Draft Environmental Impact Report for Implementation of the 1995 Bay/Delta Water Quality Control Plan

Volume 2 - Chapter XIII

November 1997

STATE WATER RESOURCES CONTROL BOARD

TABLE OF CONTENTS

VOLUME II

Table of Contents (continued)

LIST OF FIGURES

List of Figures (continued)

List of Figures (continued)

List of Figures (continued)

LIST OF TABLES

List of Tables (continued)

List of Tables (continued)

CHAPTER XIII. ALTERNATIVES FOR IMPLEMENTING THE JOINT POINTS OF DIVERSION

A. PURPOSE

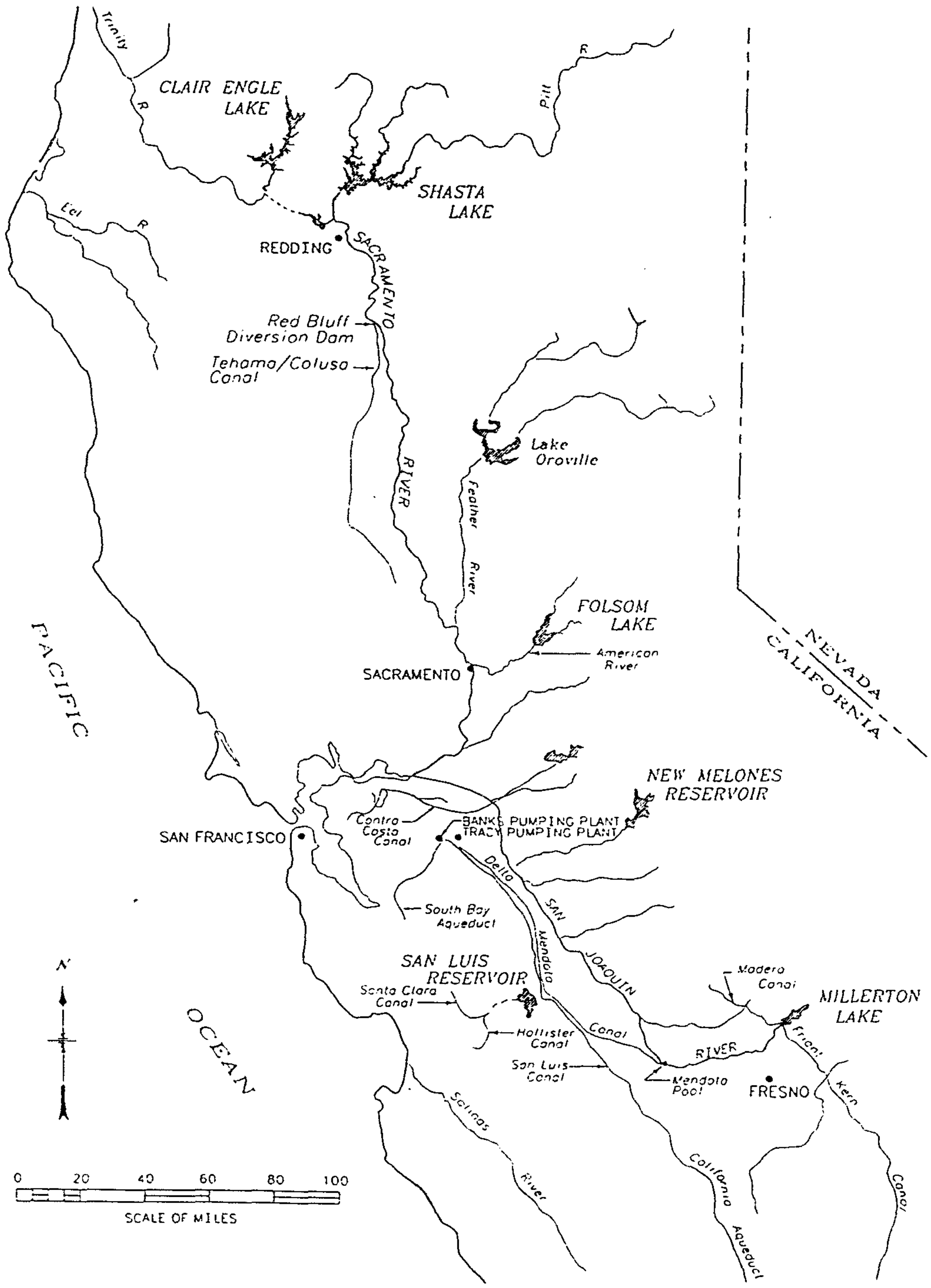
The purpose of this chapter is to disclose and analyze the significant environmental effects of alternatives for implementing the DWR's and the USBR's petition for joint use of SWP and CVP points of diversion (Joint POD) in the Delta. Specifically, the alternatives examine the joint use of the SWP's Harvey O. Banks Pumping Plant and the CVP's Tracy Pumping Plant. This volume will be evidence offered to the SWRCB during its water rights hearing regarding implementation of the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay/Delta Plan).

B. BACKGROUND INFORMATION ON JOINT POD

The CVP, operated by the USBR, and the SWP, operated by the DWR, are the largest water development projects in California and supply water to much of the state. They are also the largest water right holders in the state. The main export facilities of the projects are located in the southern Delta, and these facilities pump water south through the Delta-Mendota Canal and the California Aqueduct. This water is then directly used or placed into storage in San Luis Reservoir (see Figure XIII-1). The SWP can also move water farther south to storage facilities in southern California. The primary storage reservoirs of the CVP are Shasta Lake (Sacramento River), Trinity Reservoir (Trinity River), and Folsom Lake (American River), which are located north of the Delta. In times when water is not directly available in the Delta, stored water is released from these reservoirs to meet the CVP demands south of the Delta.

The CVP's Tracy Pumping Plant has a capacity of 4,600 cfs. Historically, flexibility in the pumping and transport system allowed maintenance and repair work to be performed without significantly affecting the ability to meet water supply demands. Recently, however, changes in the regulatory environment have eliminated that flexibility. At present, the Tracy Pumping Plant is generally operated either at its full capacity or at the maximum capacity set forth in Biological Opinions established under the Endangered Species Act (ESA) or SWRCB Order WR 95-6. The SWP's Banks Pumping Plant operates to a capacity of 6,680 cfs based on an agreement with the U.S. Army Corps of Engineers (USCOE). The SWP can operate to its physical capacity of 10,400 cfs under limited conditions established in the agreement. At certain times of the year and under certain operational conditions, the available capacity is not fully utilized by the SWP. At those times, there is excess capacity available at the Banks Pumping Plant that could be used by the CVP.

Figure XIII - 1. Location Map for Select Features of the Central Valley Project and the State Water Project



The actions and events that have increased the need for the USBR to seek assistance from the SWP to wheel[1] CVP water through DWR's Banks Pumping Plant have been progressive. Pumping restrictions for environmental purposes began in 1979 when the SWRCB implemented Water Right Decision 1485 (D-1485). This decision limited pumping at the Tracy Pumping Plant to 3,000 cfs in May and June for the protection of striped bass. The quantity of water that was foregone by this limitation could not always be recaptured solely through the use of the Tracy Pumping Plant because of the timing of demands and the Tracy Pumping Plant's limited pumping capacity. The SWRCB recognized this limitation and authorized CVP use of the Banks Pumping Plant in Condition 3 of D-1485, which states:

> *To the extent that operational constraints on the Central Valley Project to minimize diversion of young striped bass from the Delta during May and June reduce project exports, permittee, the United States Bureau of Reclamation, shall be allowed through coordinated operations to make up such deficiencies during later periods of the year by direct diversion or by re-diversion of releases of stored water through State Water Project facilities.*

After D-1485 was implemented and with increasing demands on the CVP, the Tracy Pumping Plant's flexibility became limited. Maintenance activities were difficult to perform while meeting full demands and generally were not possible without use of SWP facilities to wheel CVP water. Several temporary actions to allow wheeling for purposes other than those specified in D-1485 were filed with the SWRCB and approved. On December 7, 1981, the USBR filed a petition requesting a permanent change to CVP water rights by the addition of the Banks Pumping Plant as a point of diversion and re-diversion under those rights. This request was repeated in a subsequent petition filed on September 24, 1985, concerning the consolidated place of use. The SWRCB notified the USBR that it would defer action on the USBR's petition and integrate that action into a comprehensive Bay/Delta water rights hearing that would begin in 1987.

The SWRCB began the Bay/Delta hearings in 1987. A draft Plan issued in November 1988 met with intense opposition and was subsequently withdrawn in January 1989. In May 1991, after additional hearings, the SWRCB adopted the 1991 Bay/Delta Plan, but this water quality control plan did not address the water right issue of combined use of points of diversion. A draft decision, D-1630, was released in December 1992, but was subsequently withdrawn because of issues associated with conflicting federal and state responsibilities and the ESA. The series of events that followed from the withdrawal of D-1630 led to the development of a process that resulted in the 1994 Principles of Agreement and the 1995 Bay/Delta Plan. A summary of this process is provided in Chapter I.

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[1]The pumping and conveyance of CVP-held water through SWP facilities into San Luis Reservoir where it can then be delivered to CVP users.

On February 28, 1995, the DWR and the USBR filed a joint petition requesting the SWRCB to amend the water right permits of the SWP and CVP to allow operation to meet the objectives in the 1995 Bay/Delta Plan without violating the terms of D-1485 and to permit combined use of points of diversion. The SWRCB adopted Water Right Order 95-6 (WR 95-6) on June 8, 1995, for this purpose. WR 95-6 is an interim order that expires either (1) upon adoption by the SWRCB of a comprehensive water right decision that allocates final responsibilities for meeting the 1995 Bay/Delta Plan objectives or (2) on December 31, 1998, whichever comes first. The implementation of the new standards contained in the 1995 Bay/Delta Plan placed additional constraints on the operation of the CVP. WR 95-6 also authorized short-term combined use of the points of diversion of the SWP and the CVP subject to the condition that such use must improve fish protection and not result in an increase in average exports above the exports in the absence of the coordinated operations.

The Joint POD alternatives described in the next section are designed to incrementally increase the quantity of CVP water wheeled by the SWP under the joint point concept. Six alternatives for the use of Joint POD, one alternative representing full implementation of the 1995 Bay/Delta Plan, and the "no project alternative" are summarized in this chapter. The six Joint POD Alternatives that allow wheeling build upon Alternative 2, which represents full implementation of the 1995 Bay/Delta Plan. The environmental effects of implementing the Joint POD Alternatives are evaluated using a two-step process. River flows, Delta outflow, Delta salinity distribution, and reservoir levels resulting from implementation of the alternatives were modeled using DWRSIM and DWRDSM models (Chapter IV). The modeled hydrology was then compared to the flow and reservoir needs of fish, other aquatic resources, vegetation, and wildlife to determine the key environmental effects of implementing each alternative. Comparisons are made with the base condition to maintain consistency with the analyses presented in previous chapters. Additional comparisons are made, where possible, with Alternative 2, to analyze any incremental effects of other alternatives that allow wheeling.

C. DESCRIPTION OF ALTERNATIVES

A broad range of alternatives is analyzed to encompass all potential impacts. A preferred alternative is not identified; however, a preferred alternative will be identified in the final EIR. The preferred alternative may differ somewhat from any of the alternatives in the draft EIR. The impacts of the preferred alternative, whether it is one of the alternatives in the draft EIR, a combination of the draft EIR's alternatives, variants of the draft EIR's alternatives, or alternatives developed through negotiations by the parties, should be adequately identified and analyzed in this report.

The Joint POD alternatives are described below. For purposes of this analysis, all of the alternatives assume that the SWP and the CVP are responsible for meeting the objectives in the Bay/Delta Plan, but in actuality, any of these alternatives could be combined with any of the flow alternatives (described in Chapter II) as part of the final preferred alternative.

1. Joint POD Alternative 1 (No Project)

Under Joint POD Alternative 1 (base case), D-1485 objectives are in effect. The CVP is authorized to use the SWP's point of diversion in the Delta to make up export deficiencies occurring in May and June caused by export restrictions in D-1485.

2. Joint POD Alternative 2

Under Joint POD Alternative 2, the 1995 Bay/Delta Plan objectives are in effect. Joint use of points of diversion is not authorized. This alternative differs from Flow Alternative 2, described in Chapter II and analyzed in Chapter VI, because in this alternative all objectives are met, but in Flow Alternative 2 salinity objectives at Vernalis are not always met.

3. Joint POD Alternative 3

Under Joint POD Alternative 3, the 1995 Bay/Delta Plan objectives are in effect. The CVP is authorized to use the SWP's point of diversion in the Delta to deliver water covered by CVP contracts to the Cross Valley Canal, Musco Olive, Tracy Golf Course, and the Veterans' Administration cemetery.

4. Joint POD Alternative 4

Under Joint POD Alternative 4, the 1995 Bay/Delta Plan objectives are in effect, and the Joint POD is authorized for the uses of water identified in Joint POD Altenative 3. Additionally, the Joint Point is authorized for uses of water to provide a net benefit to fish and wildlife. Any pumping losses incurred by either of the projects as a result of reductions to benefit fish may be made up within twelve months using either or both pumping plants. This alternative is modeled by assuming that exports are reduced during the April 15 through May 15 pulse flow and that the reductions are made up through combined use of points of diversion in other months when pumping opportunities occur.

5. Joint POD Alternative 5

This alternative builds on Joint POD Alternative 3. The 1995 Bay/Delta Plan objectives are in effect. Combined use of the SWP and the CVP points of diversion in the Delta is limited by the permitted diversion rates of the projects in the Delta. Use of the SWP point of diversion is further limited by U.S. Army Corps of Engineers (USCOE) Public Notice 5820-A, as amended. The SWP and the CVP water right permits include instantaneous diversion and rediversion rates (10,350 cfs for the SWP at Banks Pumping Plant and 4,600 cfs at Tracy Pumping Plant) as well as rates of diversion to storage in San Luis Reservoir (10,350 cfs for the SWP and 4,200 cfs for the CVP). USCOE Public Notice 5820-A limits SWP Delta diversions to 6,680 cfs, except that SWP Delta diversions can be increased by one-third of the

San Joaquin River flow from December 15 through March 15 when the flow exceeds 1,000 cfs. The maximum pumping rate under Notice 5820-A is 8,500 cfs.

6. Joint POD Alternative 6

This alternative is the same as Joint POD Alternative 5, except that San Joaquin River flows at Vernalis are as specified in the Letter of Intent (SJRTG 1996). Combined use of the SWP and the CVP points of diversion in the Delta is limited by the permitted diversion rates of the projects in the Delta. Use of the SWP point of diversion is further limited by USCOE Public Notice 5820-A, as amended.

7. Joint POD Alternative 7

This alternative builds on Joint POD Alternative 5. The 1995 Bay/Delta Plan objectives are in effect. Joint use of the SWP and the CVP points of diversion in the Delta is limited by the permitted diversion rates of the projects in the Delta. The SWP and the CVP permits include instantaneous diversion and rediversion rates as well as rates of diversion to storage in San Luis Reservoir. The restrictions imposed by USCOE Public Notice 5820-A are not in effect.

8. Joint POD Alternative 8

This alternative builds on Joint POD Alternative 7. The 1995 Bay/Delta Plan objectives are in effect. Joint use of the SWP and the CVP points of diversion in the Delta is limited only by the combined physical capacities of the pumping plants and by each project's annual authorized diversion.

D. WATER SUPPLY IMPACTS

This section describes the water supply impacts of the Joint POD alternatives. With one exception, these alternatives affect only the SWP and the CVP. The exception, Alternative 6, assumes implementation of the Letter of Intent, which has a water supply impact on some San Joaquin Basin water users. The water supply impact of implementation of the Letter of Intent is, however, already evaluated in Chapter VI. Consequently, this section and all following sections of this chapter will analyze only the changes to the SWP and the CVP system that result from combined use of points of diversion in the Delta.

The following discussion is divided into four sections: (1) SWP and CVP delivery impacts, (2) SWP wheeling for the CVP, (3) carryover storage in SWP and CVP reservoirs, and (4) transfer capacity.

1. SWP and CVP Delivery Impacts

Water delivery changes to SWP and CVP contractors for the 73-year average and the critical period are summarized in Table XIII-1. As modeled, the SWP receives no benefit for the combined use of points of diversion because the SWP never uses the CVP pumping facilities. In real operation, the SWP may occasionally use the CVP facilities if necessary for fish protection, but such an operation is likely to be rare.

Table XIII-1
Water Delivery Changes (TAF)

73-Year Period Annual Average

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
SWP Deliveries	2,872	2,763	2,760	2,750	2,750	2,746	2,780	2,775
compared to Alt 1	--	-109	-112	-122	-122	-126	-92	-97
compared to Alt 2	--	--	-3	-13	-13	-17	17	12
CVP Deliveries	2,770	2,591	2,666	2,683	2,726	2,690	2,744	2,838
compared to Alt 1	--	-179	-104	-87	-44	-80	-26	68
compared to Alt 2	--	--	75	92	135	99	153	247

1928-1934 Critical Period Average

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
SWP Deliveries	2,520	2,035	2,036	2,043	2,032	2,032	2,065	2,017
compared to Alt 1	--	-485	-484	-477	-488	-488	-455	-503
compared to Alt 2	--	--	1	8	-3	-3	30	-18
CVP Deliveries	2,224	1,987	2,014	2,015	2,040	1,958	2,031	2,014
compared to Alt 1	--	-237	-210	-209	-184	-266	-193	-210
compared to Alt 2	--	--	27	28	53	-29	44	27

Comparison of the deliveries under Joint POD Alternative 2 to the deliveries under Joint POD Alternatives 3-8 shows some effect on the SWP of the combined use of points of diversion, but this is due both to changes in availability of water in the Delta because of altered upstream CVP operations and to variability within the model. Comparison of the corresponding alternatives for the CVP, however, shows a substantial potential water supply benefit over the 73-year modeled hydrology for combined use of points of diversion. Over this period, the average annual water supply increase for the CVP ranges from 75 TAF to 247 TAF. The lower end of the range applies when combined use is limited to deliveries for existing contracts (Alternative 3). When combined use is authorized up to the existing limits of the USCOE requirements, the annual average water supply increase is 135 TAF. When combined use is authorized up to the physical export capacity of the projects, the annual average water supply increase is 247 TAF. The ISDP, or some closely related project, is probably necessary before the projects can increase pumping rates above their USCOE limits.

Table XIII-1 also shows that there is much less potential benefit to the CVP of combined use of points of diversion in the critical period. In dry periods, there is insufficient water available to realize appreciable benefits from combined use of points of diversion.

2. SWP Wheeling for the CVP

Table XIII-2 identifies the quantity of water that is wheeled by the SWP at Banks pumping plant for the CVP under each alternative over the 73-year annual average period and the critical period. A comparison of the alternatives is provided for both the base case and Alternative 2. Table XIII-2 shows that substantial wheeling is presently authorized under Alternative 1, the base case condition. Over the 73-year period, wheeling for alternatives 3-8 ranges from 88 TAF to 347 TAF.

Table XIII-2
SWP Wheeling for CVP at Banks Pumping Plant (TAF)

73-Year Period Annual Average	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
SWP Wheeling	105	0	88	218	232	228	327	347
compared to Alt 1	--	-105	-17	113	127	123	222	242
compared to Alt 2	--	--	88	218	232	228	327	347

1928-1934 Critical Period Average	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
SWP Wheeling	44	0	36	47	45	33	64	51
compared to Alt 1	--	-44	-8	3	1	-11	20	7
compared to Alt 2	--	--	36	47	45	33	64	51

A comparison of Tables XIII-1 and XIII-2 shows that the average annual quantity of water wheeled relative to Alternative 2 is substantially more than the increased average annual CVP water supply relative to Alternative 2. For example, in Alternative 8 the increased annual average water supply deliveries are 247 TAF, but an annual average of 347 TAF is wheeled. The difference between these two quantities is due to altered operation of the CVP, which is able to fill its share of San Luis Reservoir earlier in the year through combined use of points of diversion and reduce pumping later in the season.

Table XIII-3 shows the monthly distribution of wheeled water under the alternatives for the 73-year average and the critical period. Under the base case operation, the water is wheeled in

July and August. In Alternatives 3-8, the water is wheeled in every month except May, but the quantity of wheeled water is relatively small in March, April and June.

Table XIII-3
SWP Wheeling of CVP Water (TAF)

73-Year Period Average Monthly Wheeling

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0	0	0	0	0	0	0	0	0	43	62	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	16	3	10	11	1	13	0	0	0	6	25	3
4	21	10	30	55	17	8	0	0	1	12	43	22
5	24	11	30	60	12	7	0	0	1	16	61	10
6	19	10	26	62	19	6	5	0	1	10	60	9
7	41	27	62	41	10	6	2	0	7	37	86	8
8	26	8	21	111	12	7	2	0	0	42	116	3

Critical Period Average Monthly Wheeling

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0	0	0	0	0	0	0	0	0	14	27	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	18	0	0	0	0	0	0	0	0	6	6	3
4	20	0	0	0	0	0	0	0	0	7	1	16
5	22	0	0	0	0	0	0	0	0	8	5	7
6	22	0	0	0	0	0	0	0	3	4	0	2
7	13	0	0	4	10	0	0	0	0	9	27	0
8	16	0	0	0	0	0	0	0	0	6	25	0

3. Carryover Storage in SWP and CVP Reservoirs

Carryover storage is the amount of water retained in a reservoir at the end of September of each year. Carryover storage helps meet future demand in the event that the next year is dry. The amount of water dedicated to carryover storage is balanced against the amount needed to meet immediate delivery needs, hydropower generation needs, and instream flow requirements of a project, according to operation rules that differ for each reservoir. For the SWP and the CVP reservoirs, the operation rules have been determined through optimization studies. Reservoir operations are modeled in DWRSIM according to these rules.

Reservoirs in this analysis include Shasta, Oroville, Folsom and New Melones. Tables XIII-4 and XIII-5 show carryover storage volumes in these reservoirs for the 73-year period and the critical period for the alternatives and for the base case. The differences in carryover storage between the alternatives and the base case are graphically represented in Figures XIII-2 through XIII-5. The differences in carryover storage between Alternatives 3 through 8 and Alternative 2 are graphically represented in Figures XIII-6 through XIII- 9. The tables and figures indicate that carryover storage in the CVP reservoirs in the Sacramento Basin declines slightly for

Alternatives 3-8 as wheeling quantities increase. This decline is due to the extra water being exported to CVP contractors through combined use of points of diversion. Unlike the Sacramento Basin CVP reservoirs, New Melones Reservoir carryover storage does not change due to combined use because this reservoir is not used to provide water for export. Carryover storage in New Melones Reservoir is substantially improved for Alternative 6 because reservoir releases for inbasin uses decline under the requirements in the Letter of Intent.

