minimum
Critical	0	2,000 cfs
Dry	0	4,000 cfs
Below Normal	0	6,000 cfs
Above Normal	0	8,000 cfs
Wet	0	10,000 cfs

As an amplification of the minimum flow recommendation at Vernalis, year classification should be determined based on the Water Year Classification Workgroup's "60-20-20" index of water availability in the San Joaquin Basin. Further, we recommend that the Board equitably allocate proportionate responsibility for meeting these minimum flows at Vernalis to each San Joaquin basin tributary. Use of the historic unimpaired contributions from each tributary to the total runoff at Vernalis is one approach. DFG has recently executed an agreement with Modesto and Turlock irrigation districts to increase the protection of salmon in the Tuolumne River. We believe that agreement provides sufficient flows from those districts to provide at least 17% of the proposed Vernalis flow in Critical, Dry and Below Normal years, 22% in Above Normal years, and 28% in Wet years. We recommend that the Board recognize those flow contributions in allocating responsibility for meeting interim Vernalis flows.

These recommendations are based on the assumption that the upper Old River Barrier will be in place as specified each year. If for any reason, the upper Old River Barrier is not in place in any year, or if the expected benefits of the barrier project do not materialize, the export limits and minimum flows at Vernalis would need to be reconsidered. A detailed evaluation of the benefits and effects of these recommendations is anticipated through the Interagency Ecological Study Program and other programs.

Winter-Run Salmon

DFG has discussed a range of alternatives with the National Marine Fisheries Service and U.S. Fish and Wildlife Service. Measures under consideration are closure of the Delta Cross Channel and Georgiana Slough, export limits, and minimum flows in the San Joaquin River at Jersey Point. The first priority is to keep as many salmon as possible in the Sacramento River, since the survival of salmon migrating through the Mokelumne and San Joaquin rivers is less than that of salmon migrating down the Sacramento River. Export limits and minimum flows at Jersey Point are intended to improve the survival of salmon which do cross into the San Joaquin River.

National Marine Fisheries Service will be presenting a wide range of alternatives to the Board. The following represents a range of alternatives under consideration:

Alternative	Delta Cross Channel Closure	Georgiana Slough Closure	Maximum Daily Export Rate	Minimum Flows at Jersey Point
1	2/1 to 4/30	Open	3000 cfs 2/1 to 4/30	None
2	2/1 to 4/30	Open	<75% of Vernalis flow 2/1 to 4/30	None
3	2/1 to 4/30	2/1 to 4/30	None	>-2000 cfs 2/1 to 4/30

During ongoing consultations under the Federal and State endangered species process, selection of an alternative within the above range is likely. That process is scheduled for completion in November. The relationship between the endangered species consultation process and the water rights proceeding is still under discussion. DFG leans towards leaving specific measures for winter-run salmon to the endangered species process. The Board should consider a set of measures within the above range to be likely and use the range in weighing potential conflicts between uses. Such an approach would provide flexibility in that decisions could be changed annually based on findings associated with the Endangered Species Act and on current biological knowledge.

Striped Bass

The striped bass population has declined from about 3 million adults in 1960 to about 600,000 adults today. DFG exhibit WRINT-DFG 3 describes a statistical model relating the abundance of adult bass to exports of water from the Estuary and the magnitude of Delta outflow. DFG Exhibits WRINT-DFG 2 and 3 describe our technical conclusions as to the causes for the decline in adult abundance.

Based on these exhibits on striped bass, DFG believes that export limits and minimum Delta outflow standards are the principal measures needed to protect the striped bass population.

Those measures need to be supplemented by minimum flows in the Sacramento River and closures of the Delta Cross Channel to maximize the survival of striped bass eggs and larvae in the Sacramento River, and also by salinity standards to maintain at least minimally satisfactory conditions for spawning in the San Joaquin River between Prisoners Point and Antioch.

The striped bass population model estimates abundance based on average April-July exports and Delta outflow, average August-December outflow, and average August-March exports. Thus, any given abundance goal could be achieved by many combinations of export and outflow.