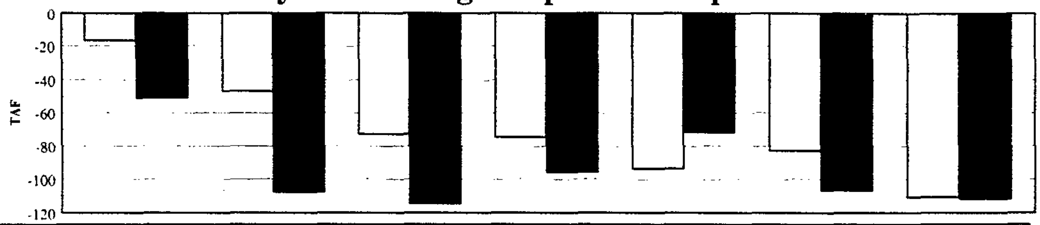
Table XIII-4
Carryover Storage in Central Valley Reservoirs (TAF)
73-Year Period Annual Average

Alternative	Shasta	Oroville	Folsom	New Melones
Alt. 1	2,910	2,310	481	1,543
Alt. 2	2,893	2,195	445	1,286
Alt. 3	2,863	2,182	434	1,291
Alt. 4	2,837	2,160	421	1,287
Alt. 5	2,836	2,188	423	1,292
Alt. 6	2,816	2,171	415	1,608
Alt. 7	2,827	2,182	422	1,292
Alt. 8	2,799	2,186	401	1,292

Table XIII-5
Carryover Storage in Central Valley Reservoirs (TAF)
Critical Period Annual Average

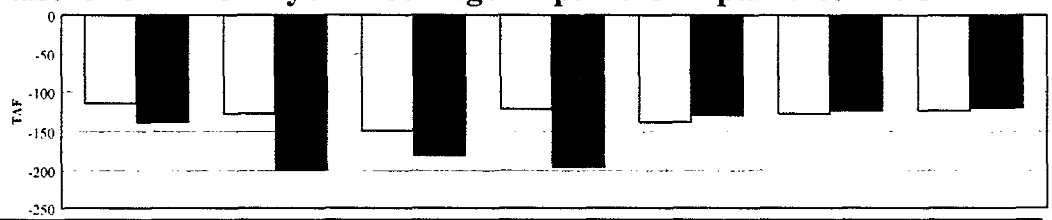
Alternative	Shasta	Oroville	Folsom	New Melones
Alt. 1	1,944	1,608	261	1,104
Alt. 2	1,893	1,469	182	620
Alt. 3	1,836	1,408	182	624
Alt. 4	1,830	1,427	170	625
Alt. 5	1,848	1,412	186	625
Alt. 6	1,872	1,478	178	1,150
Alt. 7	1,837	1,484	187	625
Alt 8	1,833	1,487	170	625

Figure XIII-2
Shasta Lake Carryover Storage Impacts Compared to Alt 1



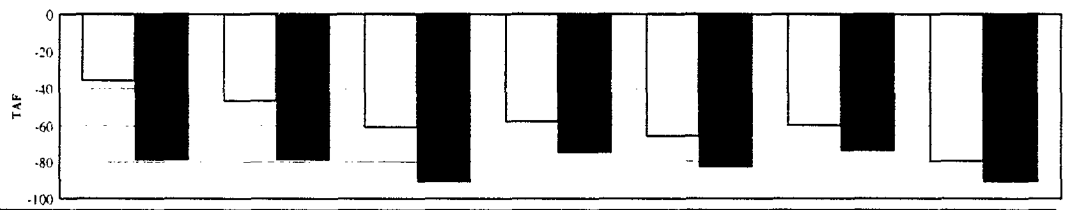
	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
73-Year Period Avg. ☐	-17	-47	-73	-75	-94	-83	-111
Critical Period Avg. ■	-51	-108	-115	-96	-72	-107	-112

Figure XIII-3
Lake Oroville Carryover Storage Impacts Compared to Alt 1



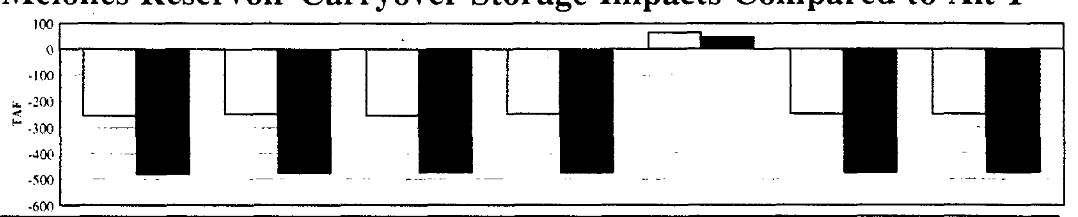
	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
73-Year Period Avg. ☐	-115	-128	-150	-122	-139	-128	-124
Critical Period Avg. ■	-139	-200	-181	-196	-130	-124	-121

Figure XIII-4
Folsom Lake Carryover Storage Impacts Compared to Alt 1



	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
73-Year Period Avg. ☐	-36	-47	-61	-58	-66	-60	-80
Critical Period Avg. ■	-79	-79	-91	-75	-83	-74	-91

Figure XIII-5
New Melones Reservoir Carryover Storage Impacts Compared to Alt 1



	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
73-Year Period Avg. ☐	-257	-252	-256	-250	65	-251	-251
Critical Period Avg. ■	-483	-480	-478	-479	47	-479	-478

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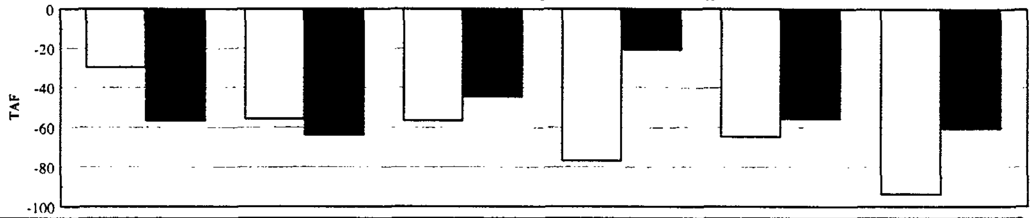
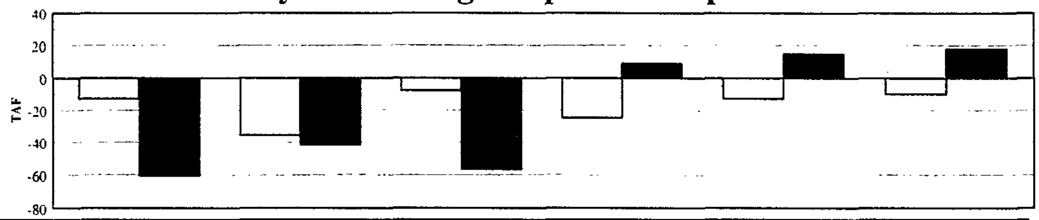
Figure XIII-6
Shasta Lake Carryover Storage Impacts Compared to Alt 2



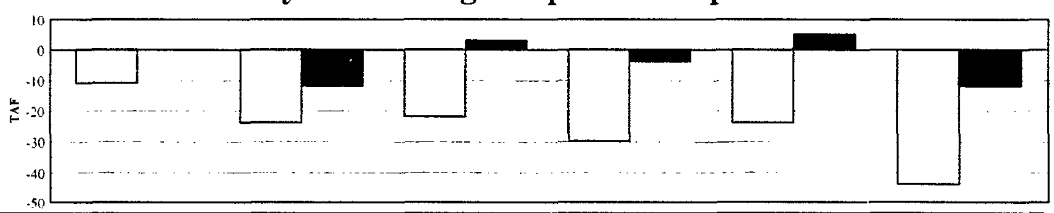
	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
73-Year Period Avg. □	-30	-56	-57	-77	-65	-94
Critical Period Avg. ■	-57	-64	-45	-21	-56	-61

Figure XIII-7
Lake Oroville Carryover Storage Impacts Compared to Alt 2



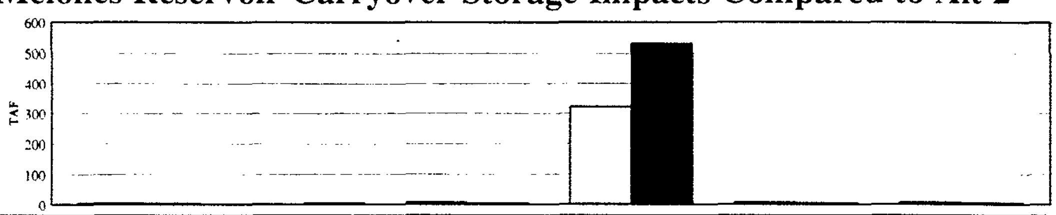
	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
73-Year Period Avg. □	-13	-36	-8	-25	-13	-10
Critical Period Avg. ■	-61	-42	-57	9	15	18

Figure XIII-8
Folsom Lake Carryover Storage Impacts Compared to Alt 2



	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
73-Year Period Avg □	-11	-24	-22	-30	-24	-44
Critical Period Avg ■	0	-12	3	-4	5	-12

Figure XIII-9
New Melones Reservoir Carryover Storage Impacts Compared to Alt 2



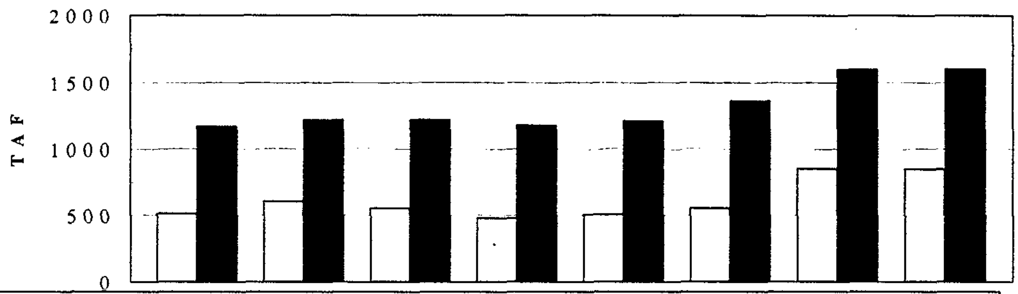
	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
73-Year Period Avg. □	5	0	6	321	6	6
Critical Period Avg. ■	4	5	4	530	5	5

4. Transfer Capacity

The capacity to use the SWP and the CVP export facilities to transfer water was analyzed using the method described in Chapter V. This method assumes that the July through October period is the most likely period for water transfers to occur and the ability of the projects to accommodate water transfers depends on two factors: (1) unused pumping capacity at Banks and Tracy pumping plants and (2) the water quality objective that not more than 65 percent of Delta inflow can be exported during this period. The analysis does not consider other possible operational restrictions, such as storage or conveyance capacity south of the Delta. Lastly, the analysis assumes that water transfers will result in new water entering the Delta. The results of the analysis are provided in Figures XIII-10 and XIII-11.

The transfer capacity for Alternative 2 increases in comparison to Alternative 1 because the higher flow objectives in Alternative 2 deplete upstream reservoirs which reduces the ability of the projects to release water for export through the Delta in the July through October period. The transfer capacities of Alternatives 3-5 decline in comparison to Alternative 2 because the SWP is using some of its excess capacity to export CVP water. The transfer capacities of Alternatives 7 and 8 increase substantially because of the higher maximum SWP export level under these alternatives.

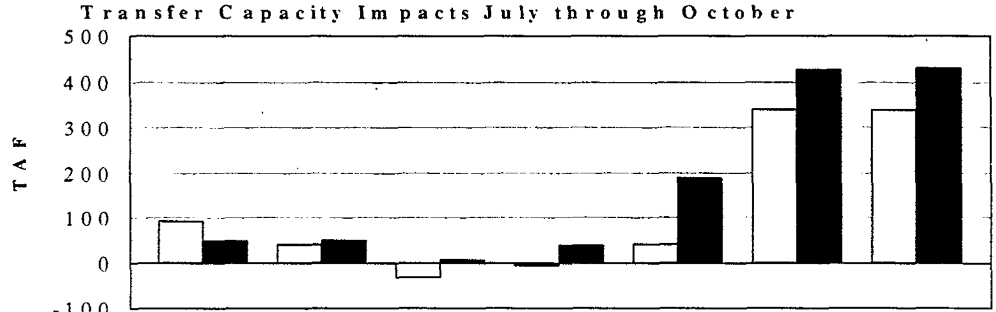
Figure XIII-10
Average Transfer Capacity July through October



	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
72-Year Period Avg	513	605	553	481	507	554	854	853
Critical Period Avg	1,171	1,219	1,220	1,178	1,209	1,361	1,598	1,601

Data based on historic 73-year hydrology
Critical Period is May 1928 through October 1934

Figure XIII-11
Transfer Capacity Impacts July through October



	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
72-Year Impact	92	40	-32	-6	41	341	340
Critical Period Impact	48	49	7	38	190	427	430

Data based on historic 73-year hydrology
Critical Period is May 1928 through October 1934

C-032247

E. ENVIRONMENTAL EFFECTS OF IMPLEMENTING JOINT POD ALTERNATIVES IN THE DELTA

The evaluation of the environmental effects of implementing the Joint POD alternatives in the Delta is divided into the following sections: (1) hydrology, (2) salinity, and (3) fish and aquatic resources.

1. Hydrology

The principal factors affecting Delta hydrology are the tides, river inflow from the Sacramento and San Joaquin river systems, net Delta outflow, exports and local diversions. Tables XIII-6 through XIII-13 list the base case and Alternative 2 monthly flows of the Sacramento River at Freeport, the San Joaquin River at Vernalis, net Delta outflow and Delta export pumping for the 73-year period and the critical period. Below the base case and Alternative 2 flows are the reductions and increases in flows resulting from the Joint POD alternatives.

Comparison of the hydrology parameters of Alternatives 3-8 in comparison to Alternative 2 shows that overall there is not a large change in Delta hydrology due to combined use of points of diversion. The following observations, however, can be drawn from the tables.

1. In comparison to Alternative 2, average annual exports for Alternatives 3-8 increase from July through January due to SWP wheeling of CVP water. Exports then decrease for these alternatives in February and March because the CVP fills its share of San Luis Reservoir early.

2. The net Delta outflow pattern is the opposite of the export pattern. Generally, net Delta outflow decreases from July through January and increases in February and March.

3. The combined use of points of diversion does not affect flows at Vernalis. The flow changes at this location is due to changes in the requirements.

2. Salinity

This section analyzes salinity conditions under the seven Joint POD alternatives and the base case as modeled by the DWR Delta Simulation Model, DWRDSM. Two analyses are discussed below to illustrate the alternatives' effects on salinity in the Estuary. In the first analysis, the position of X2, the two parts per thousand (ppt) isohaline position, for each of the Joint POD alternatives is compared with the X2 position of the base case. In the second analysis, the electrical conductivity (EC) of the alternatives at six stations throughout the Delta is compared to that of the base case.

a. X2. X2 is defined as the distance from the Golden Gate bridge in kilometers (km) of the two ppt isohaline at a depth of one meter from the bottom of the channel. The 1995 Bay/Delta Plan provides that the Delta outflow objectives are met from February through June if the

Table XIII-6
Sacramento River Flow at Freeport, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
14,211	17,053	24,238	32,539	38,481	35,441	23,335	19,893	16,904	16,385	13,951	11,812

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-693	-28	-662	-691	102	253	262	-252	2862	670	-1644	169
3	-510	-197	-782	-751	-100	123	242	-285	2849	937	-1216	20
4	-736	-420	-843	-924	-264	123	-35	-444	3095	1205	-649	179
5	-619	-299	-892	-790	-212	126	226	-319	2844	1050	-740	-77
6	-785	-591	-1025	-892	-402	74	1145	-901	3408	1032	-522	-190
7	-680	-470	-944	-741	-267	-87	228	-291	2868	2528	-1314	-545
8	-590	-715	-1048	-807	-378	-138	214	-257	2900	2645	-772	-725

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
13,518	17,026	23,576	31,848	38,583	35,694	23,598	19,641	19,766	17,055	12,307	11,982

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	184	-169	-120	-60	-202	-130	-20	-33	-13	267	428	-150
4	-43	-393	-181	-233	-366	-130	-298	-192	234	536	995	10
5	74	-271	-231	-99	-314	-128	-37	-67	-18	380	905	-246
6	-92	-563	-363	-201	-504	-179	882	-649	546	362	1123	-360
7	13	-442	-282	-50	-369	-340	-34	-39	6	1858	330	-715
8	103	-687	-386	-116	-480	-391	-48	-6	39	1975	873	-894

Table XIII-7
Sacramento River Flow at Freeport, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
14,211	17,053	24,238	32,539	38,481	35,441	23,335	19,893	16,904	16,385	13,951	11,812

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-1213	426	-735	-697	-1123	813	972	1519	3330	-913	-2158	283
3	-920	356	-664	-613	-934	-33	1053	1429	3239	-332	-2005	221
4	-890	317	-773	-781	-1246	-65	546	994	3971	-42	-1875	432
5	-869	302	-705	-697	-1057	-98	1062	1471	3327	-184	-2068	288
6	-806	207	-767	-737	-1183	41	2972	353	3839	-1252	-2391	271
7	-978	328	-718	-653	-973	-22	1053	1468	3558	335	-2679	74
8	-946	353	-670	-651	-1006	-43	992	1457	3659	286	-2623	106

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
8,973	9,319	12,133	15,618	14,003	15,507	11,506	11,640	14,359	13,408	9,904	8,391

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	293	-70	70	84	189	-846	81	-91	-91	581	153	-62
4	323	-109	-38	-84	-123	-878	-426	-525	641	871	283	149
5	344	-123	30	0	66	-911	90	-49	-2	730	91	5
6	407	-218	-33	-41	-60	-773	2000	-1166	509	-339	-232	-12
7	235	-98	16	43	150	-835	81	-51	228	1248	-520	-209
8	267	-73	65	46	117	-857	20	-63	329	1199	-465	-178

Table XIII-8
San Joaquin River Flow at Vernalis, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	3,169	2,076	2,927	4,413	6,808	6,177	5,448	4,653	3,722	1,798	1,361	1,874

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-60	-86	-177	-267	-436	-100	350	739	177	226	276	-37
3	-55	-78	-170	-256	-439	-113	351	741	181	230	280	-31
4	-61	-80	-170	-258	-457	-129	370	759	192	231	281	-29
5	-53	-76	-167	-253	-435	-112	351	741	184	233	284	-27
6	382	41	165	155	163	71	-48	260	266	228	-11	-191
7	-55	-77	-166	-248	-420	-112	352	729	184	234	284	-25
8	-51	-74	-163	-247	-422	-123	361	730	179	235	283	-28

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	3,108	1,990	2,750	4,146	6,372	6,077	5,797	5,392	3,900	2,024	1,638	1,837

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	6	8	8	11	-3	-12	1	2	3	4	4	6
4	-0	6	8	9	-21	-29	20	20	15	4	5	8
5	8	10	10	14	1	-12	2	2	7	7	7	10
6	442	126	342	422	599	171	-398	-479	88	2	-287	-154
7	5	9	11	19	16	-11	2	-10	7	8	8	12
8	10	12	14	20	13	-23	11	-9	2	9	6	9

Table XIII-9
San Joaquin River Flow at Vernalis, Critical Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	3,169	2,076	2,927	4,413	6,808	6,177	5,448	4,653	3,722	1,798	1,361	1,874

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	60	-129	-149	-141	-297	-30	210	827	281	258	272	-36
3	60	-126	-146	-138	-300	-30	210	827	283	258	274	-31
4	58	-126	-146	-138	-302	-30	210	827	283	258	274	-31
5	60	-126	-146	-138	-300	-30	210	827	283	258	276	-31
6	70	-95	-46	19	71	68	106	346	226	223	-225	-238
7	60	-126	-146	-138	-300	-30	213	827	283	260	274	-31
8	60	-129	-146	-138	-302	-30	210	827	281	249	272	-38

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1,931	1,314	1,526	1,637	2,686	2,201	2,619	2,598	1,558	1,357	1,410	1,428

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	0	3	3	3	-3	0	0	0	2	0	2	5
4	-2	3	3	3	-6	0	0	0	2	0	2	5
5	0	3	3	3	-3	0	0	0	2	0	5	5
6	9	34	103	160	367	98	-104	-481	-55	-35	-497	-202
7	0	3	3	3	-3	0	3	0	2	2	2	5
8	0	0	3	3	-6	0	0	0	0	-9	0	-2

Table XIII-10
Delta Outflow, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	8,216	9,974	22,176	38,689	49,942	42,012	24,417	18,415	12,891	6,627	3,870	4,145

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-911	582	-282	-555	944	857	3084	165	376	59	178	527
3	-983	390	-584	-829	817	728	3096	168	380	59	168	432
4	-1191	90	-972	-1564	868	1198	3769	751	505	35	156	332
5	-1177	233	-995	-1471	1206	1174	3092	126	373	35	180	355
6	-830	-11	-910	-1259	1370	1315	1987	795	743	45	147	253
7	-1801	-673	-1742	-686	1779	1132	2887	14	166	-7	149	-105
8	-1534	-717	-1317	-2511	1552	976	2943	15	181	45	194	-107

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	7,305	10,556	21,893	38,134	50,886	42,869	27,501	18,580	13,267	6,686	4,048	4,672

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	-72	-191	-302	-274	-127	-129	11	3	4	-0	-10	-95
4	-279	-491	-689	-1009	-76	341	684	586	129	-25	-22	-195
5	-266	-349	-713	-916	262	317	8	-39	-3	-25	2	-172
6	82	-593	-628	-704	426	458	-1097	630	367	-14	-32	-273
7	-890	-1255	-1460	-131	835	275	-197	-151	-210	-67	-30	-632
8	-623	-1299	-1035	-1956	608	119	-141	-149	-195	-15	15	-634

Table XIII-11
Delta Outflow, Critical Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	8,216	9,974	22,176	38,689	49,942	42,012	24,417	18,415	12,891	6,627	3,870	4,145

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-1531	1759	-374	-2163	3148	4632	1101	3566	3229	883	-957	379
3	-1545	1759	-374	-2133	3271	4467	1104	3573	3229	883	-957	384
4	-1545	1759	-388	-2198	2818	4348	1207	3559	3460	883	-971	384
5	-1545	1756	-388	-2168	3079	4372	1109	3576	3229	883	-957	384
6	-1380	1532	-366	-2095	3061	4310	983	3722	3724	883	-911	379
7	-1554	1756	-634	-3234	3118	4567	1109	3580	3308	883	-957	379
8	-1564	1756	-599	-3169	3263	4527	1123	3583	3311	883	-957	379

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	4,177	4,809	5,624	8,441	11,591	12,751	9,291	8,366	7,457	4,856	3,885	3,030

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	-14	0	0	30	123	-165	3	7	0	0	0	5
4	-14	0	-14	-35	-330	-285	106	-7	230	0	-14	5
5	-14	-3	-14	-5	-69	-260	8	9	0	0	0	5
6	151	-227	8	68	-87	-323	-118	156	495	0	46	0
7	-23	-3	-260	-1071	-30	-65	8	14	79	0	0	0
8	-33	-3	-225	-1006	115	-106	22	16	82	0	0	0

Table XIII-12
Total Delta Exports, 73-Year Period

Alternative 1 Average Monthly Exports (TAF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
534	578	624	611	544	526	527	358	323	526	592	514

Change in Exports from Alternative 1 (TAF)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	8	-42	-34	-25	-72	-45	-150	15	152	44	-101	-26
3	24	-40	-23	-11	-76	-46	-152	13	151	61	-74	-29
4	23	-35	-3	23	-89	-75	-207	-32	159	79	-38	-14
5	30	-36	-4	26	-104	-73	-152	13	151	70	-45	-30
6	22	-32	3	32	-90	-75	-60	-101	158	57	-56	-45
7	64	7	39	-19	-138	-83	-140	21	165	163	-79	-31
8	53	-5	6	90	-132	-77	-144	23	166	167	-48	-41

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
542	536	590	586	472	482	377	373	474	570	491	487

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	16	2	12	14	-4	-1	-2	-2	-1	17	27	-3
4	15	6	32	48	-17	-31	-57	-47	7	35	63	13
5	21	5	30	51	-32	-28	-3	-2	-1	25	56	-4
6	14	9	37	57	-18	-31	90	-116	6	13	45	-19
7	56	49	73	6	-67	-38	10	6	13	119	23	-4
8	45	37	41	115	-60	-33	6	8	14	123	53	-15

Table XIII-13
Total Delta Exports, Critical Period

Alternative 1 Average Monthly Exports (TAF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
534	578	624	611	544	526	527	358	323	526	592	514

Change in Exports from Alternative 1 (TAF)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	22	-87	-32	81	-255	-237	4	-80	15	-102	-64	-11
3	40	-92	-27	85	-252	-279	8	-86	10	-67	-54	-15
4	42	-94	-33	78	-244	-274	-28	-112	40	-49	-45	-3
5	44	-95	-29	82	-248	-277	8	-84	16	-57	-58	-11
6	38	-85	-28	84	-233	-259	124	-191	15	-124	-110	-23
7	38	-93	-14	150	-245	-284	8	-85	24	-26	-96	-23
8	40	-92	-14	146	-256	-284	3	-85	30	-29	-93	-22

Alternative 2 Average Monthly Exports (TAF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
356	323	542	672	402	336	234	254	311	378	302	315

Change in Exports from Alternative 2 (TAF)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	19	-5	5	3	4	-42	5	-6	-5	36	10	-4
4	21	-7	-1	-3	11	-36	-32	-32	25	54	19	9
5	22	-7	3	0	8	-40	5	-4	0	45	6	0
6	16	2	4	3	22	-21	121	-110	-1	-21	-47	-12
7	16	-6	17	69	10	-47	5	-4	9	76	-32	-12
8	18	-5	18	65	-0	-46	-0	-5	15	73	-29	-11

location of the X2 isohaline is downstream of specified locations for a certain number of days per month.

DWRSIM was used to determine the location of the X2 isohaline position for each of the seven Joint POD alternatives and the base case. The model predicts the location of X2 as a function of the current and previous months' flows (see section A of Chapter IV). Table XIII-14 shows the monthly average X2 positions for Alternative 1 for the 73-year flow record as predicted by the model. The table also compares the base case monthly average X2 positions to the X2 positions for each of the Joint POD alternatives. The significance of the changes in the X2 position are related to their effects on aquatic resources in the Delta. Positive changes indicate westward movement of the X2 line, which is generally desirable for aquatic species in the Estuary; negative changes indicate a shift toward the Delta.

There are only minor differences in the X2 position among Joint POD Alternatives 2 through 8. This result is expected because monthly average Delta outflow varies little among these alternatives. Compared to the base case, Alternatives 2 through 8 move in the upstream direction in January and October, and move downstream approximately one to three kilometers from February through September. The greatest downstream movement occurs in April and June. This movement of the X2 location is caused by implementation of the flow alternatives described in Chapter VI, not implementation of the Joint POD alternatives.

Table XIII-14
Modeled Isohaline (X2) Position

73-Year Period Average Monthly X2 Position from the Golden Gate Bridge (km)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	83.0	82.4	77.2	70.4	66.4	66.1	70.8	73.3	76.6	80.9	85.7	88.1

Change in X2 Position (km)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2 vs 1	-0.8	1.1	0.2	-0.5	1.1	1.4	3.0	1.9	2.5	1.5	1.0	1.5
3 vs 1	-1.0	0.9	-0.1	-0.7	1.1	1.4	3.0	1.9	2.5	1.5	1.0	1.4
4 vs 1	-1.2	0.6	-0.4	-1.1	0.9	1.4	3.3	2.3	2.7	1.6	1.0	1.2
5 vs 1	-1.2	0.7	-0.4	-1.1	1.0	1.5	3.0	1.9	2.5	1.5	1.0	1.3
6 vs 1	-1.0	0.5	-0.4	-1.0	1.0	1.5	2.6	2.1	2.8	1.6	1.0	1.1
7 vs 1	-1.8	-0.1	-1.0	-1.1	1.1	1.4	3.0	1.8	2.4	1.4	1.0	0.8
8 vs 1	-1.7	0.0	-0.7	-1.6	0.9	1.3	3.0	1.9	2.4	1.4	1.0	0.7

b. EC Within the Delta. DWRDSM was used to determine the effect of the eight Joint POD alternatives on EC in the Delta. DWRDSM uses the hydrology generated by DWRSIM studies as input. Thus, modeling assumptions for DWRSIM, discussed in Chapter IV, also apply to this salinity analysis. DWRDSM is not intended to provide absolute predictions of future Delta hydrodynamic and EC conditions; rather, the model is meant to be used as a tool to compare Delta conditions under various alternative actions.

This analysis examines the results of the simulations at six locations in the Delta: three locations in the western Delta (Contra Costa Canal at Pumping Plant # 1/Rock Slough, Sacramento River at Emmaton, and San Joaquin River at Jersey Point), one location in the Central Delta (San Joaquin River at Prisoners Point) and two locations in the southern Delta (San Joaquin River at Vernalis and Old River at Middle River). Figures XIII-12 through XIII-41 show expected EC conditions at these locations, except for Contra Costa Canal where chloride concentrations are reported. The figures compare the seven alternatives and the base case for water years 1976 through 1991.

Where possible, objectives have been noted on the figures. EC objectives for stations in the southern Delta (Old River near Middle River and San Joaquin near Vernalis) are the same for all year types, while EC objectives at the other stations change based on the year type. One figure is provided for each of the five water-year types. The first figure for each station shows the average EC (or chloride concentration) for wet years during the sixteen-year period, the second figure shows the average for above normal years, and so on. Year types are as defined in the 1995 Bay/Delta Plan. The 40-30-30 Sacramento Basin year type classification system is used for the western and central Delta stations, and the 60-20-20 San Joaquin Basin year type classifications is used for the southern Delta stations.

Modeled chloride concentrations at Contra Costa Canal Pumping Plant 1 are shown in Figures XIII-12 through XIII-16. A feature of these plots is that the maximum mean daily chloride objective is exceeded in some periods for all of the alternatives. This result is caused by differences between the methods used by DWRSIM and DWRDSM to calculate salinity or chloride concentrations. DWRSIM, the operations model, uses a relationship between outflow and chloride or EC to determine concentrations of these parameters at selected western Delta stations, including the Contra Costa Pumping Plant. DWRSIM makes reservoir releases as necessary to meet objectives at these locations. DWRSIM output indicates that these objectives are always met. The hydrology output from DWRSIM is used as input to DWRDSM, which uses a more complicated method for calculating salinity and chloride concentrations. The method used by DWRDSM considers other factors such as exports. Thus, output from DWRDSM shows violations of the chloride objective. In summary, the DWRDSM output indicates a need for carriage water, but the DWRSIM model does not presently include a method for calculating carriage water. Although the DWRDSM output predicts that salinity objectives at certain locations would be violated, in actual operations, the projects would be operated to meet salinity and chloride objectives in the western Delta for all of the alternatives, and violations would not be expected to occur. Because of the conditions described above, salinity information depicted in Figures XIII-12 through XIII-41 is generally discussed relative to base case salinity, rather than to the objectives.

Contra Costa Canal at Pumping Plant # 1. Figure XIII-12 shows that, in wet years, chloride levels under each of the alternatives are well below the 250 mg/l maximum mean daily chloride objective. Alternatives 2 through 8 result in considerably lower chloride levels in June through September, and higher chloride levels relative to the base case in October and December.

In above normal years, Figure XIII-13 shows that Alternatives 2 through 8 result in higher chloride levels in October through December and February relative to the base, and lower chloride levels in June, August and September.

Below normal years show the most dramatic differences between the base case and the alternatives. As shown in Figure XIII-14, average chloride levels in July through September for each of the alternatives are around 50, 80, and 150 mg/l, respectively, contrasted with the base case which has chloride levels of 227, 364, and 332 mg/l for the same months.

A similar pattern emerges in dry years (Figure XIII-15), with Alternatives 2 through 8 resulting in dramatically lower chloride levels in June through September. Base case chloride levels are dramatically lower in January.

In critical years (Figure XIII-16), the seven alternatives show dramatic improvement over the base case from March through August. In July particularly, chloride levels for Alternatives 2 through 8 are around 140 mg/l while base case chloride levels are 330 mg/l. The base case results in lower chloride levels in all other months except November.

The chloride concentrations of Alternatives 2 through 8 are similar. Alternatives 7 and 8 result in somewhat higher July, October, November and December chloride levels compared to Alternatives 2 through 6. The rest of the time effects vary from month to month and year type to year type, and the differences are generally small.

Sacramento River at Emmaton. Figures XIII-17, XIII-18, and XIII-19 show predicted salinity for Emmaton in the western Delta in wet, above normal, and below normal years. These figures show no appreciable differences among the alternatives from January through May. Alternatives 2 through 8 result in lower salinity in June through September in wet years, in August of above normal years, and June through September and December of below normal years. The base case salinity is lower in October of wet and above normal years.

In dry years (Figure XIII-20), Alternatives 2 through 8 result in lower salinities in April through September, and higher salinities in October, December, and January. In critical years, (Figure XIII-21) Alternative 2-8 salinities are lower in February through July and November. Base case salinity is lower in January, August, October, December and January.

Figure XIII-12

Chloride Concentrations for Contra Costa Canal at Pumping Plant #1 End-of-Month Simulated Values for Wet Years

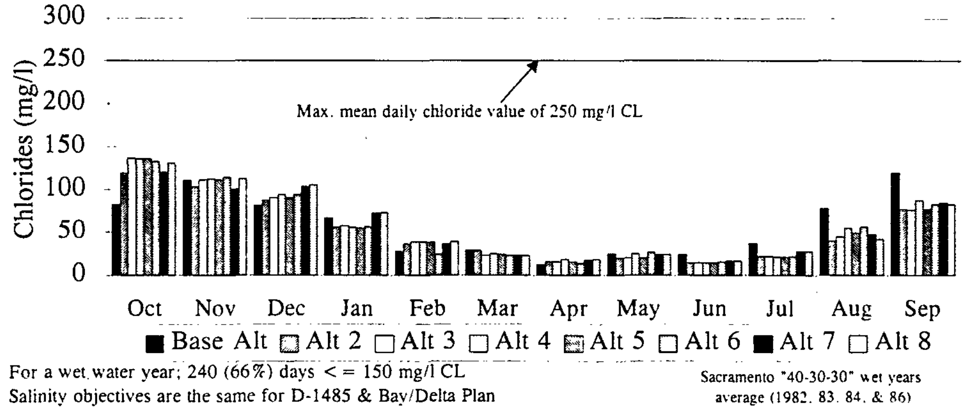


Figure XIII-13

Chloride Concentrations for Contra Costa Canal at Pumping Plant #1 End-of-Month Simulated Values for Above Normal Years

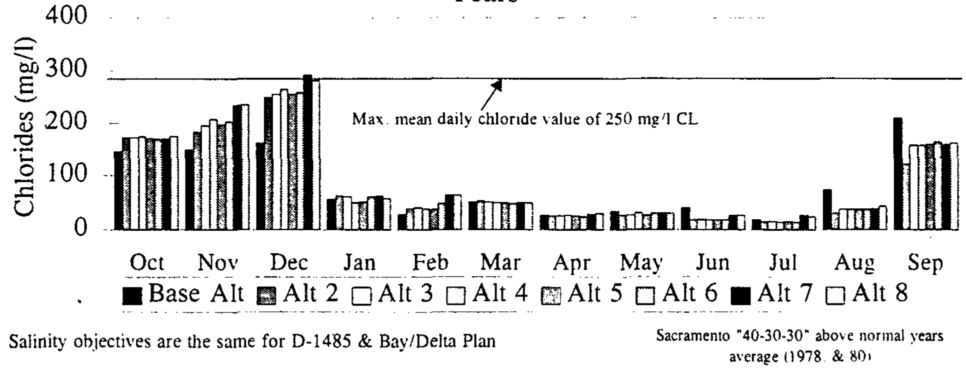


Figure XIII-14

Chloride Concentrations for Contra Costa Canal at Pumping Plant #1 End-of-Month Simulated Values for Below Normal Years

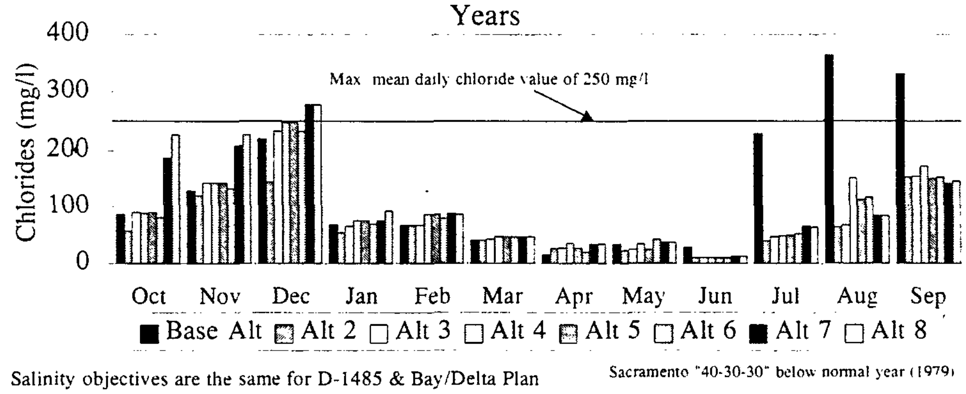


Figure XIII-15

Chloride Concentrations for Contra Costa Canal at Pumping Plant # 1 End-of-Month Simulated Values for Dry Years

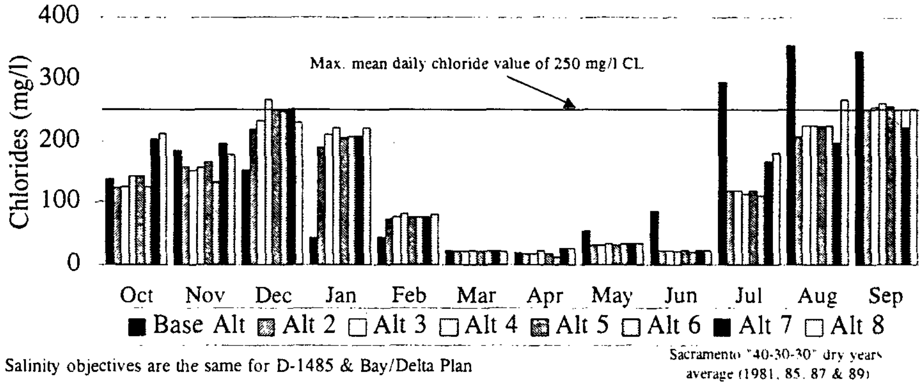


Figure XIII-16

Chloride Concentrations for Contra Costa Canal at Pumping Plant # 1 End-of-Month Simulated Values for Critical Years

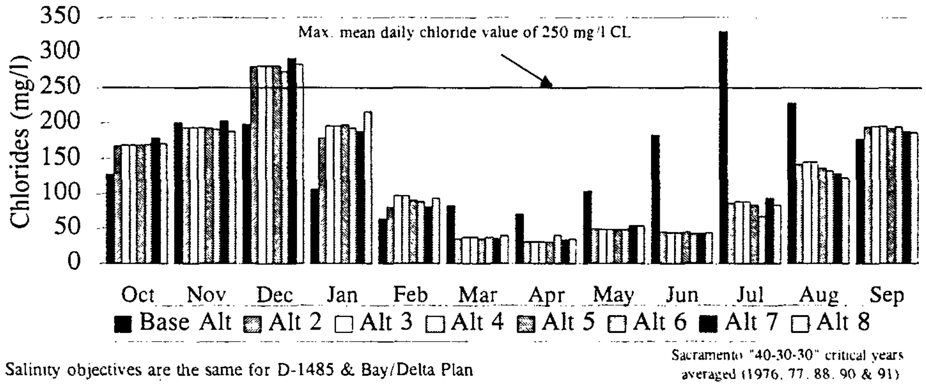


Figure XIII-17

Salinity for Sacramento River at Emmaton End-of-Month Simulated Values for Wet Years

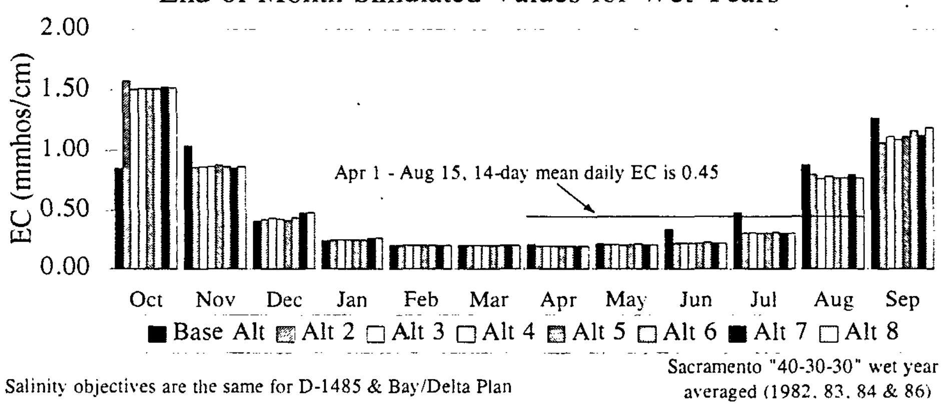


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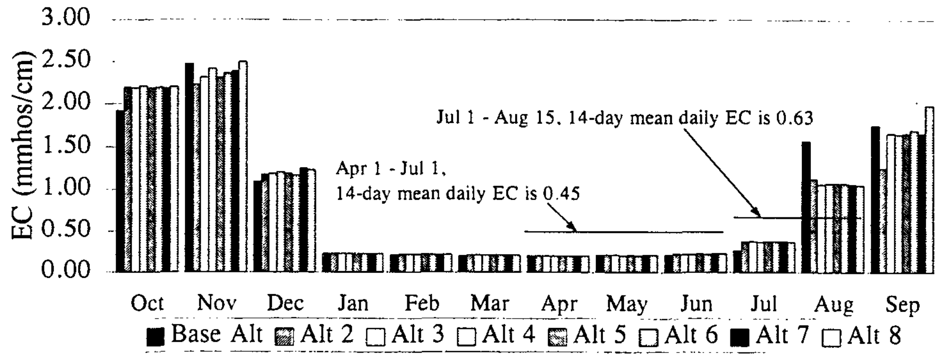
Figure XIII-18

Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Above Normal Years

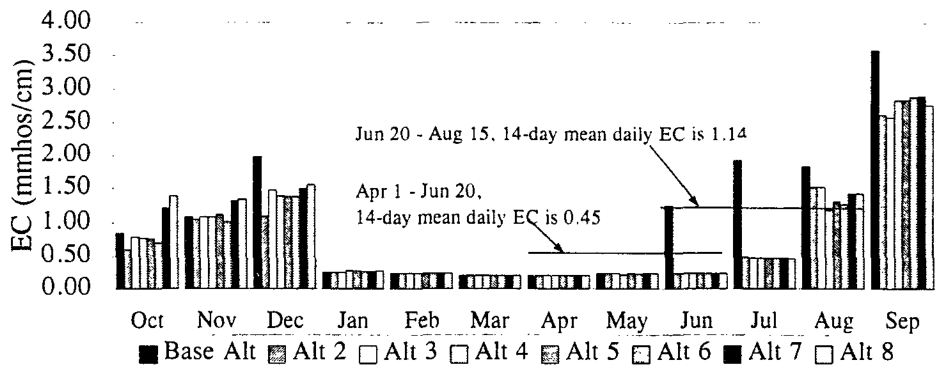


Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" above normal years averaged (1978 & 80)

Figure XIII-19

Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Below Normal Years

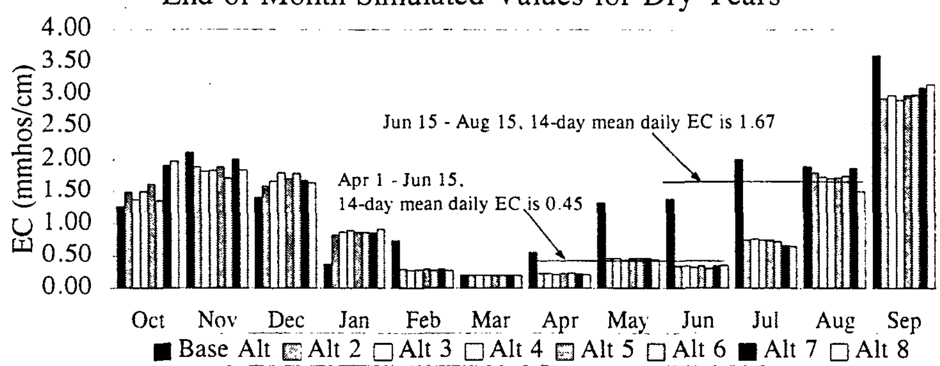


Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" below normal year averaged (1979)

Figure XIII-20

Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Dry Years

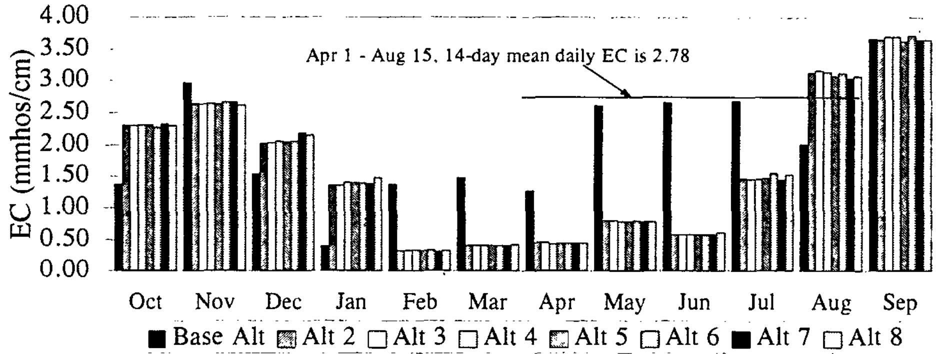


Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" dry years average (1981, 85, 87 & 89)

Figure XIII-21

Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Critical Years

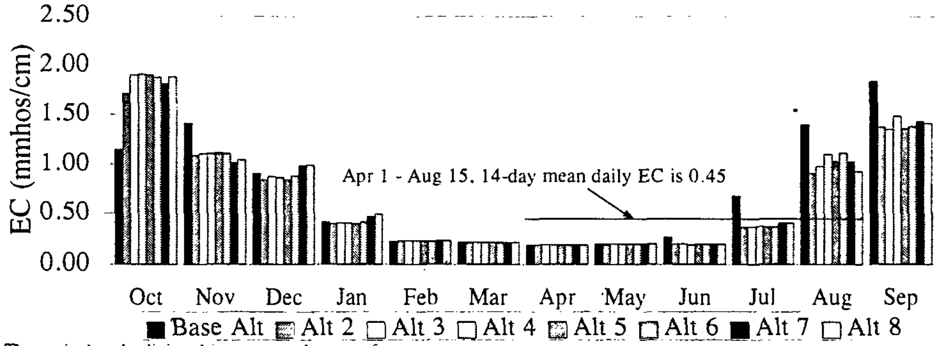


Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" critical years average (1976, 77, 88, 90 & 91)

Figure XIII-22

Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Wet Years

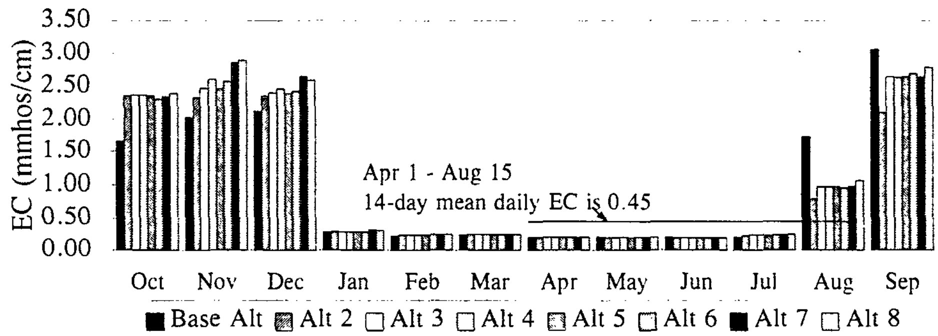


The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm.

Sacramento "40-30-30" wet years averaged (1982, 83, 84 & 86)

Figure XIII-23

Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Above Normal Years

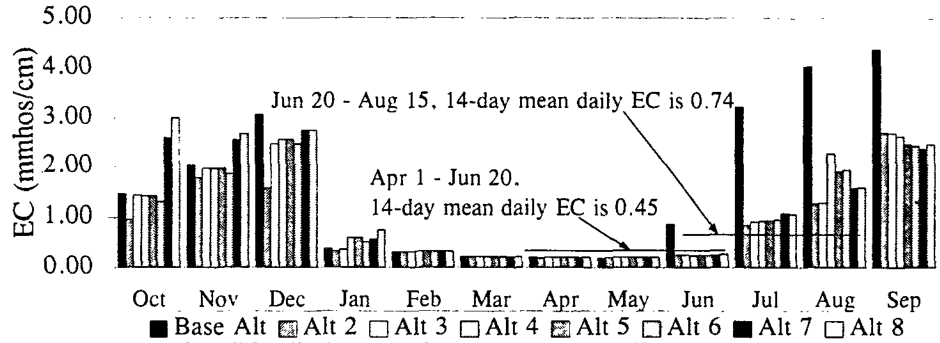


The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" above normal year averaged (1978 & 80)

Figure XIII-24

Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Below Normal Years

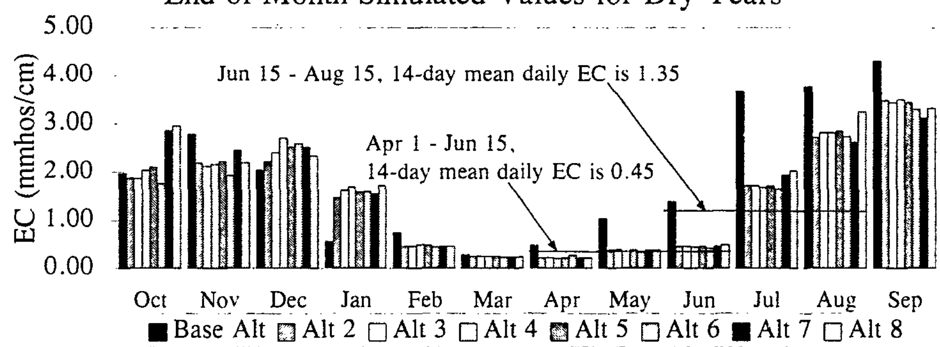


The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" below normal year (1979)

Figure XIII-25

Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Dry Years

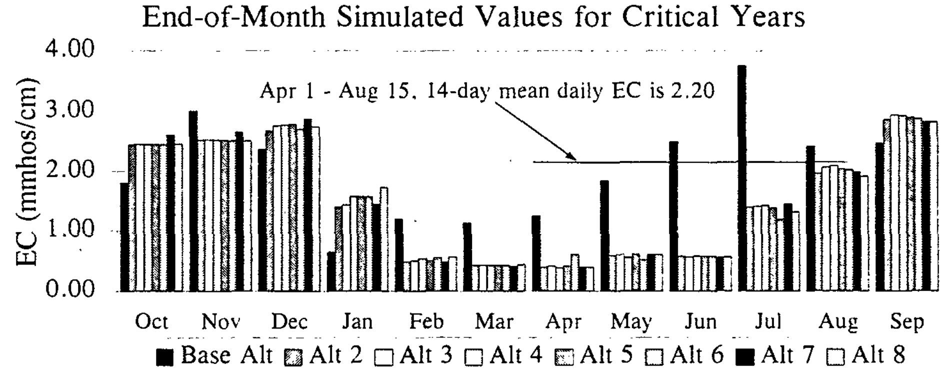


Agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" dry years averag (1981, 85, 87 & 89)

Figure XIII-26

Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Critical Years

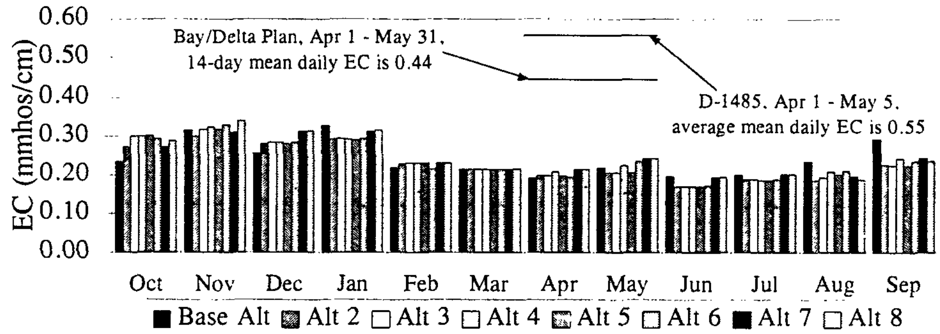


Salinity objectives are the same for D-1485 & Bay/Delta

Sacramento "40-30-30" critical year averaged (1976, 77, 88, 90 & 91)

Figure XIII-27

Salinity for San Joquin River at Prisoners Point
End-of-Month Simulated Values for Wet Years

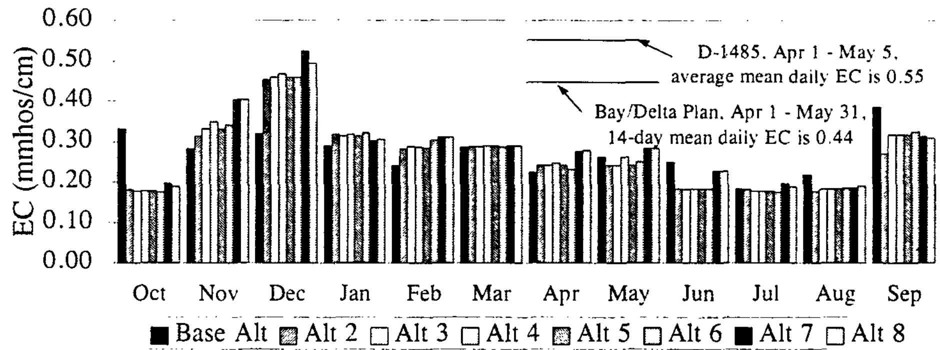


The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" wet years averaged (1982, 83, 84 & 86)

Figure XIII-28

Salinity for San Joaquin River at Prisoners Point
End-of-Month Simulated Values for Above Normal Years

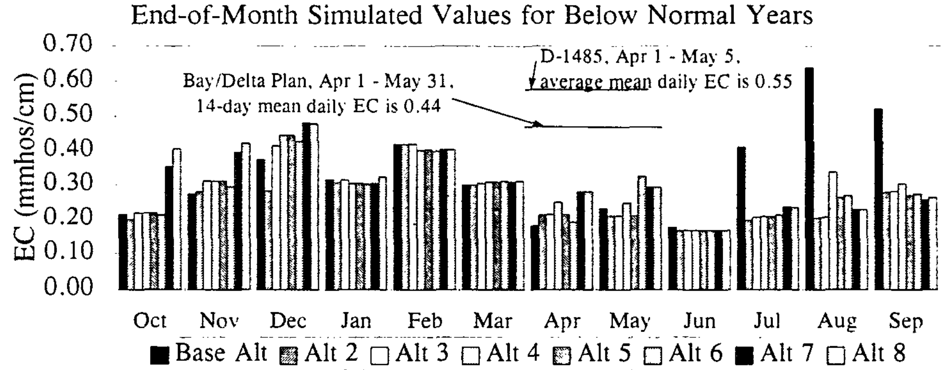


The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" above normal years averaged (1978 & 80)

Figure XIII-29

Salinity for San Joaquin River at Prisoners Point
End-of-Month Simulated Values for Below Normal Years