For the purposes of formulating a set of alternatives, DFG used operations analyses prepared by DWR for the 1995 Level of Demand (low demand option). We reasoned that using planned operations as a base would both minimize interference with operations and facilitate evaluations.

We also decided to evaluate alternatives varying the abundance target between 600,000 and 1.7 million fish for each year type.

Given those constraints and leaving average outflows as reported in the operations study, a preliminary screening of alternatives indicated that a population of 600,000 bass could be maintained with slightly more than projected exports, while populations of 1.0 and 1.7 million bass would require substantial reduction in exports (Table 1).

Table 1. Changes in Exports Required to Achieve Various Target Populations of Adult Striped Bass Given Mean Delta Outflows as in DWR's 1995 Level of Demand Operations Study.

Year Type	Desired Adult Abundance (Millions	Percent Change in Annual Exports
C	0.6	+7%
D	0.6	-2%
BN	0.6	+3%
AN	0.6	+14%
W	0.6	+28%
C	1.0	-49%
D	1.0	-44%
BN	1.0	-37%
AN	1.0	-26%
W	1.0	-12%
C	1.7	-100%
D	1.7	-84%
BN	1.7	-75%
AN	1.7	-64%
W	1.7	-51%

Given that information, the fact that bass abundance is now about 600,000, but averaged about 1 million during the late 1970s and 1980s and our desire to provide the Board with a set of alternative measures that could stop the decline in abundance and initiate restoration, we developed measures that target bass populations of 600,000 (Alternative A), 1 million (Alternative B), and 1.7 million bass (Alternative C). In this process, we sought to structure alternatives that would optimize benefits for other species. Since many fish species benefit from higher flows in the spring, one obvious strategy is to emphasize increased flows and reduced exports in the spring at the expense of reduced flows and /or increased exports during other months. In our first Alternative (A), we held flows and exports at levels near those in the 1995 level operations study. As an alternative to restore about 1 million bass, we selected a 25 percent increase in spring outflows, and for the third alternative (C ≈ 1.7

million fish), we used a 50 percent increase in spring flows. Further evaluation showed that the bass abundance could be maintained with least reduction in annual export if April-July exports were restricted more than August-March exports. Based on these approaches, three sets of flows and exports which would provide 600,000, 1 million, and 1.7 million bass were estimated. These are provided in Table 2.

Table 2. Mean Delta Outflows and Exports Required to Maintain Populations of 600,000 (Alternative A), 1 Million (Alternative B), or 1.7 Million (Alternative C) Adult Striped Bass

Year Type	Apr-Jul Outflow (cfs)	Apr-Jul Exports (cfs)	Aug-Dec Outflow (cfs)	Aug-Mar Exports (cfs)
Alternative A - 600,000 Adult Bass				
C	4,500	2,600	3,700	8,600
D	7,200	4,500	8,000	9,800
BN	9,600	6,000	10,200	10,000
AN	15,300	7,400	11,000	10,500
W	29,000	8,800	14,300	11,200
Alternative B - 1 Million Adult Bass				
C	5,600	1,600	3,700	5,000
D	9,000	3,400	8,000	6,000
BN	12,000	4,400	10,200	6,500
AN	19,200	5,400	11,000	7,100
W	36,200	6,400	14,300	7,900
Alternative C - 1.7 Million Adult Bass				
C	6,700	500	3,700	1,100
D	10,800	1,000	8,000	2,900
BN	14,400	1,500	10,200	3,700
AN	23,000	2,000	11,000	4,600
W	43,000	3,000	14,300	5,100

The next question is what is an appropriate set of monthly flows that will yield these desired mean outflows? We decided to apportion flows among months in proportion to the way that mean monthly flows occurred in the 1995 operations study.

The more difficult issue is how to specify minimum flows so the desired average flows would be achieved. Simply specifying a mean flow as a minimum is insufficient because uncontrolled flows will result in new means that exceed the targeted ones. Furthermore, in the wetter months specifying any mean flow is infeasible, as during periods of below average precipitation it would occasionally compel releases of unreasonable, and perhaps impossible, amounts of water from storage.

After considering various approaches, we selected the following:

1. For April through July in critical years the means ~~under the 3 Alternatives~~, the means plus 25 percent ~~or~~ and the means plus 50 percent , respectively, were specified as minimums (Table 3) for each of the three alternatives.

Table 3. 14-Day Running Average of Delta Outflow in Critical years for each alternative (A-C).

Flows in CFS

Month	Alt A	Alt B	Alt C
April	5,200	6,500	7,800
May	4,600	5,700	6,900
June	4,100	5,200	6,200
July	4,000	5,000	6,100

2. For April through July of other years, the 25th percentile flow was computed for each month from the 1995 LOD study. For Alternative A, this value was rounded off, and specified as the flow below which water could not be diverted to storage or exported. For Alternative B, this value was multiplied by 1.25 (since the means had been increased by 25 percent) and rounded off, and for Alternative C it was multiplied by 1.5 (50 percent increase) and rounded off (Table 4).

Table 4. Mean Daily Delta Outflows (cfs) Below Which Diversions to Storage and Exports Would be Prohibited or Limited so as to Not Reduce Outflows Below These Amounts (For Alternatives A-C)

Year Type	April	May	June	July
Alternative A- 1995 LOD, 25th Percentile				
D	7,600	7,600	6,100	6,100
BN	7,600	7,600	6,800	6,700
AN	10,800	12,000	9,500	8,000
W	14,300	19,500	14,000	10,000
Alternative B-1995 LOD, 25th Percentile + 25% Increase				
D	9,500	9,500	7,600	7,600
BN	9,500	9,500	8,600	8,300
AN	13,500	15,000	12,000	9,900
W	18,000	24,000	17,500	12,500
Alternative C- 1995 LOD, 25th Percentile + 50% Increase				
D	11,400	11,400	9,200	9,300
BN	11,400	11,400	10,300	10,000
AN	16,300	18,100	14,200	11,900
W	22,000	29,000	21,000	15,000

3. For August through December, means were specified as minimums when the mean flow was less than 8,000 cfs (Table 5). In months with higher means (December in Dry and wetter years, November in Below Normal and wetter years, and October in Wet years), minimum flows were selected to not exceed 7,300 cfs (the wet year mean in September) and provide a logical pattern of increasing flows in wetter years and later months.

Table 5. 14-Day Running Averages of Delta Outflow (cfs). Same flows apply to all 3 Alternatives.

1/ Year Type	Aug	Sept	Oct	Nov	Dec

Critical	3,300	3,000	3,600	3,600	4,700
Dry	5,000	4,000	4,500	4,500	4,700
Below Normal	5,300	4,200	4,500	4,500	4,900
Above Normal	5,600	4,200	4,500	4,500	5,400
Wet	5,800	7,300	7,300	7,300	7,300

4. In fall months with mean outflows greater than 8,000 cfs, the mean was rounded off and specified as a limit below which water could not be diverted to storage or export (Table 6). Hence in those months both a mean and a threshold for limits to storage and export are proposed. Note that the year type in October, November and December is determined by the type designated for the previous water year. Also note that limits on storage and export are based on daily flows.

Table 6. Mean Daily Delta Outflows (cfs) Below Which Diversions to Storage and Exports Would be Prohibited or Limited so as to Not Reduce Outflows Below These Amounts. Estimates apply to all Alternatives.

Year Type 1/	Oct	Nov	Dec
Dry			20,000
Below Normal		9,500	26,000
Above Normal		12,900	27,000
Wet	14,200	16,300	28,000

1/ October, November, and December are to be classified according to the previous water year.

This proposed approach to managing flows is new. It obviously warrants review and discussion from a number of perspectives including how water costs and biological benefits can be evaluated during planning, and its practical operational implications.

Note that a time lag would exist between the initiation of any set of flows and export limits and the time when the target population level would be reached. As an example, one evaluation indicated it would take about 10 years to increase the population from 600,000 to 1 million bass.

Flows and export limits to attain any preferred alternative for adult striped bass then become the export limits in Table 2 and the flow constraints in Tables 3, 4, 5, and 6. We have not attempted to apportion export limits among months but some such apportioning is probably appropriate.

One thing to note is that this approach to specifying flows does not assure attainment of the target mean flows identified in Table 2.