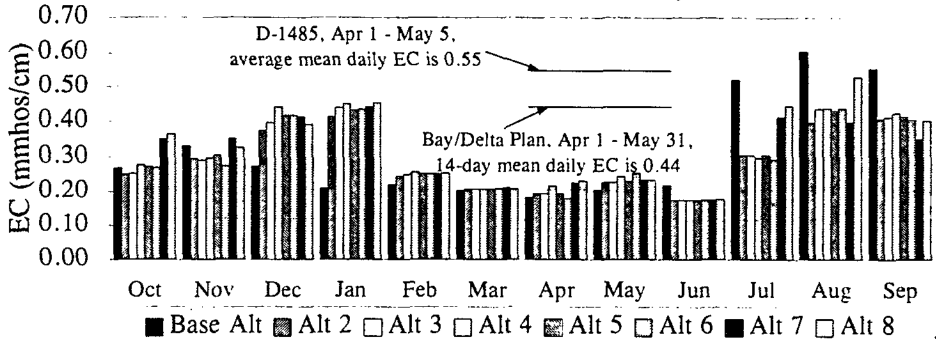


The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" below normal year (1979)

Figure XIII-30

Salinity for San Joaquin River at Prisoners Point End-of-Month Simulated Values for Dry Years

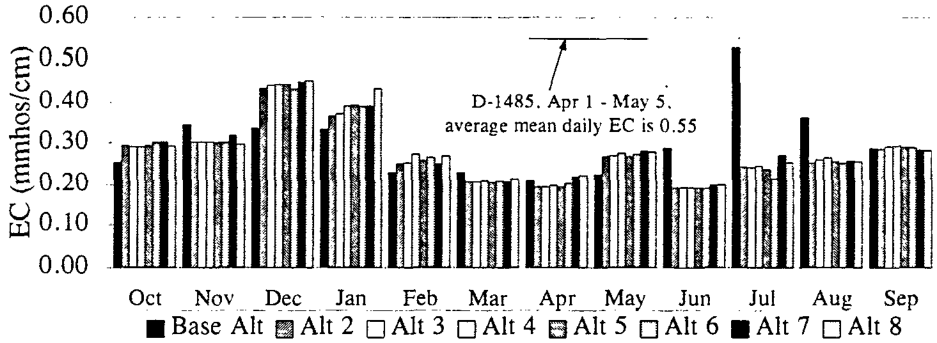


The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" dry years averaged (1981, 85, 87 & 89)

Figure XIII-31

Salinity for San Joaquin River at Prisoners Point End-of-Month Simulated Values for Critical Years

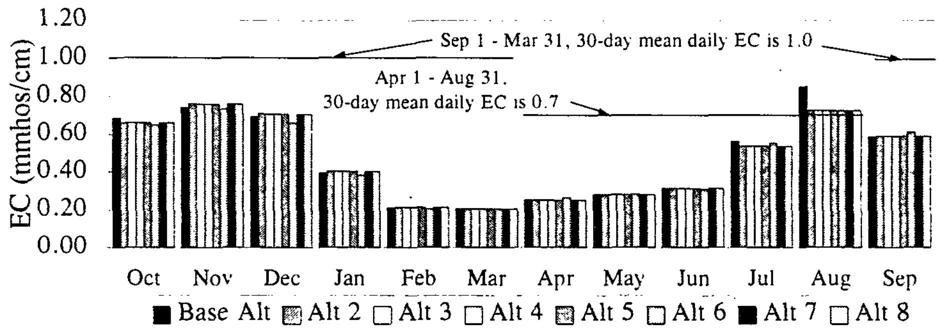


The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" critical years averaged (1976, 77, 88, 90 & 91)

Figure XIII-32

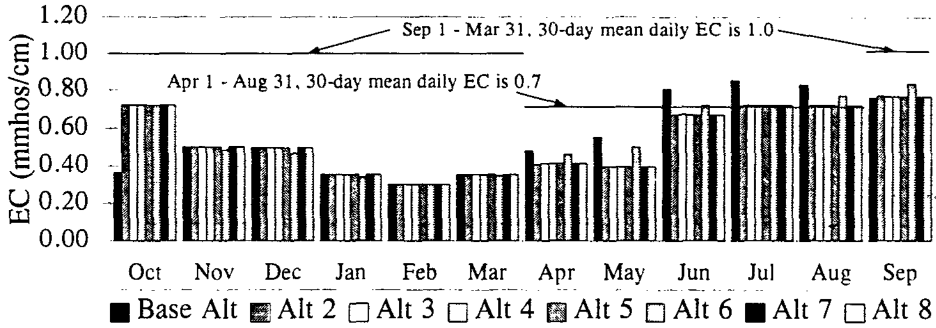
Salinity for San Joaquin River at Airport Bridge (Vernalis) End-of-Month Simulated Values for Wet Years



Water quality salinity objectives are for Bay/Delta Plan. D-1485 has no salinity objective at Vernalis; however, D-1422 requires New Melones Reservoir to be operated to maintain salinity at Vernalis at 500 ppm (0.82 mmhos/cm) year-round

Figure XIII-33

Salinity for San Joaquin River at Airport Bridge (Vernalis)
End-of-Month Simulated Values for Above Normal Years



Water quality salinity objectives are for Bay/Delta Plan. D-1485 has no salinity objective at Vernalis; however, D-1422 requires New Melones Reservior to be operated to maintain salinity at Vernalis at 500 ppm (0.82 mmhos/cm) year-roun

Figure XIII-34

Salinity for San Joaquin River at Airport Bridge (Vernalis)
End-of-Month Simulated Values for Below Normal Years

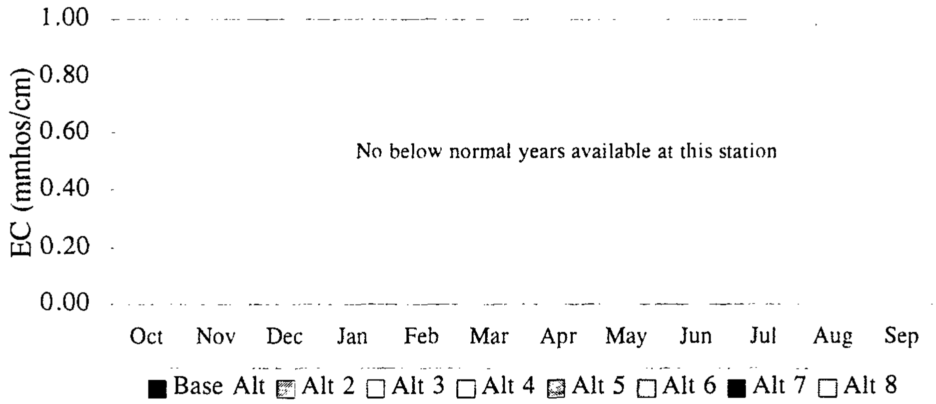
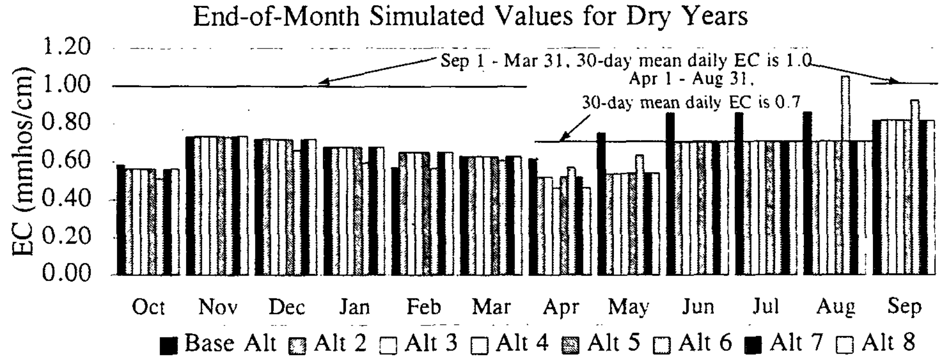


Figure XIII-35

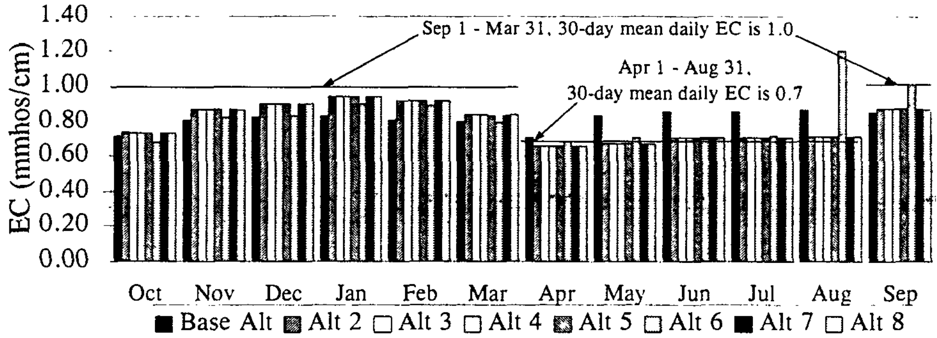
Salinity for San Joaquin River at Airport Bridge (Vernalis)
End-of-Month Simulated Values for Dry Years



Water quality salinity objectives are for Bay/Delta Plan. D-1485 has no salinity objective at Vernalis; however, D-1422 requires New Melones Reservior to be operated to maintain salinity at Vernalis at 500 ppm (0.82 mmhos/cm) year-round

Figure XIII-36

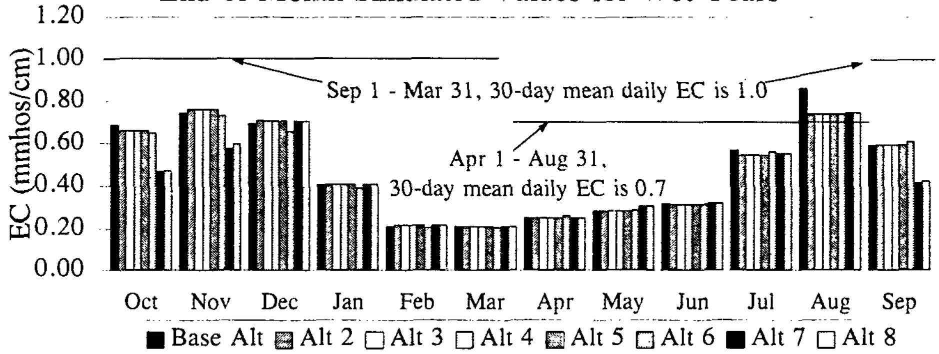
Salinity for San Joaquin River at Airport Bridge (Vernalis)
End-of-Month Simulated Values for Critical Years



Water quality salinity objectives are for Bay/Delta Plan. D-1485 has no salinity objective at Vernalis; however, D-1422 requires New Melones Reservoir to be operated to maintain salinity at Vernalis at 500 ppm (0.82 mmhos/cm) year-round

Figure XIII-37

Salinity for Old River Near Middle River
End-of-Month Simulated Values for Wet Years

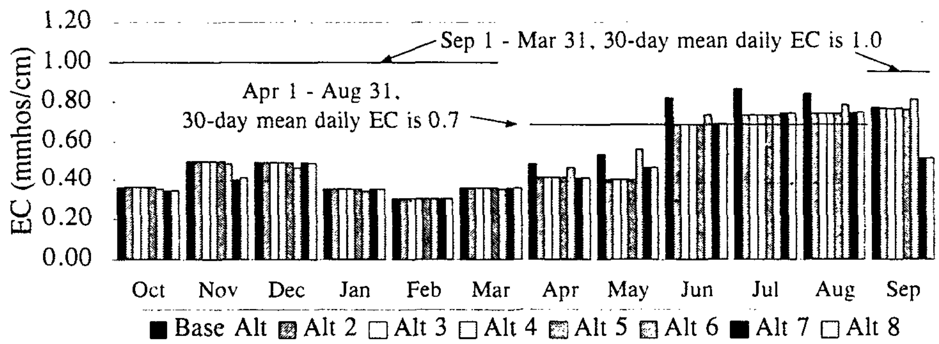


Salinity objective are for the 1995 Bay/Delta Plan

San Joaquin "60-20-20" wet years averaged (1978, 80, 82, 83 & 86)

Figure XIII-38

Salinity for Old River Near Middle River
End-of-Month Simulated Values for Above Normal Years



Salinity objective are for the 1995 Bay/Delta Plan

San Joaquin "60-20-20" above normal years averaged (1979 & 84)

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Figure XIII-39

Salinity for Old River Near Middle River
End-of-Month Simulated Values for Below Normal Years

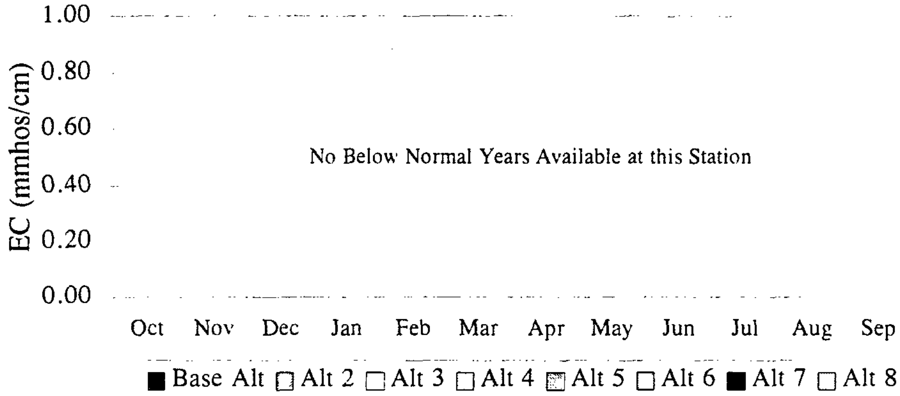
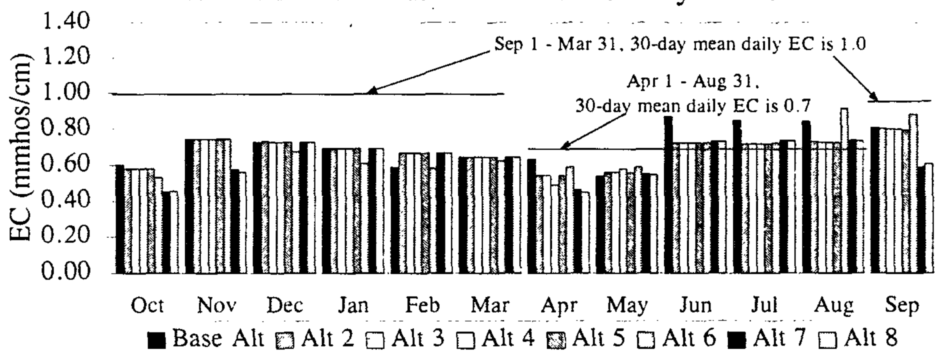


Figure XIII-40

Salinity for Old River Near Middle River
End-of-Month Simulated Values for Dry Years

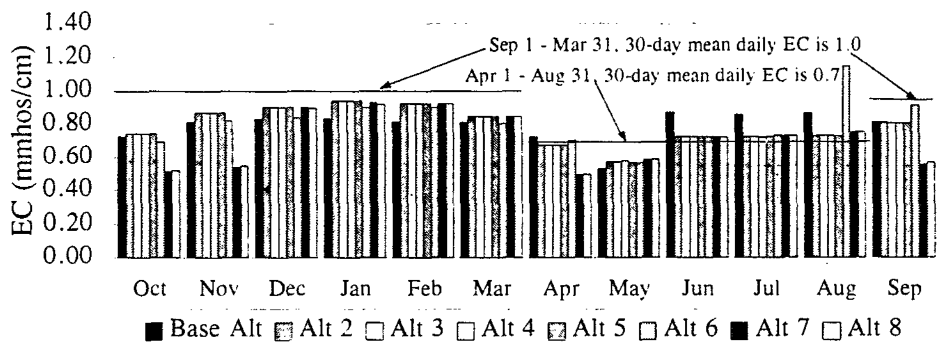


Salinity objective are for the 1995 Bay/Delta Plan

San Joaquin "60-20-20" dry years averaged (1981 & 85)

Figure XIII-41

Salinity for Old River Near Middle River
End-of-Month Simulated Values for Critical Years



Salinity objective are for the 1995 Bay-Delta Plan

San Joaquin "60-20-20" critical years averaged (1976, 77, 87, 89, 90 & 91)

The effects of the non-base case alternatives on salinity are practically indistinguishable from each other at this location.

San Joaquin River at Jersey Point. Figures XIII-22, XIII-23, and XIII-24 show no differences among the alternatives from February through June in wet years, from January to July in above normal years, and February through May in below normal years. Alternatives 2 through 8 are lower in June, July, August, and September of wet and below normal years, and August and September of above normal years, with below normal years showing the most dramatic differences in these months.

Figure XIII-25 shows Alternatives 2 through 8 as having lower salinity compared to the base case in April through September of dry years. Figure XIII-26 shows Alternatives 2 through 8 as having lower salinities from February through August and November and higher salinities in January, September, October, and December of critical years.

The effects of the non-base case alternatives on salinity are practically indistinguishable from each other at this location in all five year types.

San Joaquin River at Prisoners Point. Figures XIII-27 through XIII-31 show the salinity at this location. The base case alternative has slightly higher salinity in August and September, and slightly lower salinities in October of wet years. For above normal years, base case salinity is higher in June, September, and October, and lower in November through February and April. In below normal and dry years the base case salinity is considerably higher in July, August and September. In critically dry years, the base case salinity is higher in June, July, and August.

Practically no distinction can be made among Alternatives 2 through 8, although salinities for Alternatives 7 and 8 are highest most often, usually by a very small amount.

San Joaquin River at Vernalis. Figures XIII-32 through XIII-36 show the EC at this station for five year types. The principal factor controlling the salinity differences between the base case and the alternatives is the different Vernalis objectives that apply. The salinity objectives at Vernalis in the Bay/Delta Plan are 0.7 mmhos/cm from April through August and 1.0 mmhos/cm for September through March. The salinity objective in the base case is 500 ppm (0.82 mmhos/cm) year-round. Because of the difference in objectives, Vernalis salinity is generally lower under the base case in September through March and higher in April through August.

Alternative 6 shows higher salinities than the other alternatives in August and September for most year types because the Letter of Intent limits releases from New Melones Reservoir for salinity control to 70 TAF. No such limit applies to the other alternatives.

Old River near Middle River. Figures XIII-37 through XIII-41 show the EC at this station for the five year types. The EC at this location is similar to the EC at Vernalis with

C-032266

two exceptions. First, the EC is usually a little higher because of local agricultural drainage. Second, the EC for Alternatives 7 and 8 is lower in some months than other alternatives because the permanent southern Delta barriers are assumed to be installed. For Alternatives 1 through 6, the temporary barriers are installed.

Summary. The salinity and chloride patterns observed for Joint POD Alternatives 2 through 8 are similar. There are no significant differences among the alternatives caused by implementation of the combined use of points of diversion. The principal differences observed are caused by differences in the Flow Alternatives which are already described in Chapter VI. Specifically, within the Joint POD alternatives, salinity differences occur because of implementation of requirements in D-1485 (Joint POD Alternative 1), the Bay/Delta Plan (Joint POD Alternatives 2 through 8), and the Letter of Intent (Joint POD Alternative 6). These differences are already analyzed in Chapter VI.

3. Fish and Aquatic Resources.

The effects to aquatic resources resulting from the implementation of the 1995 Bay/Delta Plan are analyzed and disclosed in the ER and this draft EIR. The purpose of this section is to evaluate the additional effects that implementation of Joint POD alternatives would have on aquatic resources in the Delta.

Modifications to pumping patterns, reservoir releases, and other operations of the water management system caused by the combined use of points of diversion have the potential to affect aquatic resources system wide. Other impacts from temperature changes, food limitations, habitat losses, introduced species, harvesting, and contaminants discussed in Chapter VI are not expected to change significantly for any of the Joint POD alternatives. The effects attributable to implementation of the 1995 Bay/Delta Plan are represented by Alternative 2. Alternatives 3-8 demonstrate the effects that the assumptions allowing various levels of wheeling have, in addition to those attributable to implementation of the 1995 Bay/Delta Plan.

Of the factors mentioned above, entrainment is thought to have the most significant impact on aquatic resources in the Delta from implementing one of the Joint POD alternatives. Entrainment is expected to increase because exports would increase between July and January (see Table XIII-12). In general, higher exports from the SWP and the CVP are considered most harmful during the spring when eggs, larvae, and juveniles of many Bay/Delta species are present. All of the alternatives reduce exports in February and March from the base case (Alternative 2) with some reductions in April, May, and June. Entrainment from July to January would increase because of increased exports to make up for spring reductions and increased reverse flows associated with the alternatives that would shift more organisms towards the central Delta and the pumps. Impacts of these export changes are species dependent. Some anadromous species like winter-run chinook salmon may respond positively because entrainment primarily impacts the smolts which would complete their outmigration by the time exports increase in the summer. For other species like spring-run chinook salmon,

C-032267

the increased fall and winter pumping may negatively affect them because this coincides with smolt outmigration. Decreased late winter and spring pumping will not provide any benefit for spring-run because the smolt outmigration is completed by this time. Joint POD Alternative 4 provides greater protection for aquatic resources than Joint POD Alternatives 3 and 5 through 8 because the combined use of points of diversion is used principally for the benefit of aquatic resources. As modeled, Alternative 4 results in decreased exports for much of the rest of the year. Even this operation, however, can negatively affect aquatic resources if their most critical period in the Delta does not coincide with the window of export reductions.

Delta outflow is also expected to change with the implementation of the Joint POD alternatives but less severely on a percentage basis than entrainment. Delta outflow generally decreases from the base case (Alternative 2) between July and January and increases during February and March with mixed results in April, May, and June. Alternative 4 provides more continuous increased outflows in the spring (March through June) when many Delta species abundance is correlated to Delta outflows.

The effects of the Joint POD alternatives on aquatic resources in the Delta are described in this section. The aquatic resource models described in Chapter IV and Chapter VI were used. For purposes of discussion, results are grouped into three categories: (1) special status species; (2) species that characterize potential effects on food webs; (3) abundance/outflow model results, and (4) net reverse flows. Salmon, striped bass, and Delta smelt are the special status species considered. Copepods and phytoplankton are evaluated to assess food web effects. Abundance/outflow models are available for longfin smelt, Sacramento splittail, starry flounder, *Crangon franciscorum*, and *Neomysis*.

Salmon. Sacramento Basin fall-run, late-fall run and winter-run chinook salmon (*Onchorhynchus tshawytscha*) smolt survival was modeled for each of the Joint POD alternatives (USFWS 1995). These multiple regression model predict chinook salmon smolt survival through the Delta between Sacramento and Chipps Island. This model can be used to estimate the relative benefits of operations of same controllable parameters in the Delta, specifically exports, and Delta Cross Channel gate operation. The results for the Joint POD alternatives analysis are displayed in Figures XIII-42 through XIII-44. Each of the Joint POD alternatives has higher predicted smolt survival than the base case (Alternative 1). This is true for fall-run, late-fall run, and winter-run model predictions. The smolt survival increases are largely driven by the closure of the Delta Cross Channel gates. Under Joint POD Alternative 1, the Delta Cross Channel is open more often, diverting smolts into the central Delta where lower survival is predicted. The greatest increase in survival is predicted for late-fall and winter runs with implementation of the 1995 Bay/Delta Plan (Alternative 2). The fall-run indices are lower because of the higher water temperatures during their migration season. There are no discernable differences between Joint POD Alternatives that allow wheeling and Alternative 2.

Striped Bass. Adult striped bass populations were modeled for each Joint POD alternative using a predictive striped bass model (Bostford and Brittnacher 1994) that relates population numbers of striped bass to flows and diversions within the Bay/Delta. Figure XIII-45 displays the results of the model runs for each of the alternatives. The predicted population level at the end of the 73-year modeling period differs little among alternatives. However, within the modeling period, differences among the Joint POD alternatives are predicted.

Population estimates for alternatives that allow wheeling were generally predicted to be greater than the estimate for Alternative 2. Joint POD alternatives 6, 7, and 8, generally increase exports during the April through July period when young-of-year (YOY) recruitment has been correlated with export rates. The increased exports are not always associated with a reduction in Delta outflow. Therefore, the higher expected mortality rates from entrainment are sometimes offset by increases in Delta outflows when the model predicts YOY year class strength. Increased exports in the April through July period also allow for reductions in exports during the remaining part of the year. The model uses this period to predict survival of the juvenile to adult life stage. Reductions in the estimated losses of juvenile fish during this portion of the year lead to the increases in the predicted adult population level estimated for Joint POD alternatives that allow wheeling.

Delta Smelt. Entrainment rates are generally highest in dry water year types. Lower population levels also tend to occur in drier water year types, suggesting that a greater proportion of Delta smelt are entrained when the population is most sensitive. Implementation of the Joint POD alternatives would reduce exports during some of the Delta smelt's critical period during the spring. The primary mechanism for increased entrainment is low outflow, which shifts the population closer to the diversions (DWR and USBR 1994). Delta smelt are more abundant when X2 is located in Suisun Bay. The location of X2 in Suisun Bay may allow access to considerably more suitable shallow-water habitats than in the river channels upstream (IEP 1996b). The pattern and magnitude of changes to X2 for Joint POD alternatives can largely be attributed to the implementation of the 1995 Bay/Delta Plan. The mean monthly position of X2 for Joint POD alternatives that allow wheeling is not significantly different from the position predicted for Alternative 2 (Table XIII-14).