In addition to the measures presented in Tables 2-6, the following should be included in each alternative to protect striped bass:

1. Maintain a daily mean flow of not less than 13,000 cfs in the Sacramento River at Sacramento from April 15 through May 31.

2. Close the Delta Cross Channel from April 15 through May 31 and to reduce potential detrimental impacts through resulting western delta flow reversals, maintain flow in the San Joaquin River at Jersey Point whenever the Cross Channel is closed according to the following:

	14-Day Mean Flow (cfs)
C	1,000
D	1,500
BN	2,000
AN	2,500
W	3,000

3. Adopt the striped bass salinity standards as provided in the 1991 Water Quality Plan (Appendix 1).

Estuarine Fishes

As pointed out in the summary at the start of this exhibit, most anadromous and estuarine species generally increase in abundance as outflow increases in the winter and spring. The supporting evidence for this conclusion is detailed in Exhibit WRINT-DFG 6. Splittail follow a similar pattern (WRINT-DFG Exhibit 5).

These fishes have all been depleted by the current drought. The low flows which have occurred in the last 5 years are unprecedented in their experience. While the cumulative unimpaired water supply in the current drought has been similar to the 1929-1934 drought, Delta outflow has been dramatically decreased (Figure 1). It remains to be seen what the long-term consequences of the drought are for these species.

In order to prevent further decreases in these species and initiate recovery, DFG has formulated a set of alternative measures based on abundance--outflow relationships for longfin smelt, bay shrimp (Crangon franciscorum), starry flounder and splittail. As with striped bass, the measures are based on increasing mean flows in DWR's 1995 LOD operations study (Alternative A) by 25 and 50 percent (Alternatives B and C, respectively).