Delta Food Webs. The Estuary is a large, complex system with many sources of biological variation, many of which are unknown. The proliferation of introduced species into the Estuary has contributed to the uncertainty about how the aquatic communities respond to changes. The exotic species now present in the Estuary have altered the lower trophic levels by reducing phytoplankton concentrations and the abundance of native benthic and pelagic species (IEP 1996a). Export pumping has also been negatively correlated with phytoplankton community composition and chlorophyll *a* concentrations (Lehman 1992). Jassby and Powell (1994) found that diversion and Delta outflow together account for 86 percent of the variability in chlorophyll *a* concentrations in the entrapment zone. Changes in lower trophic levels have not been as obvious in higher trophic levels. Zooplankton populations, such as rotifers and copepods, may be entrained at rates that can affect local populations, but there is probably no

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Figure XIII-42

Sacramento River Fall-Run Chinook Salmon Smolt Survival

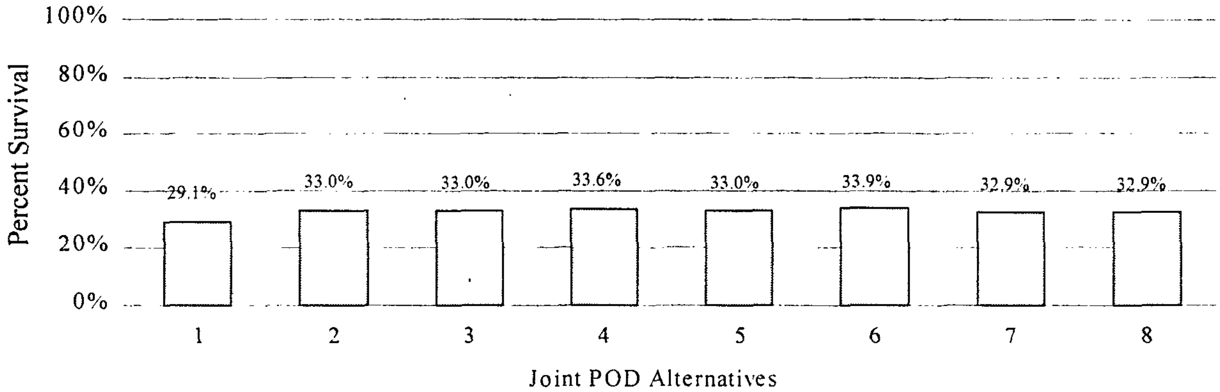


Figure XIII-43

Sacramento River Late-Fall Run Chinook Salmon Smolt Survival

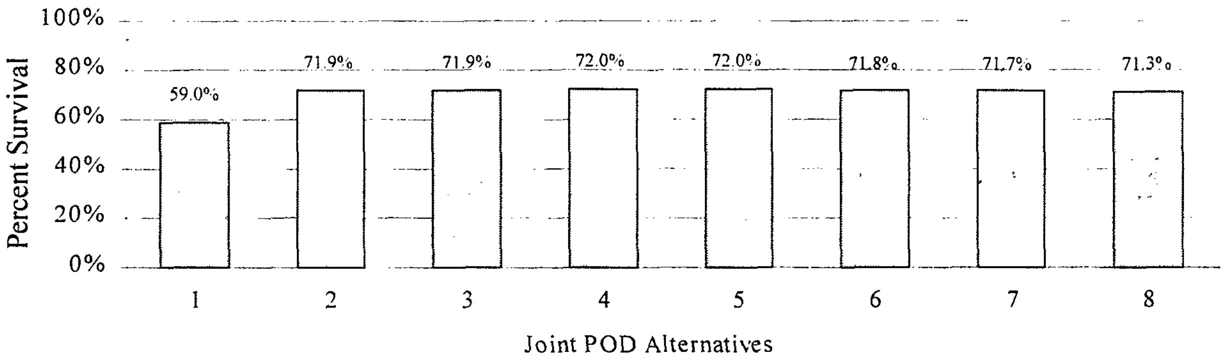


Figure XIII-44

Sacramento River Winter-Run Chinook Salmon Smolt Survival

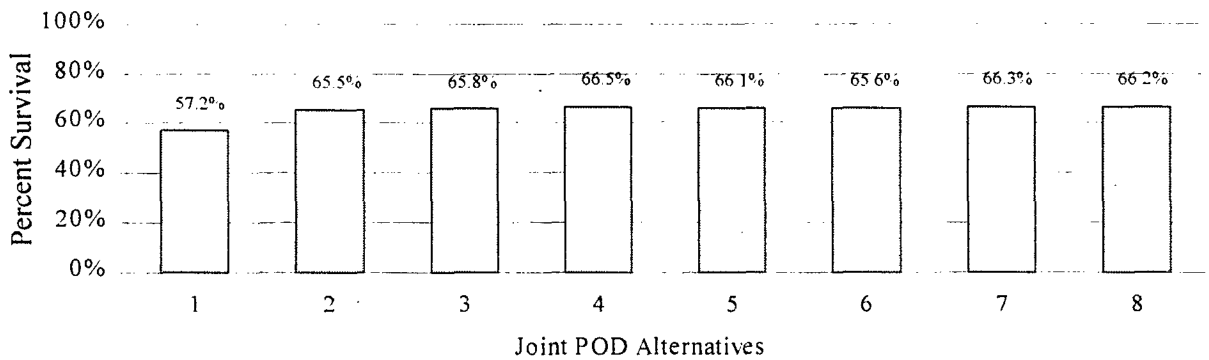
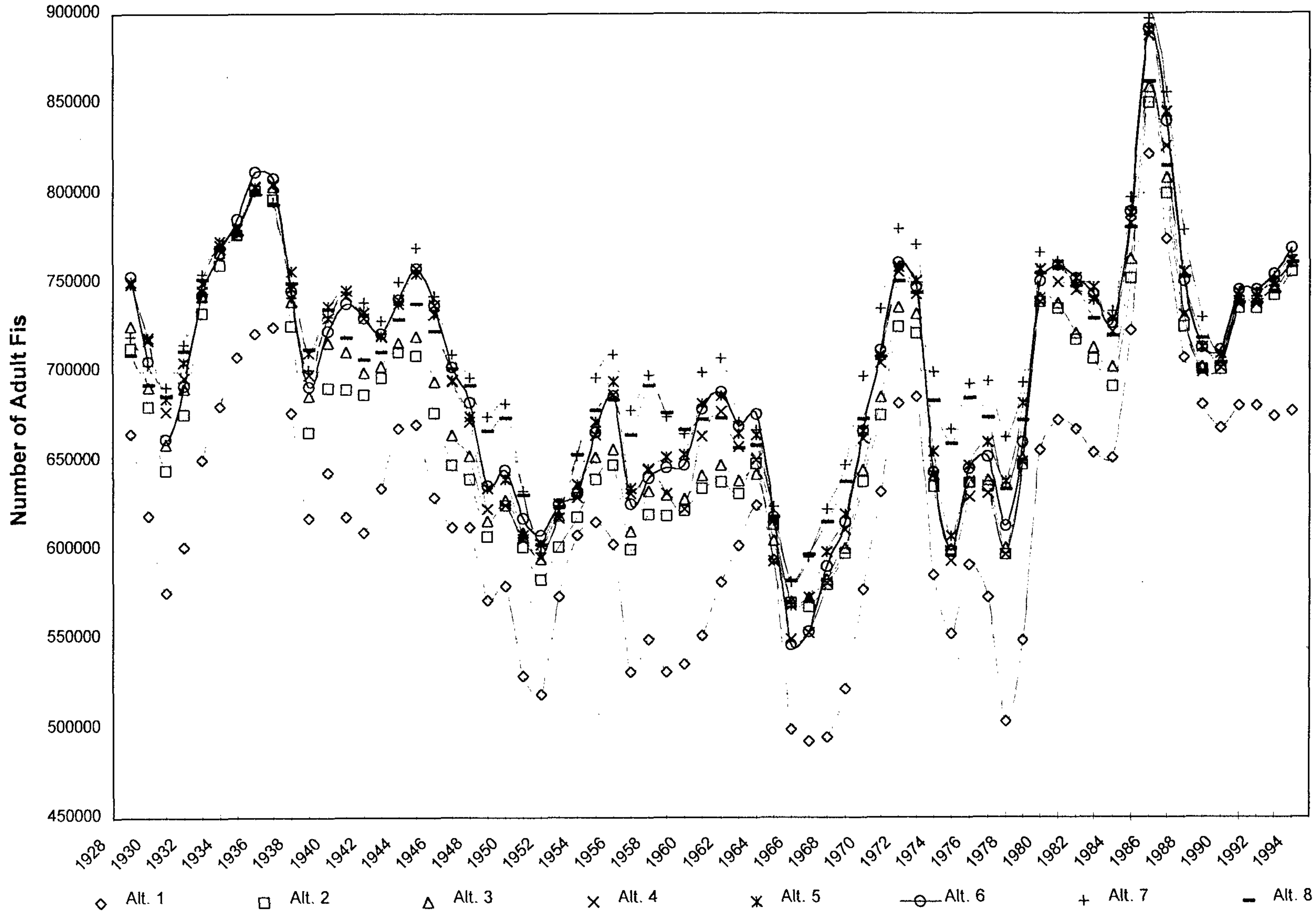


Figure XIII-45
Striped Bass Model Comparison of Joint POD Alternatives



population effect because the proportion of the whole population entrained is small (IEP 1996a). Joint POD alternatives that allow wheeling would increase exports and reduce Delta outflow, which may lead to increased localized effects on populations over those that would be provided through implementation of the standards. However, the protections provided by the 1995 Bay/Delta standards remain in effect.

Abundance/Outflow Model Result. Results of the abundance/outflow models for Joint POD alternatives are shown in Figures XIII-46 through XIII-50. All Joint POD alternatives are predicted to increase the abundance indices over Alternative 1 for all species considered. There are no discernible differences between Joint POD alternatives that allow wheeling and Alternative 2. Most indices under Alternative 4 are slightly higher.

Net Reverse Flows. Net reverse flows occur when the net flow in Delta channels is toward the Delta rather than downstream towards Suisun Bay. These reverse flows may have adverse affects on the aquatic resources in the Delta. Flows may disorient fish, causing increased straying; and they may carry eggs, larvae and juvenile fish into the central and southern Delta causing a reduction in rearing conditions, increased predation, and increased entrainment at export facilities and local agricultural, municipal, and industrial diversions.

Table XIII-15 lists QWEST flows from the DWRSIM studies used as a measure of reverse flows in Delta channels. To a certain extent, QWEST can be used as a measure of reverse flows conditions in Delta channels. As QWEST flows decrease, net reverse flows in some Delta channels will increase. The model output shows that the QWEST flows for the Joint POD alternatives are relatively mixed for each alternative in the 73-year annual average with no clear best alternative. QWEST generally increase from the base case for all alternatives in February, March, and May. In April and June, the QWEST flows are varied. Between July and January, QWEST flows for the alternatives generally decrease from the base case. For the critical period annual averages, the alternatives are still mixed and follow the same overall pattern. During critical periods, the Joint POD alternatives result in decreased QWEST flows (increased net reverse flows) from October through January and again in July.

Summary of Effects on Fish and Aquatic Resources. All Joint POD alternatives are beneficial to most species when compared to D-1485 (Alternative 1). However, for all the alternatives there is a potentially negative effect from entrainment for the Joint POD alternatives with respect to Alternative 2. Alternatives 2 and 4 appear to be the alternatives that are most beneficial to aquatic resources. Alternative 3 is less beneficial than Alternatives 2 and 4. Alternatives 5 and 6 have moderate impacts compared to Alternative 2, and Alternatives 7 and 8 are the least beneficial to the aquatic resources. Part of the positive effect of implementation of the objective in the Bay/Delta Plan is eliminated by implementing the Joint POD alternatives.

Figure XIII-46

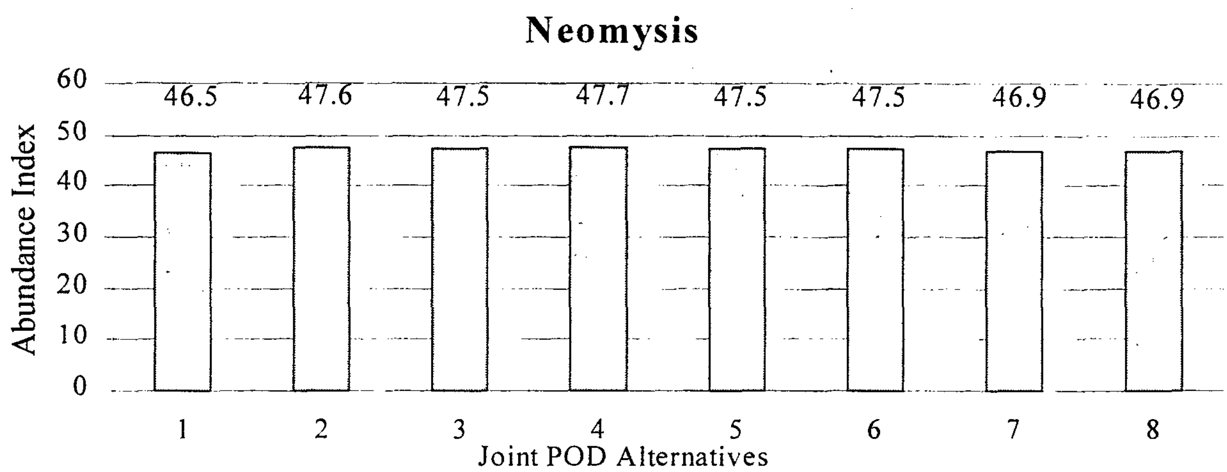


Figure XIII-47

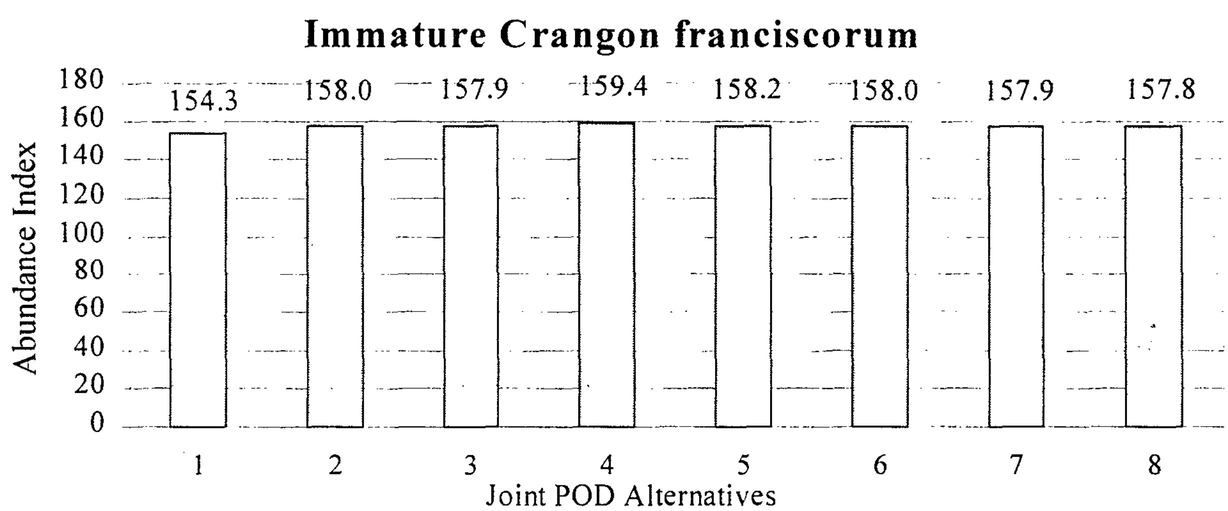


Figure XIII-48

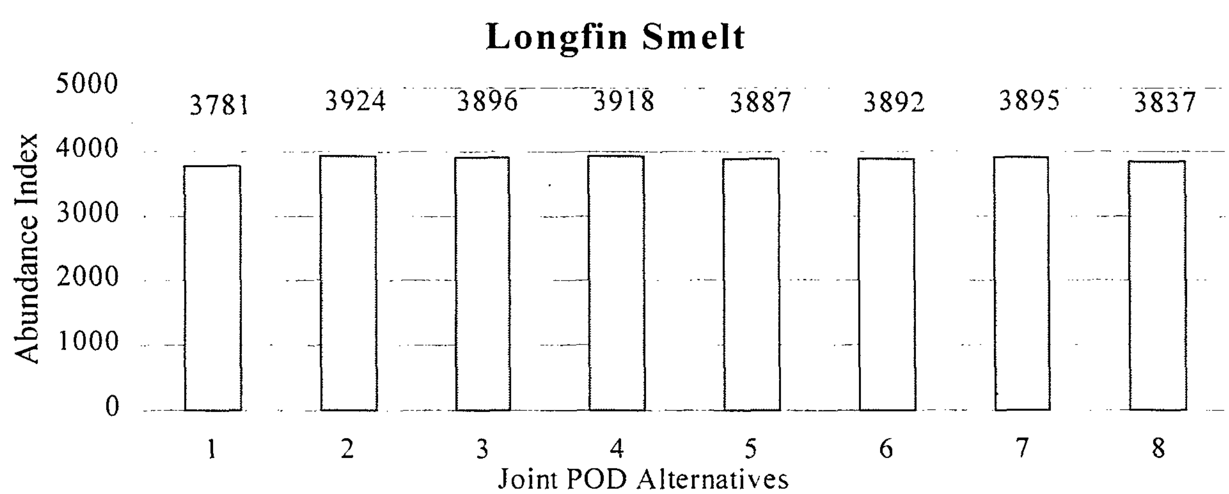


Figure XIII-49

One-Year-Old Starry Flounder

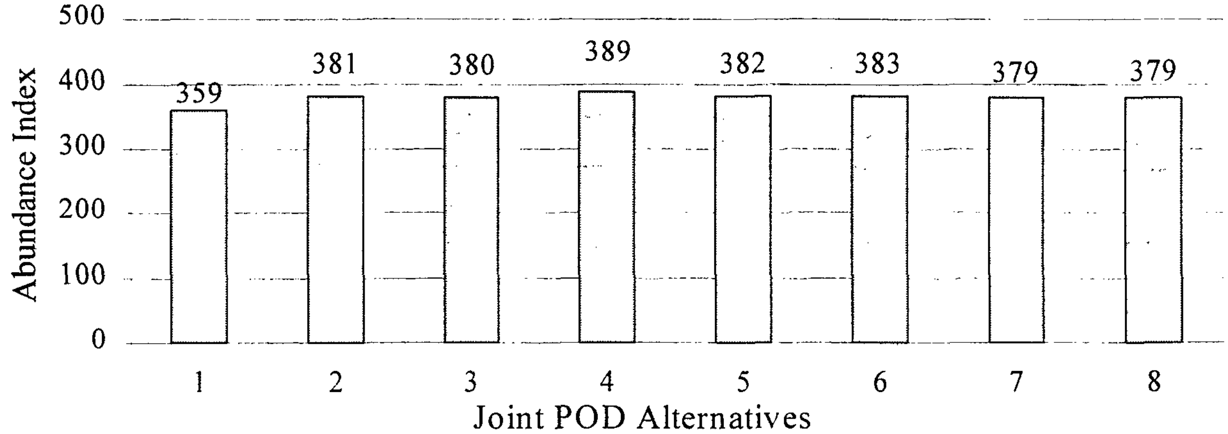


Figure XIII-50

Sacramento Splittail

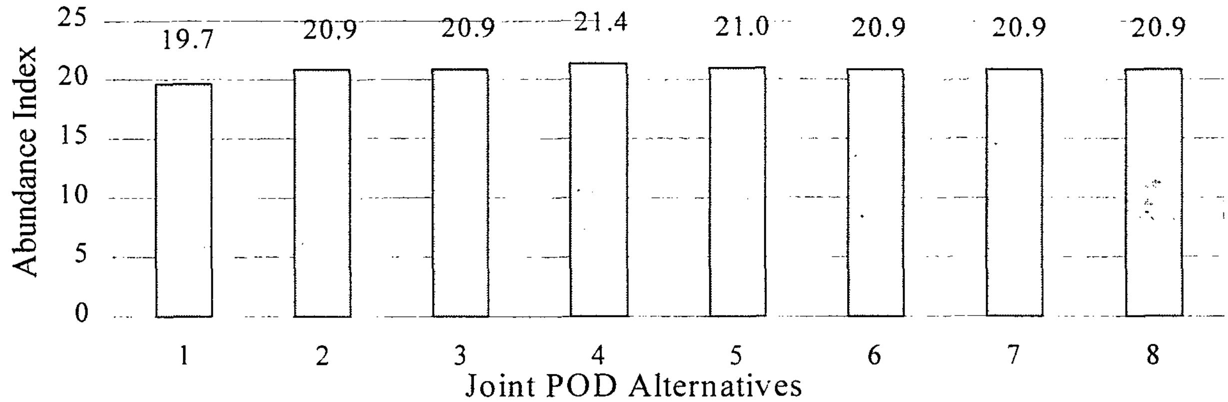


Table XIII-15

QWEST Flow (cfs)

73-Year Annual Average

Alternative	October	November	December	January	February	March	April	May	June	July	August	September
1	243	-1,133	786	4,357	7,453	6,367	3,335	3,539	3,245	-1,665	-3,111	-1,710
2	-186	-1,481	-153	3,657	7,597	6,319	4,600	2,826	1,119	-2,081	-1,771	-1,313
3	-313	-1,538	-318	3,434	7,646	6,303	4,629	2,856	1,134	-2,270	-2,085	-1,303
4	-362	-1,666	-688	2,923	7,839	6,772	5,543	3,577	1,077	-2,484	-2,497	-1,516
5	-430	-1,623	-632	2,827	8,134	6,745	4,639	2,845	1,130	-2,374	-2,409	-1,313
6	34	-1,634	-433	3,153	8,462	6,931	2,470	4,019	1,088	-2,352	-2,597	-1,336
7	-1,011	-2,339	-1,371	3,570	8,761	6,888	4,434	2,709	905	-3,534	-2,033	-1,444
8	-880	-2,186	-822	1,797	8,629	6,776	4,502	2,682	895	-3,565	-2,373	-1,317

Critical Period Annual Average

Alternative	October	November	December	January	February	March	April	May	June	July	August	September
1	720	-884	-1,299	-365	-1,144	717	2,404	424	-339	-2,771	-702	-397
2	-105	-614	-2,625	-3,204	-185	1,724	806	-213	53	-1,254	-140	-255
3	-318	-645	-2,829	-3,249	-221	2,083	747	-130	121	-1,661	-249	-212
4	-340	-658	-2,765	-3,736	-83	2,286	1,368	229	-188	-1,868	-353	-360
5	-355	-647	-2,813	-3,757	-58	2,331	748	-162	56	-1,767	-202	-258
6	-216	-769	-2,736	-3,667	-162	2,359	-1,056	954	178	-1,012	71	-247
7	-300	-1,172	-3,287	-4,076	28	2,438	673	-154	-32	-1,387	230	-109
8	-333	-1,113	-3,012	-4,611	181	2,417	747	-140	-105	-1,344	192	-131

F. ENVIRONMENTAL EFFECTS OF IMPLEMENTING JOINT POD ALTERNATIVES IN THE UPSTREAM AREAS

The evaluation of the environmental effects of impelementing the joint POD alternatives in the upstream areas is divided into the following sections: (1) hydrology, (2) aquatic resources habitat, (3) geology, (4) energy, (5) recreation, (6) cultural resources, and (7) economics.

1. Hydrology

This section discusses impacts of the Joint POD alternatives on upstream hydrology. For this analysis, average monthly flows at selected points on Central Valley rivers were compared for each of the Joint POD alternatives. The flows were modeled using DWRSIM, and the analysis focuses on the change in flow on the rivers below the major SWP and CVP reservoirs. The selected points include: the Sacramento River at Red Bluff, Feather River at Gridley, Sacramento River at Verona, American River at Nimbus Dam, and the Stanislaus River at the San Joaquin River.

Tables XIII-16 through XIII-25 illustrate the change in flow among the alternatives at the selected locations. Average monthly flows are compared for the 73-year period and the critical period. Each table presents a comparison of Joint POD Alternatives 2-8 to Alternative 1 (base case) and a comparison of Joint POD Alternatives 3-8 to Alternative 2. The latter comparison demonstrates the effects of combined use of points. Most flow changes seen in the comparison to Alternative 1 are the result of the implementation of the Plan's flow objectives. Those impacts are analyzed in Chapter VI.

Tables XIII-16 and XIII-17 show Sacramento River flows at Red Bluff. In comparing Joint POD Alternatives 3-8 to Alternative 2, there are no dramatic changes in flows, but overall, for the 73-year period, flows are lower from September through March and in May, and higher in April and June through August. During the critical period, flows are lower from November through March and in May, and higher in April, June, July and October.

Tables XIII-18 and XIII-19 show Feather River flows at Gridley. Releases from Lake Oroville by the SWP appear to vary considerably under the various Joint POD alternatives, although most of the changes from Alternative 2 are relatively small. However, under Joint POD Alternatives 7 and 8, there is a significant increase in flow in July and a similar decrease in August.

Tables XIII-20 and XIII-21 show Sacramento River flows at Verona. Flows at this point reflect the combined, and sometimes offsetting, effects of changes in releases from Shasta and Oroville. Flows under Joint POD Alternatives 3-8 are generally lower than Alternative 2 from November through March and higher from June through August.

C-032276

Table XIII-16
Sacramento River Flow at Red Bluff, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	7,277	8,978	12,377	15,272	18,163	15,350	11,477	10,672	10,936	12,776	10,506	6,236

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	72	229	30	-127	220	138	15	-184	1161	-583	-688	38
3	142	79	-37	-158	82	104	33	-220	1186	-439	-451	-15
4	40	-71	-66	-215	49	50	-66	-275	1371	-336	-284	92
5	5	-41	-130	-177	63	-4	42	-242	1193	-280	-120	-19
6	-95	-218	-190	-207	-37	63	433	-497	1590	-438	11	-94
7	-34	-80	-147	-162	17	-84	36	-274	1200	-101	143	-234
8	30	-244	-214	-194	-74	-87	15	-296	1162	-25	547	-296

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	7,349	9,207	12,407	15,145	18,383	15,488	11,492	10,488	12,097	12,193	9,818	6,274

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	70	-151	-67	-32	-138	-34	19	-36	25	144	238	-53
4	-32	-300	-96	-89	-171	-89	-81	-91	209	246	404	54
5	-67	-270	-161	-50	-157	-143	27	-58	32	303	568	-57
6	-166	-447	-220	-80	-257	-76	418	-313	428	144	699	-132
7	-106	-310	-177	-35	-203	-222	21	-90	39	482	832	-271
8	-42	-473	-244	-67	-294	-225	1	-112	1	558	1235	-334

Table XIII-17
Sacramento River Flow at Red Bluff, Critical Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	7,277	8,978	12,377	15,272	18,163	15,350	11,477	10,672	10,936	12,776	10,506	6,236

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-190	180	-81	-84	-49	325	51	343	683	811	-1352	111
3	-35	-40	-81	-84	-39	10	453	290	752	976	-1420	135
4	-49	34	-123	-125	-90	-36	124	234	1010	1124	-1457	213
5	-56	-85	-123	-125	-81	-38	446	303	840	1043	-1400	162
6	-129	-157	-164	-167	-132	-61	730	113	1318	752	-1604	131
7	-144	-139	-123	-125	-90	-29	468	282	895	1069	-1222	87
8	-35	-69	-123	-125	-46	-18	414	248	934	947	-1166	67

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	4,603	4,970	6,704	6,820	6,899	6,795	6,958	7,947	8,935	10,550	8,420	5,302

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	155	-220	0	0	9	-316	402	-54	69	165	-68	24
4	141	-146	-42	-42	-42	-361	73	-109	327	313	-105	102
5	134	-266	-42	-42	-33	-363	395	-40	156	232	-48	50
6	61	-337	-83	-83	-83	-386	679	-230	635	-58	-252	20
7	46	-319	-42	-42	-42	-354	418	-61	211	258	130	-25
8	155	-249	-42	-42	3	-343	363	-95	250	136	186	-44

Table XIII-18
Feather River Flow at Gridley, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,941	2,623	4,525	5,627	6,472	6,280	3,160	3,948	3,351	4,398	3,727	1,818

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-578	-218	-461	-424	79	26	222	-173	867	1601	-576	-189
3	-553	-205	-457	-424	65	-2	181	-187	857	1640	-565	-174
4	-600	-213	-520	-508	23	38	70	-257	775	1761	-277	-131
5	-488	-128	-463	-450	39	99	193	-170	834	1514	-666	-140
6	-561	-249	-539	-476	-39	-6	552	-390	843	1696	-518	-132
7	-520	-236	-464	-412	13	-5	177	-140	864	2725	-1587	-247
8	-514	-232	-460	-408	68	-18	175	-148	880	2675	-1593	-250

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,363	2,405	4,064	5,203	6,551	6,306	3,383	3,775	4,218	5,999	3,151	1,628

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	25	13	5	-0	-14	-27	-41	-14	-10	39	12	15
4	-23	5	-59	-84	-56	13	-152	-83	-92	160	299	58
5	90	90	-2	-26	-40	74	-29	3	-33	-87	-89	49
6	16	-31	-78	-52	-119	-32	330	-216	-24	95	59	57
7	58	-18	-2	13	-66	-30	-45	33	-3	1124	-1010	-57
8	64	-14	2	16	-11	-43	-48	26	13	1073	-1017	-61

Table XIII-19
Feather River Flow at Gridley, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,941	2,623	4,525	5,627	6,472	6,280	3,160	3,948	3,351	4,398	3,727	1,818

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-1161	73	-167	-155	-126	220	764	714	633	-445	-48	-374
3	-1175	78	-172	-155	-105	132	569	706	616	35	21	-496
4	-1168	84	-169	-155	-126	136	399	419	605	210	248	-496
5	-1181	70	-173	-155	-105	136	575	707	619	96	-6	-497
6	-1146	-14	-192	-155	-145	155	1781	212	418	-620	143	-440
7	-1151	97	-186	-155	-105	183	621	804	711	646	-986	-444
8	-1148	104	-185	-155	-103	188	613	778	766	637	-983	-468

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,680	1,941	2,329	1,030	1,396	1,865	2,425	2,503	3,651	3,937	2,438	1,181

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	-14	5	-5	0	21	-87	-195	-8	-17	479	69	-122
4	-7	11	-1	0	0	-84	-364	-295	-28	655	297	-122
5	-19	-3	-5	0	21	-83	-188	-7	-14	540	43	-122
6	16	-87	-25	0	-19	-65	1017	-502	-215	-175	192	-66
7	10	24	-19	0	21	-37	-143	90	78	1091	-938	-70
8	13	31	-18	0	24	-32	-151	64	133	1081	-935	-93

Table XIII-20
Sacramento River Flow at Verona, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
11,776	13,579	19,218	26,962	31,867	30,444	19,148	15,623	12,712	12,853	10,543	9,488

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-509	8	-435	-553	349	165	236	-355	2030	1019	-1264	-152
3	-414	-129	-498	-585	197	104	213	-404	2044	1202	-1015	-190
4	-563	-286	-590	-726	122	89	3	-529	2147	1425	-560	-40
5	-487	-172	-598	-630	152	96	234	-409	2028	1235	-785	-160
6	-659	-470	-733	-686	-27	58	984	-884	2434	1258	-506	-227
7	-557	-319	-614	-576	79	-87	212	-411	2066	2624	-1443	-481
8	-487	-479	-677	-604	43	-103	189	-441	2044	2650	-1046	-547

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
11,267	13,587	18,782	26,409	32,216	30,610	19,384	15,268	14,741	13,872	9,279	9,336

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	95	-137	-62	-32	-152	-61	-23	-49	14	183	249	-37
4	-54	-295	-155	-173	-227	-76	-233	-174	118	406	704	112
5	23	-180	-162	-76	-197	-69	-2	-55	-2	216	479	-7
6	-150	-478	-298	-133	-375	-107	748	-529	405	239	758	-75
7	-48	-328	-179	-22	-270	-253	-24	-57	36	1606	-179	-328
8	22	-487	-242	-51	-306	-268	-47	-87	14	1631	218	-395

Table XIII-21
Sacramento River Flow at Verona, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
11,776	13,579	19,218	26,962	31,867	30,444	19,148	15,623	12,712	12,853	10,543	9,488

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-1357	253	-250	-240	-153	542	809	1055	1319	369	-1405	-259
3	-1216	38	-254	-240	-122	139	1016	993	1370	1013	-1404	-357
4	-1223	119	-292	-281	-194	98	518	651	1618	1337	-1213	-279
5	-1242	-16	-296	-281	-164	95	1015	1007	1461	1142	-1410	-331
6	-1280	-171	-358	-323	-255	91	2505	322	1738	135	-1465	-305
7	-1301	-42	-310	-281	-173	151	1084	1084	1608	1718	-2213	-354
8	-1189	36	-309	-281	-126	167	1022	1023	1702	1586	-2154	-396

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
7,137	7,485	9,587	13,601	12,078	12,626	8,920	8,740	9,654	10,615	7,660	6,773

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	141	-215	-5	0	30	-403	207	-62	52	644	1	-98
4	134	-134	-43	-42	-42	-444	-291	-404	299	968	192	-20
5	115	-269	-47	-42	-11	-447	207	-47	142	773	-5	-72
6	77	-424	-108	-83	-102	-451	1696	-733	420	-234	-59	-46
7	57	-295	-60	-42	-20	-391	275	29	289	1349	-807	-95
8	168	-217	-60	-42	27	-375	213	-31	383	1217	-748	-138

Table XIII-22
American River Flow at Nimbus, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,159	2,696	3,651	4,374	5,145	4,001	3,695	3,359	3,895	3,513	2,762	1,898

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-189	-37	-227	-140	46	91	29	102	832	-348	-379	319
3	-101	-68	-285	-169	-6	22	31	119	804	-265	-200	206
4	-178	-134	-253	-201	-98	38	-37	84	949	-219	-88	216
5	-138	-127	-295	-163	-73	33	-6	89	816	-185	46	80
6	-131	-122	-292	-209	-89	19	162	-18	975	-225	-15	34
7	-128	-151	-331	-168	-57	4	17	120	803	-96	128	-67
8	-214	-316	-434	-265	-197	-106	-80	44	669	-205	80	-353

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,970	2,659	3,424	4,234	5,191	4,092	3,724	3,461	4,727	3,165	2,383	2,216

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	88	-31	-58	-28	-52	-69	2	17	-28	83	179	-113
4	12	-97	-25	-60	-144	-53	-66	-17	117	129	292	-102
5	51	-90	-68	-23	-119	-57	-35	-13	-16	163	426	-239
6	58	-85	-65	-69	-135	-71	133	-120	143	123	364	-285
7	61	-114	-104	-28	-103	-86	-11	18	-29	252	508	-386
8	-25	-279	-207	-124	-243	-197	-109	-58	-162	144	460	-672

Table XIII-23
American River Flow at Nimbus, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,159	2,696	3,651	4,374	5,145	4,001	3,695	3,359	3,895	3,513	2,762	1,898

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	143	177	-481	-462	-892	275	162	461	2009	-1280	-754	537
3	292	317	-407	-378	-733	-166	38	433	1867	-1348	-602	575
4	331	200	-481	-503	-976	-157	27	343	2354	-1380	-663	707
5	371	320	-405	-420	-816	-189	46	460	1866	-1328	-661	614
6	468	374	-406	-420	-852	-45	463	27	2100	-1389	-926	572
7	318	373	-407	-378	-724	-167	-34	383	1949	-1386	-470	426
8	152	252	-409	-420	-856	-266	-118	313	1798	-1469	-635	357

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,713	1,490	796	750	1,147	2,143	2,784	2,252	4,725	2,930	1,658	1,113

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	149	140	74	83	160	-441	-125	-28	-142	-68	152	38
4	189	24	0	-42	-84	-433	-136	-118	344	-100	91	170
5	228	144	76	42	76	-464	-116	-1	-143	-48	93	77
6	326	197	75	42	40	-320	301	-434	90	-108	-172	35
7	175	197	74	83	169	-442	-196	-78	-60	-106	284	-111
8	9	75	72	42	36	-541	-280	-148	-212	-189	119	-180

Table XIII-24
Stanislaus River Flow at Mouth, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	853	523	588	739	1,048	736	1,124	789	877	634	601	597

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-106	-63	-135	-203	-329	-70	337	572	178	240	289	-14
3	-103	-58	-134	-197	-334	-80	337	572	178	239	287	-14
4	-105	-59	-135	-198	-352	-92	354	588	177	238	289	-14
5	-103	-58	-134	-196	-333	-80	336	571	176	237	288	-14
6	396	46	164	158	176	75	-132	224	267	235	-6	-183
7	-106	-59	-132	-196	-325	-80	336	570	177	237	284	-14
8	-102	-58	-133	-196	-325	-91	345	571	170	239	285	-14

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	746	460	452	536	718	666	1,461	1,362	1,055	874	890	583

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	4	5	2	6	-5	-10	0	0	-0	-1	-2	0
4	1	4	0	5	-23	-21	18	16	-1	-2	0	0
5	4	5	2	7	-3	-10	-1	-1	-2	-2	-1	0
6	502	108	300	361	506	145	-469	-348	89	-5	-295	-169
7	1	3	3	7	5	-9	-1	-2	-1	-3	-5	-0
8	5	5	3	7	4	-20	8	-1	-8	-1	-4	0

Table XIII-25
Stanislaus River Flow at Mouth, Critical Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	853	523	588	739	1,048	736	1,124	789	877	634	601	597

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-22	-119	-142	-106	-65	-16	11	276	249	281	293	-14
3	-22	-119	-142	-106	-65	-16	14	274	248	281	293	-14
4	-22	-119	-142	-106	-65	-16	12	274	248	281	293	-14
5	-22	-119	-142	-106	-65	-16	14	276	248	282	293	-14
6	114	-78	-36	26	104	90	49	284	262	254	-203	-210
7	-22	-119	-142	-106	-65	-16	14	276	248	281	293	-14
8	-22	-119	-142	-106	-65	-16	10	279	247	280	293	-14

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	352	332	265	227	242	328	852	884	902	927	939	574

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	0	0	-0	-0	0	0	3	-1	-0	0	-0	0
4	0	0	-0	-0	0	0	0	-1	-1	0	-0	0
5	0	0	-0	-0	0	0	3	0	-0	0	0	0
6	136	41	106	132	170	106	38	9	14	-27	-496	-196
7	0	0	-0	-0	0	0	3	0	-1	-0	-1	0
8	0	0	-0	-0	0	0	-1	3	-1	-1	-1	0

Tables XIII-22 and XIII-23 show American River flows at Nimbus Dam. Releases from Folsom Lake under Joint POD Alternatives 3-8 are generally lower than Alterative 2 in September and from November through May, and higher in July, August and October. During the critical period, flows are considerably lower in March.

Tables XIII-24 and XIII-25 show Stanislaus River flows above the confluence with the San Joaquin River. Only Joint POD Alternative 6 shows any significant change from Alternative 2 and this is a result of using the Letter of Intent flows at Vernalis. Under this Alternative, flows would be lower in March-April and August-September; flows would be higher from October through March and in June.

2. Aquatic Resources Habitat

The two habitat conditions that would be most directly affected by water operations under the proposed Joint POD alternatives are river flows and reservoir storage. The natural flow regimes of rivers have been changed by water supply operations in terms of the frequency, magnitude, and timing of downstream flows. These changes influence the aquatic habitat in rivers by changing the streambed and river channel geometry, riparian habitat, substrate composition, and water temperatures. Water supply operations also affect the frequency, duration, magnitude.and timing of drawdown in reservoirs. The upstream aquatic habitat impact assessment focuses on the season, timing, and magnitude of these changes to instream flows and reservoir surface elevations. The next section compares the Joint POD modeled alternatives with the Anadromous Fish Restoration Plan (AFRP) flow recommendations and also evaluates reservoir elevation changes of fivet of the major reservoirs in the Central Valley under the different Joint POD alternatives.

a. Rivers. Anadromous fish habitat in terms of instream flow is used as the benchmark for comparison of Joint POD alternatives with regard to flow factors affecting anadromous fish. Anadromous fish populations are considered to be reliable indicators of the relative health and condition of riverine habitat. The AFRP and Working Paper addresses 27 rivers and includes specific instream flow recommendations for anadromous fish in various drainages in the Central Valley. On the Sacramento River, one of the AFRP goals is to develop a flow regime that imitates natural flow changes and avoids dewatering of redds or isolating and stranding juveniles due to daily or monthly flow changes (USFWS 1995). AFRP recommendations are being used because this plan is the most recent and comprehensive evaluation of anadromous fish requirements in the Sacramento River basin. The proposed Joint POD alternatives were compared to the different AFRP recommended flows for five major rivers. How the recommended flows and modeled flows compare to each other is assumed to be an indicator of the relative quality of the riverine aquatic habitat.

Locations with numerical flow recommendations in the AFRP Working Paper were matched as closely as possible to corresponding Joint POD modeled control points. The six locations selected include: (1) the Sacramento River below Keswick, (2) the Feather River at Nicolaus, (3) the American River at the H Street Bridge, (4) the Sacramento River at Verona, (5) the Stanislaus River from Goodwin Dam downstream to the mouth. (6) and the San Joaquin River at Vernalis.

The modeled average flows for April through June are compared to the AFRP Working Paper recommendations in Tables XIII-26 through XIII-31. The April through June period was selected for this summary analysis because: (1) it is the most biologically important period for the species of concern; (2) it is a period in which flows have been severely curtailed by storage projects and direct diversion; and (3) it is the period with the highest AFRP Working Paper flow recommendations. Ratios of less than one indicate that the average modeled flow for the three months is less than the highest recommended flow. Ratios greater than one indicate that modeled flows exceed the highest recommended flows. The range, shown below the three-month average, indicates the lowest and highest ratios during the three-month period.

For the Upper Sacramento River below Keswick (Table XIII-26) the recommended flows are not based on water year type, but on Shasta reservoir carryover storage. These recommendations are given for October through April only and remain constant throughout this period. Comparisons of the average modeled flows to recommended flows for the Joint POD alternatives demonstrate mixed results. Implementation of Joint POD alternatives changes the operations of Shasta Reservoir resulting in different numbers of years within each of the carryover storage categories. No pattern of change between the base case or with increased wheeling can be detected. All alternatives, regardless of carryover storage capacity meet or exceed recommended flows on the seven-month average basis.

Results of the analysis are consistent at the remaining five locations (Tables XIII-27 through XIII-31). Little to no change occurs in the average index between any alternatives during wet years. Small improvements in average index result from the implementation of the 1995 Bay/Delta Plan. Some minor reductions in the average indices resulted from the addition of wheeling in some cases. In general, the indices indicate that conditions should be improved when compared to Alternative 1 and that very small, and probably insignificant changes occur between Alternatives 2 to 8. Major changes in flow occasionally occur outside of the April - June critical period. Flow on the Feather River is decreased by 38 percent in August during the critical period for Alternatives 7 and 8. Even under these reduced flow conditions, the AFRP flow recommendations are exceeded. Hence, there should be no detrimental impact on aquatic resources.

b. Reservoirs. Habitat conditions in relation to initial reservoir elevation and fluctuations were analyzed for each of the five major reservoirs in the CVP and SWP project areas. These reservoirs include: Lake Shasta, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Habitat conditions evaluated include the spawning and rearing habitat quality for warmwater fisheries including largemouth bass, smallmouth bass, and spotted bass. A discussion of the assumptions and analytical methods used in the analysis can be found in Chapter VI. The methodology assumes that increases in the quantity and quality of habitat are indicated by increases in the index. Decreases indicate a decrease in habitat value. Modeled reservoir elevations may be expected to have a margin of error on 10 to 20 percent. Therefore, effects of the various alternatives are considered significant only if the differences from the base case are greater than 10 percent.

Table XIII-26 Upper Sacramento River Below Keswick Dam								
Shasta Reservoir Carryover Storage (MAF)	Comparison of October - April Average Flows of the Alternatives to Flows Recommended by the AFRP Working Paper (Based on Shasta Reservoir Carryover Storage)							
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
< 2.2	1.44	1.51	1.86	1.50	1.53	1.70	1.49	1.68
≥ 2.2	1.98	2.31	1.79	3.05	1.77	N/A[1]	3.03	1.81
≥ 2.3	2.85	2.23	1.14	1.41	2.36	N/A[1]	2.88	1.41
≥ 2.4	1.43	1.12	1.13	1.87	1.14	1.73	1.08	1.14
≥ 2.5	1.88	3.20	2.68	1.15	3.19	1.15	2.67	2.22
≥ 2.6	1.02	2.35	1.99	1.72	1.88	1.80	1.54	2.09
≥ 2.7	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
≥ 2.8	1.00	1.77	1.79	1.19	2.17	1.59	1.16	1.03
≥ 2.9	1.93	1.16	1.19	1.62	1.73	1.51	1.87	2.39
≥ 3.0	1.80	1.76	1.88	1.84	1.84	1.83	1.82	1.80

[1] In these cases, there were no Shasta Reservoir model years with carryover storage falling into this category

Table XIII-27 Feather River at Nicolaus									
Year Type		Comparison of April, May, and June Modeled Flows of the Alternatives to Flows Recommended by the AFRP Working Paper							
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Wet	3-mo Avg Range	.87 .76-.95	.88 .78-.93	.88 .77-.93	.87 .77-.93	.88 .77-.93	.88 .77-.94	.88 .77-.93	.88 .77-.93
Above Normal	3-mo Avg Range	.77 .52-1.02	.86 .63-1.16	.86 .63-1.16	.84 .61-1.14	.86 .63-1.16	.86 .59-1.18	.86 .63-1.16	.86 63-1.16
Below Normal	3-mo Avg Range	.56 .33-.75	.67 .35-1.15	.67 .35-1.15	.66 .35-1.11	.67 ..36-1.15	.66 .38-1.13	.67 .35-1.15	.67 .35-1.16
Dry	3-mo Avg Range	.50 .36-.71	.65 .25-1.26	.64 .25-1.25	.60 .22-1.21	.62 .26-1.21	.62 .21-1.20	.64 .25-1.24	.64 .25-1.25
Critical	3-mo Avg Range	.46 .20-.65	.52 .20-.80	.51 .19-.79	.50 .19-.79	.52 .20-.80	.57 .14-.78	.53 .22-.82	.54 .22-.82

Table XIII-28 Lower American River at H Street Bridge									
Year Type		Comparison of April, May, and June Modeled Flows of the Alternatives to Flows Recommended by the AFRP Working Paper							
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Wet	3-mo Avg Range	.58 .46-.70	.59 .46-.73	.59 .46-.73	.58 .46-.73	.59 .46-.73	.59 .45-.73	.59 .46-.73	.57 .45-.71
Above Normal	3-mo Avg Range	.57 .36-.86	.59 .38-.89	.59 .38-.89	.59 .38-.90	.59 .38-.89	.61 .37-.94	.59 .38-.89	.57 .37-.85
Below Normal	3-mo Avg Range	.49 .32-.77	.55 .34-.92	.55 .34-.91	.56 .34-.95	.55 .34-.91	.57 .33-.97	.55 .34-.90	.53 .33-.89
Dry	3-mo Avg Range	.52 .31-.92	.71 .30-1.49	.71 .32-1.49	.73 .29-1.60	.70 .29-1.50	.75 .28-1.65	.70 .33-1.46	.68 .30-1.40
Critical	3-mo Avg Range	.58 .29-.99	.96 .37-2.03	.92 .37-1.95	.96 .35-2.09	.93 .38-1.97	.93 .27-1.94	.94 .35-2.02	.86 .32-1.85

Table XIII-29 Sacramento River at Verona									
Year Type		Comparison of April, May, and June Modeled Flows of the Alternatives to Flows Recommended by the AFRP Working Paper							
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Wet	3-mo Avg Range	.97 .87-1.58	.97 .88-1.59	.97 .88-1.58	.97 .88-1.59	.97 .88-1.58	.97 .87-1.58	.97 .88-1.58	.97 .88-1.58
Above Normal	3-mo Avg Range	.63 .52-1.35	.66 .57-1.34	.66 .57-1.34	.66 .56-1.34	.66 .57-1.34	.66 .54-1.33	.66 .57-1.35	.66 .57-1.35

Table XIII-30 Stanislaus River from Goodwin Dam to the San Joaquin River Confluence									
Year Type		Comparison of April, May, and June Modeled Flows of the Alternatives to Flows Recommended by the AFRP Working Paper							
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Wet	3-mo Avg Range	.29 .17-.39	.30 .22-.44	.30 .22-.44	.30 .22-.44	.30 .22-.44	.27 .19-.37	.30 .22-.44	.30 .22-.44
Above Normal	3-mo Avg Range	.20 .13-.30	.31 .28-.38	.31 .27-.38	.32 .39-.38	.31 .27-.38	.22 .18-.29	.31 .27-.38	.31 .27-.38
Below Normal	3-mo Avg Range	.19 .12-.23	.36 .32-.40	.36 .32-.40	.36 .32-.37	.36 .32-.40	.25 .19-.32	.36 .32-.40	.36 .32-.40
Dry	3-mo Avg Range	.26 .18-.36	.49 .41-.54	.44 .41-.54	.49 .41-.54	.49 .41-.54	.38 .27-.54	.49 .41-.54	.49 .41-.54
Critical	3-mo Avg Range	.51 .33-.68	.67 .47-.97	.68 .47-.97	.67 .47-.97	.67 .47-.97	.64 .46-.97	.68 .47-.97	.67 .47-.97

Table XIII-31 San Joaquin River at Vernalis									
Year Type		Comparison of April, May, and June Modeled Flows of the Alternatives to Flows Recommended by the AFRP Working Paper							
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Wet	3-mo Avg Range	.50 .93-2.17	.50 .90-2.21	.50 .90-2.21	.50 .90-2.21	.50 .90-2.21	.50 .96-2.06	.50 .90-2.21	.50 .90-2.21
Above Normal	3-mo Avg Range	.28 .44-1.20	.32 .31-1.25	.32 .31-1.25	.33 .32-1.25	.32 .31-1.25	.29 .28-1.22	.32 .31-1.25	.32 .31-1.25
Below Normal	3-mo Avg Range	.28 .26-.73	.36 .34-.86	.36 .34-.86	.37 .34-.87	.36 .34-.86	.32 .32-.79	.36 .34-.86	.36 .34-.86
Dry	3-mo Avg Range	.28 .32-.70	.39 .41-.92	.39 .41-.92	.40 .41-.94	.39 .41-.92	.33 .40-.77	.39 .41-.92	.40 .41-.94
Critical	3-mo Avg Range	.32 .46-.88	.38 .57-.96	.38 .57-.96	.38 .57-.96	.38 .57-.96	.35 .53-.88	.38 .57-.96	.38 .57-.96

The results of the analysis of Joint POD Alternatives are shown in Tables XIII-32 and XIII-33 as the 73-Year Average Index and the Critical Period Index. Changes in the 73-year average reservoir index occur primarily at Shasta, Folsom, New Melones, and San Luis Reservoirs which are part of the CVP. Significant decreases are predicted at Folsom Reservoir for Alternative 8 and at New Melones Reservoir for all Joint POD Alternatives except Alternative 6. The decreases at New Melones Reservoir are caused by implementation of the 1995 Bay/Delta Plan. Beneficial effects are also predicted at San Luis Reservoir for all alternatives that allow wheeling. Little or no change occurs in the 73-year average reservoir index at the other reservoirs analyzed.

Significant decreases in the critical period reservoir index are predicted at Folsom Lake under all Joint POD alternatives except Alternative 7 and at New Melones Reservoir for all alternatives except Alternative 6. The decreases at Folsom Lake are primarily a cumulative impact of implementing both the 1995 Bay/Delta Plan and the Joint POD. A significant increase in the critical period reservoir index is predicted to occur at San Luis Reservoir for Alternative 6. Minor or no changes are predicted at all other reservoirs for all alternatives. The significant effects identified in this analysis can not be mitigated.

c. Riparian Wetland Habitat. The condition of riparian vegetation and wetland habitat in the riparian zone of major rivers was assessed using simulated river water surface elevation (stage) at 6 locations. Average monthly stage was calculated for the base case and each alternative for average, wet, and dry year conditions[2]. Differences among alternatives are expressed as a percent change from the base case. Low summer stages represent drought conditions and high year-round stages indicate inundation mortality. Modeled surface water elevations may be expected to have a margin of error of plus or minus 10 to 20 percent. Differences among alternatives are considered to be significant only if greater than 20 percent. A complete description of the analysis approach and methodology is contained in Chapter VI.

Tables XIII-34 through XIII-37 present the results of this analysis. Values that exceed the 20 percent significance threshold are indicated in bold type and in italics if there is negative impact. Significant reductions in all dry year June and some July and September indices are predicted at the Natoma and Verona stations on the Sacramento River. A similar pattern of reductions is predicted at the Feather River station which also has some significant increases predicted to occur in May. Significant decreases followed by significant increases are also predicted for July and August of Wet years at the Feather River site. No significant differences were predicted at other study sites and the effects of Joint POD alternatives could not be distinguished from the effects resulting from implementation of the 1995 Bay/Delta Plan.

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[2]"Wet" years are the average of wet and above normal years as defined in the 1995 Bay/Delta Plan for the Sacramento and San Joaquin river basins. "Dry" years are the average of below normal, dry, and critically dry year types.