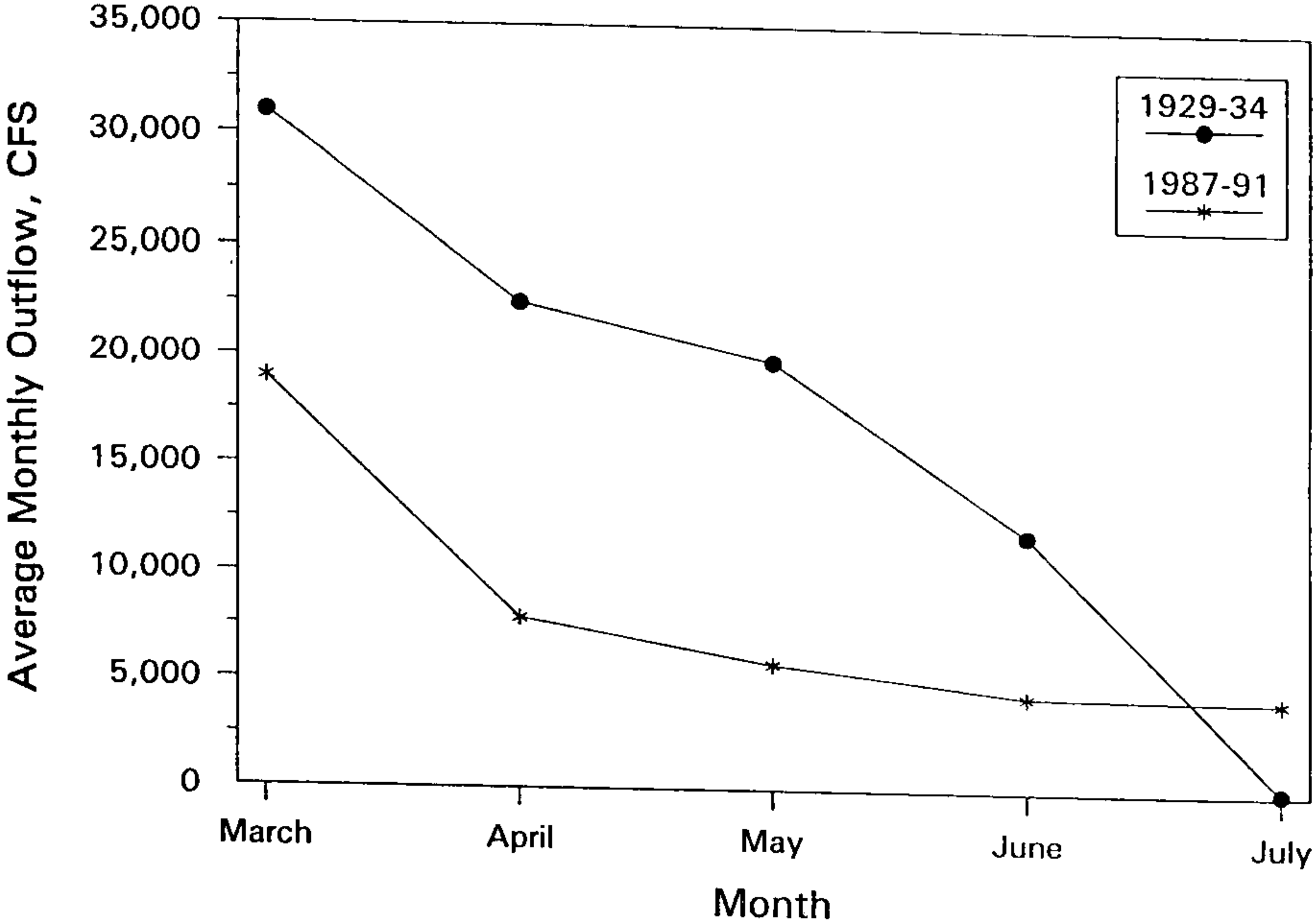

Figure 1. Comparison of delta outflow during the historic 1929-1934 drought and the current drought (1987-91)

Initial evaluations of this approach indicated that projected abundances of the four species in Dry and Critical years were lower than estimated abundances based on actual flows during the current drought (Table 7). This occurs because projected average dry and critical year flows in the 1995 operations study are only 70 to 80% of actual flows from 1987 to 1991 (Table 7). Therefore, even Alternative B mean flows (Table 8) would result in further declines in abundance during Dry and Critical years. As an initial step towards dealing with this issue, Critical Year target flows in Alternative A were increased by 25%.

Table 7. Comparison of 1995 Operations Study Projections in Dry and Critical Years with Actual Flows in Dry and Critical Years Between 1987 and 1991.

Critical Year Comparisons

	Mean Chipps Island Outflows			Calculated Abundances			
	Feb-May	Mar-Jun	Mar-Jun	Longfin Smelt	Starry Flounder	Crangon franc.	Split-tail
Mean 1995 LOD	5491	4923	5148	330	3	946	38
Mean 1995 LOD + 25%	6900	6200	6500	457	3	1433	42
Dayflow:1988,1990,1991	7355	6946	7887	501	4	1838	45

Dry Year Comparison

	Mean Chipps Island Outflows			Calculated Abundances			
	Feb-May	Mar-Jun	Mar-May	Longfin Smelt	Starry Flounder	Crangon franc.	Split-tail
Mean 1995 LOD	11821	9551	10634	989	5	2463	52
Mean 1995 LOD + 25%	14800	12000	13300	1365	7	2930	59
Dayflow 1987 and 1989	14464	12783	15408	1320	7	3238	65

Table 8. Target Mean Monthly Flows for Three Alternatives Based on Data from A) DWR's 1995 LOD Operations, B) 1995 LOD + 25% Increase, and C) LOD + 50% Increase.

Alternative A - Based on 1995 LOD Operations Study

Year Type	Feb	Mar	Apr	May	Jun
C	8,000	7,200	6,500	5,700	5,200
D	15,400	15,900	8,400	7,600	6,300
BN	34,400	21,100	11,500	10,700	8,900
AN	61,100	60,500	23,300	16,100	13,400
W	93,500	74,300	49,400	33,400	22,500

Alternative B - Based on 1995 LOD + 25% Increase

Year Type	Feb	Mar	Apr	May	Jun
C	8,000	7,200	6,500	5,700	5,200
D	19,200	19,900	10,500	9,500	7,900
BN	43,000	26,300	14,400	13,300	11,100
AN	76,300	75,600	29,200	20,100	16,700
W	95,000	89,000	61,700	41,700	28,100

Alternative C - Based on 1995 LOD + 50% Increase

Year Type	Feb	Mar	Apr	May	Jun
C	9,600	8,600	7,800	6,900	6,200
D	23,100	23,900	12,600	11,400	9,500
BN	51,600	31,600	17,300	16,000	13,300
AN	91,600	90,000	35,000	24,100	20,100
W	95,000	89,000	74,100	50,000	33,800

As with striped bass, we developed alternatives based on restricting diversions to storage and export in dry and wetter years (Table 9) and maintenance of mean outflows in critical years (Table 10).