Table XIII-32 Average Reservoir Habitat Index for 73-Years Under the Joint POD Alternatives								
Alternative	73-Year Average Index							
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Shasta	459	460	454	448	450	436	448	444
Oroville	388	385	383	378	385	377	391	391
Folsom	438	426	418	410	412	405	411	393 [D]
New Melones	298	258 [D]	261 [D]	259 [D]	260 [D]	340 [I]	259 [D]	260 [D]
San Luis	265	287	326 [I]	305 [I]	331 [I]	331 [I]	373 [I]	342 [I]
Totals	1848	1794	1842	1800	1838	1889	1882	1830

[I] - Increase greater than 10 percent
[D] - Decrease greater than 10 percent

Table XIII-33 Critical Period Reservoir Habitat Index Under the Joint POD Alternatives								
Alternative	Critical Period Index							
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Shasta	202	202	201	200	201	203	201	198
Oroville	184	191	190	189	191	188	193	189
Folsom	250	213 [D]	222 [D]	222 [D]	223 [D]	214 [D]	229	219 [D]
New Melones	219	186 [D]	187 [D]	186 [D]	186 [D]	219	186 [D]	187 [D]
San Luis	191	187	197	184	192	235 [I]	199	195
Totals	1046	979	997	981	993	1059	1008	988

[I] - Increase greater than 10 percent
[D] - Decrease greater than 10 percent

Table XIII-34
Sacramento River at Natoma Riparian Wetland Habitat Analysis

73-Year Average Monthly River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	3.7	3.9	4.4	4.7	5.2	4.7	4.6	4.3	4.8	4.6	4.1	3.3

Percent Change in Average Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	5.4	0.0	4.5	4.3	0.0	-2.1	0.0	-2.3	-10.4	4.3	7.3	-9.0
Alt 3	2.7	2.6	6.8	4.3	1.9	0.0	0.0	-2.3	-10.4	4.3	4.9	-6.0
Alt 4	2.7	2.6	4.5	4.3	1.9	0.0	2.1	-2.3	-12.5	2.1	2.4	-9.0
Alt 5	2.7	2.6	6.8	4.3	1.9	0.0	0.0	-2.3	-10.4	2.1	0.0	-3.0
Alt 6	2.7	2.6	6.8	4.3	1.9	0.0	-2.2	0.0	-12.5	2.1	2.4	-3.0
Alt 7	2.7	2.6	6.8	4.3	1.9	0.0	0.0	-2.3	-10.4	2.1	0.0	0.0
Alt 8	5.4	7.7	9.1	6.4	3.8	2.1	2.1	-2.3	-8.3	2.1	0.0	9.0

Average Monthly Wet Year River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	2.4	2.4	3.3	3.9	4.0	3.3	3.5	3.5	3.5	3.0	2.7	2.7

Percent Change in Wet Year Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	8.3	4.1	3.0	0.0	0.0	0.0	0.0	0.0	-2.8	10.0	-3.7	-7.4
Alt 3	4.1	8.3	3.0	0.0	0.0	0.0	0.0	0.0	-2.8	6.7	-7.4	-3.7
Alt 4	12.5	8.3	3.0	0.0	0.0	0.0	0.0	0.0	-2.8	6.7	-7.4	-3.7
Alt 5	8.3	12.5	6.0	0.0	0.0	0.0	0.0	0.0	-2.8	6.7	-11.1	0.0
Alt 6	8.3	12.5	6.0	0.0	0.0	0.0	0.0	0.0	-2.8	6.7	-11.1	3.7
Alt 7	4.1	12.5	6.0	0.0	0.0	0.0	0.0	0.0	-2.8	6.7	-7.4	0.0
Alt 8	8.3	12.5	9.0	2.5	0.0	0.0	0.0	0.0	-2.8	6.7	-7.4	11.1

Average Monthly Dry Year River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	3.5	3.6	3.5	3.4	3.9	3.9	3.7	3.6	4.1	4.5	4.4	2.2

Percent Change in Dry Year Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	-2.8	-2.7	0.0	0.0	2.6	-5.1	0.0	0.0	***-24.4***	-6.7	13.6	***-31.8***
Alt 3	-5.7	-2.7	2.8	2.9	2.6	0.0	-2.7	0.0	***-24.4***	-8.8	11.4	***-31.8***
Alt 4	-2.8	-2.7	0.0	2.9	5.1	-2.6	2.7	0.0	***-31.7***	-8.8	11.4	***-31.8***
Alt 5	-2.8	-2.7	0.0	2.9	5.1	-2.6	2.7	2.7	***-26.8***	-8.8	9.1	***-22.7***
Alt 6	-5.7	0.0	2.8	5.8	5.1	-5.1	0.0	2.7	***-34.1***	-8.8	11.4	-13.6
Alt 7	-2.8	-2.7	2.8	2.9	5.1	0.0	2.7	-2.7	***-24.4***	-8.8	11.5	-13.6
Alt 8	-2.8	2.7	2.8	5.8	7.7	5.1	2.7	-2.7	***-22.0***	-8.8	9.1	-4.5

Table XIII-35
Feather River Riparian Wetland Habitat Analysis

73-Year Average Monthly River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	2.9	2.6	3.4	3.8	4.2	4.1	2.7	3.1	3.1	3.7	3.2	2.1

Percent Change in Average Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	13.8	3.8	5.9	7.9	0.0	0.0	-7.4	3.2	12.9	-16.2	12.5	4.8
Alt 3	13.8	3.8	5.9	7.9	0.0	0.0	-3.7	3.2	12.9	-16.2	12.5	4.8
Alt 4	13.8	3.8	5.9	7.9	0.0	0.0	-3.7	3.2	12.9	-18.9	6.3	4.8
Alt 5	10.3	3.8	5.9	7.9	0.0	-2.4	-3.7	3.2	12.9	-16.2	12.5	4.8
Alt 6	13.8	3.8	8.8	7.9	2.4	0.0	-14.8	6.5	12.9	-16.2	9.4	4.8
Alt 7	13.8	3.8	5.9	7.9	0.0	0.0	-3.7	0.0	12.9	***-27.0***	**28.1**	9.5
Alt 8	13.8	3.8	5.9	7.9	0.0	0.0	-3.7	3.2	12.9	***-27.0***	**28.1**	9.5

Average Monthly Wet Year River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	1.7	1.4	2.7	3.4	3.6	3.3	2.8	2.9	2.4	2.0	1.7	1.3

Percent Change in Wet Year Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	5.9	0.0	11.1	5.9	-2.7	0.0	0.0	3.4	4.2	-15.0	**23.5**	0.0
Alt 3	5.9	0.0	11.1	5.9	-2.7	0.0	0.0	3.4	4.2	-15.0	**23.5**	0.0
Alt 4	5.9	0.0	14.8	8.8	-2.7	0.0	0.0	3.4	4.2	***-20.0***	11.8	0.0
Alt 5	0.0	0.0	11.1	8.8	-2.7	0.0	0.0	3.4	4.2	-15.0	**23.5**	0.0
Alt 6	5.9	0.0	14.8	2.9	0.0	0.0	-3.6	3.4	4.2	***-25.0***	17.6	0.0
Alt 7	5.9	0.0	11.1	5.9	-2.7	0.0	0.0	3.4	4.2	***-20.0***	**29.4**	0.0
Alt 8	5.9	0.0	7.4	5.9	-2.7	0.0	0.0	3.4	4.2	***-20.0***	**29.4**	0.0

Average Monthly Dry Year River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	2.7	2.2	2.3	2.4	2.3	2.6	2.0	2.8	2.8	4.0	3.6	2.2

Percent Change in Dry Year Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	18.5	4.5	0.0	8.3	-4.3	0.0	-15.0	**25.0**	***-32.0***	***-25.0***	5.6	13.6
Alt 3	18.5	0.0	0.0	8.3	-4.3	0.0	-10.0	**25.0**	***-32.0***	***-27.5***	2.8	10.0
Alt 4	18.5	4.5	0.0	8.3	-4.3	-3.8	0.0	**28.6**	***-32.0***	***-27.5***	-2.8	10.0
Alt 5	18.5	0.0	0.0	4.2	-8.7	-7.7	-5.0	**25.0**	***-32.0***	***-22.5***	8.3	10.0
Alt 6	14.8	4.5	0.0	8.3	0.0	-3.8	-20.0	**28.6**	***-32.0***	***-20.0***	13.9	10.0
Alt 7	18.5	0.0	0.0	4.2	-4.3	3.8	-10.0	**25.0**	***-32.0***	***-42.5***	**25.0**	**22.7**
Alt 8	18.5	0.0	0.0	4.2	-4.3	0.0	-10.0	**25.0**	***-32.0***	***-40.0***	**25.0**	**22.7**

Table XIII-36
Sacramento River at Red Bluff Riparian Wetland Habitat Analysis

73-Year Average Monthly River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	5.3	6.0	7.2	8.1	9.1	8.2	7.0	6.8	7.0	7.7	6.8	4.9

Percent Change in Average Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	-1.9	-1.7	0.0	1.2	0.0	0.0	0.0	0.0	-5.7	2.6	4.4	0.0
Alt 3	-1.9	0.0	0.0	1.2	0.0	0.0	0.0	1.5	-5.7	2.6	2.9	2.0
Alt 4	-1.9	0.0	1.4	1.2	0.0	0.0	0.0	1.5	-7.1	1.3	1.5	0.0
Alt 5	0.0	0.0	1.4	1.2	0.0	0.0	0.0	1.5	-5.7	1.3	0.0	2.0
Alt 6	0.0	1.7	1.4	1.2	0.0	0.0	-2.9	2.9	-8.6	2.6	0.0	2.0
Alt 7	0.0	0.0	1.4	1.2	0.0	1.2	0.0	1.5	-7.1	0.0	-1.5	4.1
Alt 8	-1.9	1.7	1.4	1.2	1.1	1.2	0.0	1.5	-5.7	0.0	-2.9	4.1

Average Monthly Wet Year River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	3.4	3.7	6.0	6.5	7.2	5.7	5.7	4.8	4.4	4.8	4.2	3.4

Percent Change in Wet Year Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	-2.3	6.3	2.4	-2.9
Alt 3	-2.9	0.0	0.0	0.0	0.0	0.0	1.8	0.0	-2.3	6.3	0.0	0.0
Alt 4	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	-4.5	6.3	-2.4	0.0
Alt 5	0.0	0.0	1.7	0.0	0.0	0.0	1.8	0.0	-2.3	4.2	-2.4	0.0
Alt 6	2.9	0.0	1.7	0.0	0.0	0.0	1.8	0.0	-4.5	4.2	-4.8	2.9
Alt 7	0.0	0.0	1.7	0.0	0.0	0.0	1.8	0.0	-2.3	4.2	-2.4	0.0
Alt 8	-2.9	0.0	1.7	0.0	0.0	0.0	1.8	0.0	-2.3	4.2	-4.8	2.9

Average Monthly Dry Year River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	5.1	5.7	5.6	5.5	6.6	6.5	5.8	6.3	7.1	7.5	6.9	4.4

Percent Change in Dry Year Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	-3.9	-3.5	0.0	0.0	0.0	-1.5	1.7	4.8	-12.7	-1.3	4.3	4.5
Alt 3	-3.9	-3.5	0.0	0.0	0.0	0.0	1.7	4.8	-12.7	-1.3	2.9	4.5
Alt 4	-2.0	-1.8	0.0	0.0	1.5	-1.5	1.7	4.8	-14.1	-2.7	2.9	2.3
Alt 5	0.0	-1.8	0.0	0.0	0.0	-1.5	1.7	4.8	-12.7	-2.7	2.9	4.5
Alt 6	-2.0	0.0	0.0	0.0	0.0	-1.5	-1.7	6.3	-16.9	-2.7	0.0	6.8
Alt 7	0.0	0.0	0.0	0.0	0.0	1.5	1.7	4.8	-12.7	-4.0	1.4	4.5
Alt 8	-2.0	0.0	0.0	0.0	1.5	1.5	1.7	4.8	-12.7	-5.3	-2.9	4.5

Table XIII-37
Sacramento River at Verona Riparian Wetland Habitat Analysis

73-Year Average Monthly River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	9.1	9.8	12.2	15.5	17.4	16.6	12.2	10.7	9.5	9.7	8.5	7.9

Percent Change in Average Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	3.3	-1.0	1.6	1.3	1.1	0.6	-1.6	1.9	-11.6	-5.2	8.2	1.3
Alt 3	2.2	0.0	1.6	1.3	1.1	-0.6	-1.6	1.9	-11.6	-6.2	9.4	2.5
Alt 4	3.3	1.0	1.6	1.9	-1.1	-0.6	-0.8	2.8	-11.6	-7.2	3.5	1.3
Alt 5	3.3	0.0	1.6	1.9	1.1	-0.6	-1.6	1.9	-11.6	-6.2	5.9	1.3
Alt 6	4.4	2.0	2.5	1.9	-1.1	0.0	-4.9	4.7	-13.7	-6.2	3.5	2.5
Alt 7	3.3	1.0	1.6	1.3	-1.1	0.0	-1.6	1.9	-11.6	-13.4	7.1	3.8
Alt 8	3.3	2.0	2.5	1.3	-1.1	0.0	-0.8	2.8	-11.6	-13.4	9.4	5.1

Average Monthly Wet Year River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	5.9	6.3	9.5	12.5	13.9	12.4	10.9	9.8	7.6 3.4	6.3	4.9	5.1.7

Percent Change in Wet Year Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	1.7	0.0	3.2	1.6	-1.4	0.0	0.0	0.0	-1.3	1.6	8.2	-3.8
Alt 3	1.7	0.0	3.2	1.6	-0.7	-0.8	0.0	0.0	-1.3	0.0	6.1	-1.8
Alt 4	3.4	0.0	4.2	1.6	-1.4	-0.8	0.9	1.0	-1.3	-1.6	0.0	0.0
Alt 5	0.0	0.0	4.2	1.6	-0.7	0.0	0.0	1.0	-1.3	0.0	2.0	0.0
Alt 6	1.7	1.6	6.3	0.8	-0.7	0.0	0.0	1.0	-2.6	-3.2	0.0	0.0
Alt 7	1.7	0.0	4.2	1.6	-1.4	0.0	0.0	0.0	-1.3	-3.2	8.3	0.0
Alt 8	0.0	0.0	4.2	1.6	-1.4	0.0	0.0	0.0	-1.3	-3.2	6.1	1.8

Average Monthly Dry Year River Stage (ft)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1	8.8	9.0	9.4	10.8	12.8	13.3	9.0	8.1	7.9	9.3	8.6	7.3

Percent Change in Dry Year Monthly River Stage Compared to the Base Case

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2	3.4	-1.1	0.0	0.9	-1.6	0.0	-2.2	12.3	***-27.8***	-12.9	5.8	5.5
Alt 3	3.4	-1.1	0.0	0.9	-1.6	0.0	-1.1	11.1	***-27.8***	-15.1	3.5	5.5
Alt 4	4.5	0.0	0.0	1.9	-0.8	-0.8	1.1	16.0	***-29.1***	-15.1	1.2	4.1
Alt 5	5.7	0.0	0.0	1.9	-1.6	-1.5	0.0	11.1	***-26.6***	-14.0	4.7	5.5
Alt 6	4.5	1.1	0.0	1.9	-0.8	-0.8	-5.6	16.0	***-31.6***	-11.8	5.8	6.8
Alt 7	5.7	0.0	0.0	0.9	-1.6	1.5	-1.1	11.1	***-27.8***	***-24.7***	11.6	9.6
Alt 8	4.5	1.1	0.0	1.9	-0.8	1.5	-1.1	11.1	***-27.8***	***-26.9***	5.8	8.2

The lower river stages predicted on the Feather River under average conditions are small enough that riparian wetlands and vegetation would adjust without specific mitigation. The effects seen under dry year conditions are larger and can not be mitigated.

C-032292

3. Geology

This analysis of geology addresses lands and soils, subsidence, soil quality, agricultural production, and soil erosion.

a. Methods of Analysis. The evaluation of lands and soils is based on water availability to agricultural lands. Urban water users tend to have priority for limited water supplies in dry years. Agricultural users tend to pump more ground water in areas where it is available at a reasonable cost. Extensive ground water overdraft has limited water supply in many areas. This analysis assumes the cumulative water supply over the period 1921-1994 is an indicator for agriculture and that relative differences in water supply between alternatives will result in differences in ground water overdraft potential and agricultural production.

Subsidence has been widespread in the San Joaquin Valley and occurs locally in the Sacramento Valley. Water level declines due to ground water overdraft have caused the subsidence in most areas. Although much of this damage has already occurred, further damage is possible if overdraft continues to dewater aquifers. This analysis assumes that any alternative that reduces agricultural water supplies will lead to ground water overdraft and increase subsidence potential. Damage to agriculture from subsidence includes reducing irrigation canal capacity and increasing the need to relevel fields to maintain a uniform gradient.

Soil quality refers to factors such as organic matter content, friability, permeability, and water holding capacity. Soil salinity and sodicity are also important components of soil quality. Irrigation tends to maintain or improve soil quality in irrigated areas; however, soil salinity and sodicity problems can also develop. Any alternative that reduces surface water supply will encourage the use of ground water for irrigation. In some areas, this will tend to lead to an increase in soil salinity and, in some areas, sodicity because ground water is nearly always more saline than surface water supplies. The following land types are most affected: westside alluvial fans, basin and basin rim areas, and old eastside terraces. Any alternative that reduces agricultural water supply will lead to increases in ground water use and will generally increase soil salinity and sodicity and reduce soil quality.

The study area is very dependent on irrigation water for crop production. In years when water is short, these shortages tend to be felt most by agricultural users. In areas where good supplies of ground water are available, agricultural production is reduced slightly; however, in areas where adequate supplies of ground water are not available, or are too deep to pump economically, agricultural production is severely reduced. Because of ground water conditions and priority of service in certain districts, the alluvial fans on the west side of the San Joaquin Valley tend to be affected significantly, and large tracts of idle lands are present during drought years.

Wind erosion potential increases significantly in dry years because more lands are idle and groundcover is sparse because of inadequate water supply. Chronic water shortages could increase water erosion potential if lands are abandoned or if management intensity is reduced. Damages are most likely to occur in steeper areas where orchards have been developed and adequate ground water is unavailable.

b. Impact Analysis. Based on the delivery reductions shown in Table XIII-1, a qualitative assessment of the impacts of the the Joint POD alternatives to lands compared to Alternative 2 are shown in Table XIII-38. Ground water overdraft estimates and potential water level declines were calculated for the different alternatives and are shown in Table XIII-39.

Joint POD Alternative 1. Joint POD Alternative 1 reflects D-1485 conditions for 1921-1994. Only Alternative 8 is more beneficial to land and soil resources. California agriculture development has taken place because of water deliveries available under this alternative.

Joint POD Alternative 2. When compared to Alternative 1, Joint POD Alternative 2 results in a reduced water supply for agriculture. The cumulative reduction in water supply amounts to about 21 million acre-feet over the 1921-1994 period. Average annual water supplies for agriculture would be reduced about 6.7 percent. If irrigators decided to pump ground water to make up the deficit, then ground water levels may decline on average by 1.2 feet per year.

In areas where ground water is available, irrigators would probably pump more ground water in the short term; however, in the long term, the agricultural production would be reduced as cropping patterns and irrigated acreage come into balance with the reduced water supply. (Refer to the agricultural economics section of this report for further information on agriculture production.)

Compared to Alternative 1, Alternative 2 would tend to decrease soil quality by increasing soil salinity and sodicity because ground water nearly always contains more salt than surface water.

Soil erosion potential would increase because more land would be idled and thus be susceptible to wind erosion, especially where adequate supplies of ground water are not available.

Subsidence potential would increase because overdraft under this alternative could dewater some aquifers. Following dewatering, there is a potential for a reduction in pore space due to aquifer consolidation.

Joint POD Alternatives 3, 4, 5, and 6. When compared to Alternative 2, Joint POD Alternatives 3, 4, 5, and 6 would cummulatively increase agricultural water supply by 5 million to 9 million acre-feet over the 73-year period. Agricultural production would increase, soil quality would improve, and soil erosion potential would decrease. Subsidence potential would decrease. These alternatives are very slightly beneficial when compared to Alternative 2.

Table XIII-38. Summary of Impacts of Joint POD Alternatives on Lands (compared to Alternative 2)

Joint POD Alternative	Soil Quality: Soil Salinity and Sodicity	Erosion: Wind and Water	Agricultural Production	Subsidence Potential
1	Slightly beneficial	Slightly beneficial	Slight increase	Slightly beneficial
2	—	—	—	—
3	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial
4	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial
5	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial
6	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial
7	Slightly beneficial	Slightly beneficial	Slight increase	Slightly beneficial
8	Slightly beneficial	Slightly beneficial	Slight increase	Slightly beneficial

Table XIII-39. Ground Water Overdraft and Water Level Decline Resulting from Joint POD Alternatives for the 73-Year Period

Alternative	Cumulative Deliveries MAF[1]	Shortage (Overdraft) MAF	Average Annual Overdraft TAF[2]	Percent of Average Ag. Deliveries	Annual Average Ground Water Level Decline[3] (ft)	Agriculture Ranking
1	412	—	—	—	—	—
2	391	21	288	6.7	1.2	7 (worst)
3	396	16	216	5.0	0.92	6
4	397	15	209	4.9	0.86	4
5	400	12	166	3.9	0.78	3
6	397	15	206	4.9	0.86	4
7	403	9	118	2.7	0.52	2
8	410	2	29	0.7	0.11	1 (best)

[1] Million acre-feet.
[2] Thousand acre-feet.
[3] Calculated based on 1.6 million acres agricultural service area and aquifer specific yield of 15 percent. Regional ground water flow systems not considered.
73-year period ground water level decline = (Shortage/1.6)/0.15
Assumptions: All shortages accrue to agriculture.
Average agriculture deliveries - 4.3 million acre-feet.

Joint POD Alternatives 7 and 8. Joint POD Alternatives 7 and 8 would result in agricultural water supplies similar to Alternative 1. When compared to Alternative 2, these alternatives would result in improved soil quality, reduced subsidence and erosion potential, and increased agricultural production. Alternative 8 tends to maximize benefits to agriculture, land, and soil resources.

4. Energy

Joint POD alternatives will affect energy production and consumption. This section discusses the impact of implementing the alternatives on: (1) hydroelectric power availability, (2) ground water pumping, and (3) fossil fuel consumption. Standard outputs of energy generation and consumption from DWR's planning model, DWRSIM, were used to evaluate effects on power availability.

a. Hydroelectric Power Availability. Hydroelectric power is an important component in California's energy budget. Hydroelectric generation plants provide approximately 24 percent of the State's generation capacity. In a typical year, in excess of $1.3 billion of power, as measured by replacement costs, is produced (McCann 1994). Electric utilities seek to maximize the value of their hydroelectric power production. Power produced during peak energy demand periods is more valuable than that produced during lower demand periods. Utilities generally employ hydropower to meet peak loads because it provides a low cost energy source that can be turned on and off quickly. Peak load periods in California typically occur in the summer when electrical demands for ground water pumping, air conditioning, and industrial needs are the greatest. Changes in the operation of hydropower reservoirs that limit or reduce the availability of water during the peak demand period may result in reductions in hydroelectric plant's ability to meet peak load requirements. This loss of flexibility accelerates the need for additional peaking resources and increases utility costs.

The SWP and the CVP are both producers and consumers of hydroelectric power. Hydroelectric power plants at the reservoirs produce the power and pumping plants at export facilities consume it. The SWP includes 22 dams and reservoirs, eight hydroelectric plants and 17 pumping plants. The CVP includes 19 dams and reservoirs, seven hydroelectric power plants, two pump/generation plants, and 39 pumping plants. The CVP is a net energy producer, having greater production capacity than consumption. The SWP is a net energy consumer, primarily because of the number and size of pumped lifts required along the length of the California Aqueduct. Together, the SWP and CVP produce more energy than is consumed. The Joint POD alternatives permit increased pumping by the SWP, resulting in higher consumption. This higher consumption decreases the availability of energy otherwise produced and utilized outside the SWP and CVP projects. This loss accelerates the need for additional resources and may increase utility costs.

Net SWP, CVP, and combined SWP and CVP energy generation were evaluated. The values reported are a composite index resulting from the complex interaction among the many factors and model assumptions that affect the simulated operations of the SWP and CVP. At any given time it can be difficult to determine the cause of differences among alternatives. The net values reported were calculated by subtracting energy consumption from energy generation for each alternative and then comparing the index to that calculated for Alternative 1. Positive effects on this index generally occur with increases in reservoir releases used for generation or from reductions in pumping and consumption. Negative effects on this index generally occur with decreased reservoir releases and increases in pumping.

Net CVP Hydropower Generation. Table XIII-40 shows the average monthly difference in net CVP energy generation for Joint POD Alternatives 2-8 compared to Alternative 1 (base case) for the 73-year period of analysis. This information is graphically represented in Figure XIII-51. The comparison of Alternative 2 with Alternative 1 demonstrates the effect of full implementation of the 1995 Bay/Delta Plan. The increase in the long-term average annual net CVP generation is consistent with similar flow objective alternatives analyzed in Chapter VI, Section 7 and with Beck (1994) who reported that slightly increased amounts of energy are available to the CVP from implementation of the Bay/Delta Plan due to reduced export pumping. Alternatives 3-8 show a similar pattern of change in mean monthly net CVP energy generation to that which occurs with implementation of the 1995 Bay/Delta Plan represented by Alternative 2. Increases occur from February through May, when reservoir releases are increased and pumping is curtailed to meet 1995 Bay/Delta Plan objectives. Decreases occur in June and from September through January when the conditions necessary to permit wheeling exist. However, the annual difference over the 73-year period of record shows that net energy generation for all alternatives that allow wheeling would be less than the mean for Alternative 1. Alternative 8, which assumes maximum wheeling, is expected to cause the greatest decrease in net CVP energy generation. Alternative 4 is expected to cause the least decrease in net CVP energy generation. The CVP remains a net energy producer for all alternatives considered.

Net SWP Hydropower Generation. Table XIII-41 shows the average monthly difference in net SWP energy generation for Alternatives 2-8 compared to Alternative 1 for the 73-year period analysis. This information is graphically represented in Figure XIII-52. All Joint POD alternatives result in an increase in net SWP energy generation. The greatest increase is predicted to occur with Alternative 2, which represents implementation of the 1995 Bay/Delta Plan. The predicted increases are less for the alternatives that allow wheeling. The smallest net increase is predicted to occur with Alternative 7.