In order to compensate for the low flows in Dry and Critical years in the 1995 Operations Study, flows for Dry years in Table 9 were based on mean flows rather than 25th percentile flows except that they were not increased above flows in Below Normal years. Also, Critical year flows in Table 10 were increased 25% for Alternative A and 35% for Alternative B, both in relation to the 1995 Operations Study.

It also seems unnecessary to restrict diversions to storage and export when Delta outflows are very large. Hence an arbitrary cap of 50,000 cfs was placed on limits in Table 9. As with striped bass we are uncertain whether these alternatives would result in the target mean flows.

Assuming they do increase by those amounts, the estimated increase in abundance for longfin smelt, bay shrimp, starry flounder and splittail using Alternative B measures would average about 28, 19, 11, and 13 percent respectively, while for Alternative C measures increases would average about 58,37, 23, and 21 percent respectively.

Table 9. Mean Daily Delta Outflows (cfs) Below Which Diversions to Storage and Exports Would be Prohibited or Limited so as to Not Reduce Outflows Below Those Specified for 3 Alternatives

Alternative A - (Critical year = 1995 L Mean + 25%, all others = 1995 L 25th Percentile)

Year Type	Feb	March	April	May	June
D	7,800	7,400	7,600	7,600	6,300
BN	17,700	12,300	7,600	7,600	6,900
AN	39,800	43,300	10,800	12,000	9,500
W	50,000	36,100	14,300	19,500	14,000

Alternative B - (Critical + 1995 L Mean + 25%, all others = 1995 L 25th Percentile + 25%)

Year Type	Feb	March	April	May	June
D	19,200	15,000	9,500	9,500	7,900
BN	22,200	15,400	9,500	9,500	8,600
AN	50,000	50,000	13,600	15,000	11,900
W	50,000	45,000	17,900	24,400	17,500

Alternative C - (Critical = 1995 L Mean + 50%, all others = 1995 L 25th Percentile + 50%)

Year Type	Feb	March	April	May	June
D	23,100	11,000	11,400	11,400	9,500
BN	26,600	18,400	11,400	11,400	10,300
AN	50,000	50,000	16,300	18,100	14,200
W	50,000	50,000	21,500	29,300	21,000

Table 10. 14-Day Running Averages of Delta Outflow in Critical Years for each alternative.

	Feb	Mar	Apr	May	Jun
Alt A	8,000	7,200	6,500	5,700	5,200
Alt B	8,700	7,800	7,000	6,200	5,600
Alt C	9,600	8,600	7,800	6,900	6,200

The proposed approach for estuarine fishes does not address directly the phenomenon of progressive, widespread depletions in fish populations noted during the current drought (WRINT-DFG-Exhibit 6). The cause of that depletion is not known. Possible explanations are toxicity, resulting from decreased dilution of wastes; decreased production at the base of the food chain, due to decreased nutrient input from upstream rivers; and possibly changes in energy flow through the food chain, as more energy is directed to benthic species instead of pelagic species. In any event we are unsure whether the proposed constraints on diversion and storage in critical years would avoid such depletions in a future drought.

Delta Smelt and Other Fishes

DFG has decided not to offer specific standards for the protection of Delta smelt because of uncertainties about quantitative relationships between their abundance and likely controlling environmental parameters (Exhibit WRINT-DFG-9). As stated in that Exhibit, however, we believe it is highly likely that Delta smelt populations are adversely impacted by the effects of Delta exports and reduced Delta outflows. As with striped bass, they seem to be very vulnerable to being drawn to the south Delta export facilities throughout the year. They are likely even more vulnerable to mortality at that point, as they