Net Combined SWP and CVP Hydropower Generation. The effects on combined net SWP and CVP energy generation are shown in Table XIII-42 and Figure XIII-53. Alternative 2 shows the greatest increase in net energy generation because of gains in both SWP and CVP net generation with implementation of the 1995 Bay/Delta Plan. The gains predicted for the SWP are greater than the reductions predicted for the CVP, resulting in a net increase in combined generation for Alternatives 3 through 6. Net combined energy generation is predicted to be reduced under Alternatives 7 and 8, which assume combined use would be permitted up to the SWP's maximum pumping capacity of 10,300 cfs.

Table XIII-40. Net CVP Energy Generation[1] (Alternatives 2-8 versus Alternative 1 Base Case) Expressed in Gigawatt hours

Month	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
October	-19.1	-27.4	-31.6	-36.1	-18.8	-53.1	-40.5
November	3.5	-4.5	-13.8	-14.2	-15.6	-25.2	-20.6
December	-9.4	-22.5	-38.4	-40.7	-30.2	-65.9	-40.2
January	-18.2	-29.2	-57.5	-59.8	-49.5	-39.2	-116.7
February	5.2	-1.7	3.3	13.3	13.3	29.0	20.3
March	12.3	5.2	26.9	26.9	28.9	25.7	17.7
April	67.6	67.1	93.4	70.1	20.5	64.3	61.4
May	1.5	2.8	20.7	3.6	30.1	1.1	0.3
June	-19.9	-17.1	-15.7	-15.4	-9.7	-23.5	-10.9
July	10.6	9.7	7.1	5.7	11.1	-4.7	-2.5
August	19.2	8.9	2.0	-3.4	-3.5	-16.2	-25.4
September	10.7	-15.9	-20.4	-20.2	-20.2	-26.8	-31.5
Annual Difference (73 Years)	42.6	-24.6	-24.1	-70.1	-43.5	-134.7	-188.5

[1] Negative numbers indicate less energy is produced (net) under the alternatives than the base case.

Figure XIII-51

Net CVP Energy Generation

73 year monthly average compared to Alternative 1 (Base Case)

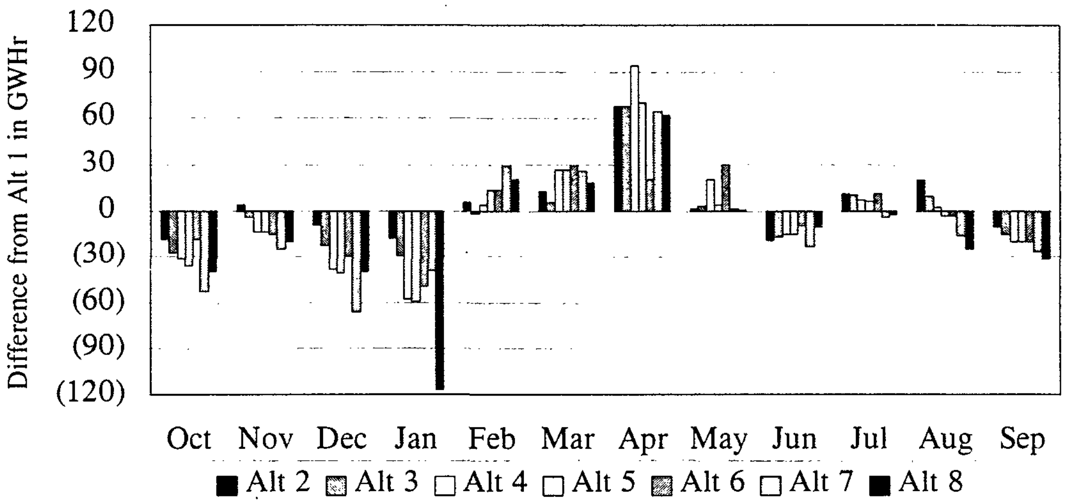

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Table XIII-41. Net SWP Energy Generation[1]
(Alternatives 2-8 versus Alternative 1 Base Case)
Expressed in Gigawatt hours

Month	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
October	-25.0	-25.2	-22.5	-23.3	-23.2	-56.6	-54.4
November	-2.7	-1.2	-0.2	2.5	1.9	-26.3	-20.0
December	-1.0	-3.8	-8.4	-7.5	-18.0	-23.9	-19.5
January	24.3	20.6	12.1	14.5	8.8	21.6	9.5
February	47.1	47.4	39.4	42.3	43.6	54.2	54.2
March	25.0	21.2	22.3	25.6	18.2	19.9	21.5
April	54.5	55.2	64.0	55.8	47.3	46.5	46.5
May	-8.1	-8.3	1.6	-6.3	8.4	-17.6	-18.1
June	13.9	13.9	10.6	15.4	15.9	-0.3	0.5
July	49.8	49.3	52.3	48.3	54.9	51.9	51.0
August	7.6	4.4	7.7	1.0	7.2	-27.5	-31.0
September	18.6	19.4	19.1	23.2	21.8	-6.4	0.4
Annual Difference (73 Years)	202.0	193.0	198.0	191.5	186.8	35.5	40.6

[1] Negative numbers indicate less energy is produced (net) under the alternatives than the base case

Figure XIII-52

Net SWP Energy Generation

73 year monthly average compared to Alternative 1 (Base Case)

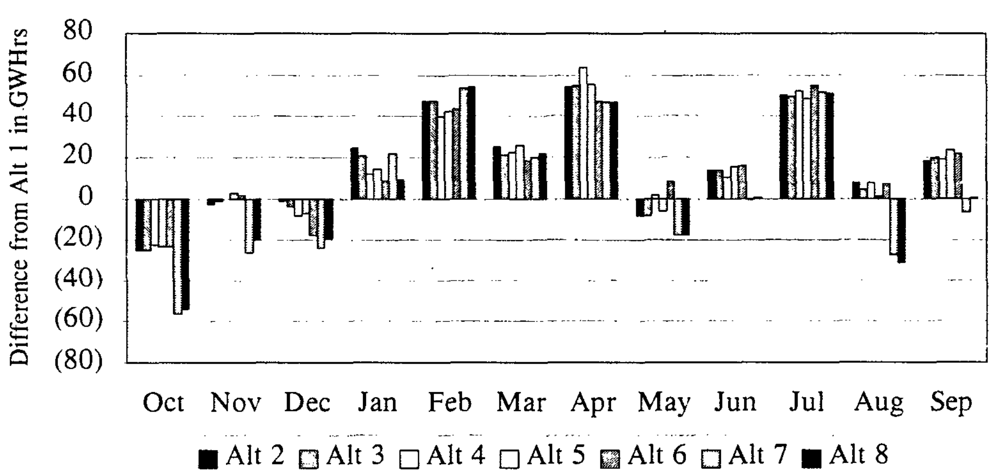

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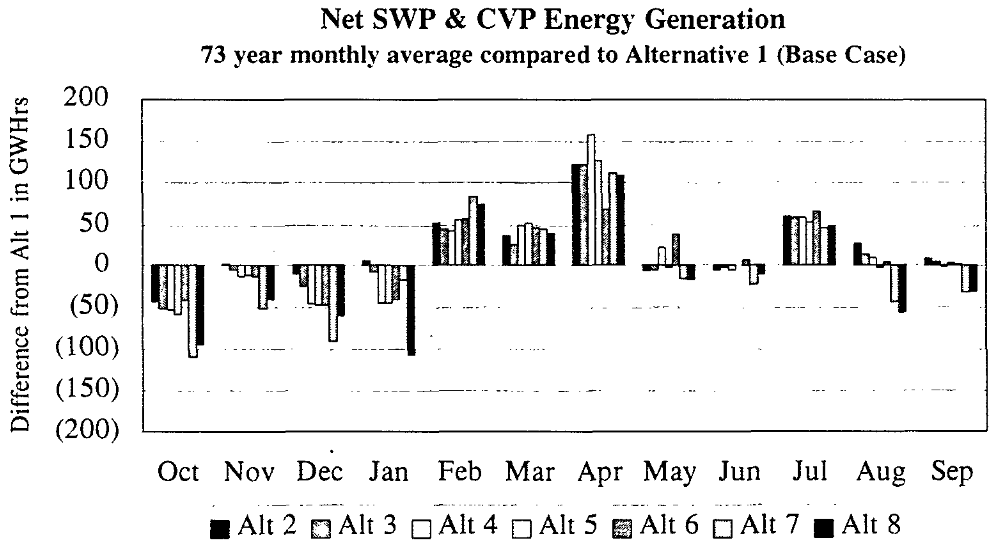
Table XIII-42. Net SWP and CVP Energy Generation[1]
(Alternatives 2-8 versus Alternative 1 Base Case)
Expressed in Gigawatt hours

Month	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
October	-44.0	-52.6	-54.1	-59.5	-42.0	-109.7	-94.9
November	0.8	-5.7	-14.0	-11.7	-13.8	-51.5	-40.6
December	-10.4	-26.3	-46.8	-48.1	-48.2	-89.8	-59.8
January	6.1	-8.6	-45.4	-45.3	-40.7	-17.6	-107.1
February	52.3	45.7	42.7	55.6	56.9	83.1	74.5
March	37.3	26.3	49.2	52.5	47.1	45.6	39.2
April	122.1	122.3	157.4	125.9	67.9	110.7	107.9
May	-6.6	-5.4	22.2	-2.7	38.4	-16.5	-17.7
June	-6.0	-3.2	-5.1	0.0	6.2	-23.9	-10.4
July	60.4	59.0	59.5	54.0	66.0	47.2	48.5
August	26.7	13.4	9.7	-2.4	3.8	-43.7	-56.3
September	7.9	3.4	-1.3	3.1	1.7	-33.2	-31.1
Annual Difference (73 Years)	246.7	168.4	173.9	121.4	143.3	-99.2	-147.9

[1] Negative numbers indicate less energy is produced (net) under the alternatives than the base case.

Figure XIII-53



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Impacts on Other Facilities. The analysis of the flow alternatives in Chapter VI indicates that the implementation of the 1995 Bay/Delta Plan will affect hydropower operations other than the SWP and the CVP. However, the implementation of any of the Joint POD alternatives that allow wheeling would affect only the hydropower operations of the SWP and the CVP.

b. Ground Water Pumping. The analysis of alternatives in Chapter VI indicates that the implementation of the 1995 Bay/Delta Plan may cause deficiencies in surface water deliveries. The reductions in surface water supplies have a potential to cause an increase in ground water pumping. Increased ground water pumping may lower ground water levels, resulting in higher pumping lifts and, thus, further increase energy consumption. Implementation of alternatives that include wheeling would reduce the loss of surface water supplies and offset increases in ground water pumping.

c. Fossil Fuels. No attempt was made to estimate the effect of the Joint POD alternatives on fossil fuel consumption. A qualitative assessment of the effects is difficult because decreased hydropower generation will be offset to some extent by decreased ground water pumping. Overall, it is possible that fossil fuel consumption will increase significantly, but if this occurs, the effect is unmitigable, as described in Chapter VI.

5. Recreation

This section presents the results of the assessment of impacts to recreation that would occur with implementation of the Joint POD. The assessment of recreation impacts analyzes how changes in reservoir storage would affect opportunities for water-related activities at key recreation facilities. Recreation impacts are assessed for the major reservoirs that are operated by the SWP and the CVP. The reservoirs include Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir.

The methodology for this assessment of recreation impacts is the same as described in Chapter VI for analyzing the impacts of implementing the 1995 Bay/Delta Plan. The recreation impact analysis considers the frequency of occurrence with which end-of-month storage (converted to surface elevation) falls below or, in some cases, exceeds the various threshold levels established for each reservoir. Tables XIII-43 through XIII-46 summarize the frequency of occurrence in absolute numbers and as a percentage of the total number of months in the study period.

In general, the end-of-month storage under Joint POD Alternatives 2 through 8 falls below the threshold levels established for each reservoir more often than under Joint POD Alternative 1. However, the differences illustrate the effects of the Bay/Delta Plan over the D-1485 objectives, and not the effects of the Joint POD.

There is little difference in recreation impacts between Joint POD Alternative 2 and Joint POD Alternatives 3 through 8. Joint POD Alternatives 3-8 generally have a slightly higher frequency of occurrence with which end-of-month storage falls below the various thresholds

Table XIII-43
Recreation Impact Assessment for Lake Shasta

Main Area
Peak Season (May - Sept.)

Period/Alternative	Total Months	844 ft. total	844 ft. %	947 ft. total	947 ft. %	987 ft. total	987 ft. %
		Frequency with which Reservoirs are below Critical Elevation Thresholds					
73-YEAR PERIOD	365						
Alternative 1 (Base Case)		0	0%	17	5%	64	18%
Alternative 2		0	0%	22	6%	72	20%
Alternative 3		0	0%	25	7%	75	21%
Alternative 4		0	0%	23	6%	76	21%
Alternative 5		0	0%	26	7%	75	21%
Alternative 6		0	0%	22	6%	76	21%
Alternative 7		0	0%	25	7%	76	21%
Alternative 8		0	0%	27	7%	78	21%
CRITICAL PERIOD	35						
Alternative 1 (Base Case)		0	0%	9	26%	22	63%
Alternative 2		0	0%	8	23%	23	66%
Alternative 3		0	0%	11	31%	24	69%
Alternative 4		0	0%	10	29%	24	69%
Alternative 5		0	0%	10	29%	24	69%
Alternative 6		0	0%	8	23%	24	69%
Alternative 7		0	0%	10	29%	24	69%
Alternative 8		0	0%	10	29%	24	69%

Main Area
Off-Season (Oct.- April)

Period/Alternative	Total Months	844 ft. total	844 ft. %	947 ft. total	947 ft. %
		Frequency with which Reservoirs are below Critical Elevation Thresholds			
73-YEAR PERIOD	511				
Alternative 1 (Base Case)		0	0%	26	5%
Alternative 2		0	0%	36	7%
Alternative 3		0	0%	41	8%
Alternative 4		0	0%	41	8%
Alternative 5		0	0%	42	8%
Alternative 6		0	0%	35	7%
Alternative 7		0	0%	39	8%
Alternative 8		0	0%	39	8%
CRITICAL PERIOD	43				
Alternative 1 (Base Case)		0	0%	14	33%
Alternative 2		0	0%	15	35%
Alternative 3		0	0%	16	37%
Alternative 4		0	0%	16	37%
Alternative 5		0	0%	16	37%
Alternative 6		0	0%	15	35%
Alternative 7		0	0%	16	37%
Alternative 8		0	0%	16	37%

Critical Elevation Thresholds:
<844 ft. msl - last boat ramp out of operation
<947 ft. msl - limited lake surface area (boating constrained)
<987 ft. msl - marina relocated

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Table XIII-44
Recreation Impact Assessment for Lake Oroville

Peak Season (April - Sept.)

Frequency with which Reservoirs are below Critical Elevation Thresholds

Period/Alternative	Total Months	700 ft. total	700 ft. %	710 ft. total	710 ft. %	750 ft. total	750 ft. %	819 ft. total	819 ft. %	840 ft. total	840 ft. %
73-YEAR PERIOD	438										
Alternative 1 (Base Case)		13	3%	24	5%	46	11%	133	30%	176	40%
Alternative 2		17	4%	25	6%	64	15%	157	36%	191	44%
Alternative 3		19	4%	29	7%	68	16%	158	36%	196	45%
Alternative 4		20	5%	29	7%	68	16%	160	37%	199	45%
Alternative 5		20	5%	29	7%	65	15%	161	37%	192	44%
Alternative 6		17	4%	27	6%	63	14%	167	38%	198	45%
Alternative 7		18	4%	28	6%	69	16%	169	39%	201	46%
Alternative 8		18	4%	25	6%	68	16%	169	39%	201	46%
CRITICAL PERIOD	41										
Alternative 1 (Base Case)		2	5%	4	10%	12	29%	34	83%	36	88%
Alternative 2		1	2%	3	7%	21	51%	36	88%	36	88%
Alternative 3		4	10%	7	17%	24	59%	35	85%	36	88%
Alternative 4		4	10%	6	15%	23	56%	34	83%	36	88%
Alternative 5		4	10%	6	15%	23	56%	35	85%	36	88%
Alternative 6		2	5%	4	10%	19	46%	36	88%	36	88%
Alternative 7		2	5%	3	7%	20	49%	36	88%	36	88%
Alternative 8		2	5%	3	7%	20	49%	36	88%	36	88%

Off-Season (Oct.- March)

Frequency with which Reservoirs are below Critical Elevation Thresholds

Period/Alternative	Total Months	710 ft. total	710 ft. %	750 ft. total	750 ft. %
73-YEAR PERIOD	438				
Alternative 1 (Base Case)		39	9%	77	18%
Alternative 2		42	10%	87	20%
Alternative 3		52	12%	89	20%
Alternative 4		53	12%	89	20%
Alternative 5		51	12%	88	20%
Alternative 6		40	9%	88	20%
Alternative 7		52	12%	87	20%
Alternative 8		51	12%	88	20%
CRITICAL PERIOD	37				
Alternative 1 (Base Case)		9	24%	18	49%
Alternative 2		8	22%	25	68%
Alternative 3		15	41%	25	68%
Alternative 4		14	38%	25	68%
Alternative 5		15	41%	24	65%
Alternative 6		8	22%	23	62%
Alternative 7		10	27%	22	59%
Alternative 8		10	27%	23	62%

Critical Elevation Thresholds:
- <700 ft. msl - decline in campground/picnicking use
- <710 ft. msl - limited boat ramp availability/marina relocation
- <750 ft. msl - limited lake surface area (boating constrained)
- <819 ft. msl - beach area closed
- <840 ft. msl - decline in beach use

Table XIII-45
Recreation Impact Assessment for Folsom Lake

Peak Season (April - Sept.)

Frequency with which Reservoirs are below Critical Elevation Thresholds (or >450 ft.)

Period/Alternative	Total Months	360 ft. total	360 ft. %	400 ft. total	400 ft. %	405 ft. total	405 ft. %	430 ft. total	430 ft. %	> 450 ft. total	> 450 ft. %
73-YEAR PERIOD	438										
Alternative 1 (Base Case)		39	9%	76	17%	85	19%	167	38%	101	23%
Alternative 2		56	13%	106	24%	113	26%	180	41%	99	23%
Alternative 3		61	14%	105	24%	114	26%	189	43%	99	23%
Alternative 4		61	14%	111	25%	122	28%	193	44%	97	22%
Alternative 5		58	13%	110	25%	120	27%	195	45%	98	22%
Alternative 6		61	14%	118	27%	127	29%	202	46%	92	21%
Alternative 7		61	14%	110	25%	124	28%	198	45%	96	22%
Alternative 8		68	16%	118	27%	131	30%	204	47%	88	20%
CRITICAL PERIOD	41										
Alternative 1 (Base Case)		13	32%	20	49%	22	54%	30	73%	3	7%
Alternative 2		18	44%	28	68%	28	68%	34	83%	1	2%
Alternative 3		18	44%	27	66%	27	66%	34	83%	2	5%
Alternative 4		18	44%	28	68%	29	71%	34	83%	2	5%
Alternative 5		18	44%	27	66%	28	68%	34	83%	2	5%
Alternative 6		18	44%	30	73%	30	73%	35	85%	1	2%
Alternative 7		18	44%	28	68%	29	71%	34	83%	2	5%
Alternative 8		18	44%	28	68%	30	73%	34	83%	2	5%

Off-Season (Oct.- March)

Frequency with which Reservoirs are below Critical Elevation Thresholds

Period/Alternative	Total Months	360 ft. total	360 ft. %	400 ft. total	400 ft. %
73-YEAR PERIOD	438				
Alternative 1 (Base Case)		29	7%	128	29%
Alternative 2		39	9%	127	29%
Alternative 3		48	11%	139	32%
Alternative 4		46	11%	145	33%
Alternative 5		46	11%	143	33%
Alternative 6		54	12%	152	35%
Alternative 7		46	11%	140	32%
Alternative 8		54	12%	156	36%
CRITICAL PERIOD	37				
Alternative 1 (Base Case)		4	11%	26	70%
Alternative 2		12	32%	26	70%
Alternative 3		15	41%	28	76%
Alternative 4		15	41%	28	76%
Alternative 5		15	41%	27	73%
Alternative 6		19	51%	28	76%
Alternative 7		15	41%	27	73%
Alternative 8		16	43%	28	76%

Critical Elevation Thresholds:
- <360 ft. msl - last boat ramp out of operation
- <400 ft. msl - limited lake surface area (boating constrained)
- <405 ft. msl - marina closes
- <430 ft. msl - decline in campground/picnicking use
- >450 ft. msl - beach area inundated

Table XIII-46
Recreation Impact Assessment for New Melones Reservoir

Peak Season (April - Sept.)

Period/Alternative	Total Months	Frequency with which Reservoirs are below Critical Elevation Thresholds							
		850 ft.		860 ft.		880 ft.		900 ft.	
73-YEAR PERIOD	438	total	%	total	%	total	%	total	%
Alternative 1 (Base Case)		8	2%	9	2%	11	3%	15	3%
Alternative 2		18	4%	22	5%	34	8%	47	11%
Alternative 3		18	4%	22	5%	34	8%	46	11%
Alternative 4		18	4%	22	5%	34	8%	46	11%
Alternative 5		18	4%	22	5%	34	8%	46	11%
Alternative 6		4	1%	4	1%	10	2%	13	3%
Alternative 7		18	4%	22	5%	34	8%	46	11%
Alternative 8		18	4%	22	5%	34	8%	46	11%
CRITICAL PERIOD	41								
Alternative 1 (Base Case)		0	0%	0	0%	0	0%	1	2%
Alternative 2		8	20%	10	24%	14	34%	20	49%
Alternative 3		8	20%	10	24%	14	34%	20	49%
Alternative 4		8	20%	10	24%	14	34%	20	49%
Alternative 5		8	20%	10	24%	14	34%	20	49%
Alternative 6		0	0%	0	0%	1	2%	3	7%
Alternative 7		8	20%	10	24%	14	34%	20	49%
Alternative 8		8	20%	10	24%	14	34%	20	49%

Off-Season (Oct.- March)

Period/Alternative	Total Months	Frequency with which Reservoirs are below Critical Elevation Thresholds			
		850 ft.		860 ft.	
73-YEAR PERIOD	438	total	%	total	%
Alternative 1 (Base Case)		9	2%	10	2%
Alternative 2		22	5%	26	6%
Alternative 3		22	5%	25	6%
Alternative 4		22	5%	25	6%
Alternative 5		22	5%	25	6%
Alternative 6		4	1%	4	1%
Alternative 7		22	5%	25	6%
Alternative 8		22	5%	25	6%
CRITICAL PERIOD	37				
Alternative 1 (Base Case)		0	0%	0	0%
Alternative 2		7	19%	8	22%
Alternative 3		7	19%	8	22%
Alternative 4		7	19%	8	22%
Alternative 5		7	19%	8	22%
Alternative 6		0	0%	0	0%
Alternative 7		7	19%	8	22%
Alternative 8		7	19%	8	22%

Critical Elevation Thresholds:
- <850 ft. msl - last boat ramp out of operation
- <860 ft. msl - limited lake surface area and decline in campground/picnicking use
- <880 ft. msl - marina closes
- <900 ft. msl - decline in beach use

than Joint POD Alternative 2. One exception to this is seen at New Melones Reservoir under Joint POD Alternative 6. Here, the frequency of occurrence with which end-of-month storage falls below the various thresholds is similar to Alternative 1 and much lower than the other alternatives. However, this is a result of assuming the Letter of Intent flows at Vernalis and not the result of the Joint POD.

Potential impacts to recreation on the rivers below the major reservoirs as a result of implementing the 1995 Bay/Delta Plan were assessed in Chapter VI. In general, increased flows would result in beneficial impacts to recreation. River flows are not expected to change dramatically as a result of the Joint POD alternatives and would be within the normal range experienced on those rivers. The principal effect of the Joint POD alternatives on river flows is to shift the timing of releases somewhat. These changes will not result in significant impacts to recreation.

6. Cultural Resources

This section presents the results of the assessment of impacts to cultural resources that would occur with implementation of the Joint POD alternatives.

Federal law requires federal agencies to consider the effect of their undertakings on cultural resources. The National Historic Preservation Act of 1966, as amended (NHPA), is the basic federal law governing preservation of cultural resources of national, regional, state and local significance. Specifically, section 106 of the NHPA requires each federal agency to consider the effect of its actions on "any district, site, building, structure or object that is included in or eligible for inclusion in the National Register." Eligible cultural resources may also include traditional cultural properties, which are generally defined as specific locations that are significant due to their association with cultural practices or beliefs of a living community that are rooted in the community's history and are important in maintaining the continuing cultural identity of the community" (National Park Service, Bulletin 38). Procedures for meeting section 106 requirements are defined in Federal regulations, at 36 CFR section 800, et seq. Other federal legislation further promotes and requires the protection of historic and archaeological resources by the federal government. Among these laws are the Archaeological Resources Protection Act and the Native American Graves Protection and Repatriation Act for federal lands.

a. <u>Impacts</u>. All the proposed alternatives deal with changing project operations to affect varying degrees of use of the joint points of diversion. The reservoirs to be affected include Lake Shasta, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Rivers include the Sacramento, Feather, American, and Stanislaus. No construction or ground-disturbing activities are involved. The maximum water surface elevation at the subject reservoirs under all alternatives is at 100-percent capacity and will not exceed that which has occurred under historic operations (i.e., flood operations that completely fill the reservoir or operations in wet years in which the reservoirs fill in the spring snowmelt). It should be noted that New Melones Reservoir has never filled completely (i.e., the emergency overflow spillway has never been used), but as a practical matter can be considered to have filled completely with its maximum elevation being only 4 feet from the elevation of the emergency spillway. No new lands will be inundated around the reservoirs.

River flows will also not exceed high-level flows experienced under the range of normal associated reservoir operations. Inundation of cultural resources adjacent to rivers is, therefore, not expected. Implementing the alternatives would not result in changes to reservoir operations related to flood control. Flood flows in the tributaries downstream from the reservoirs are a function of hydrology and not reservoir operation.

Cropping patterns are expected to remain the same and no new lands will be brought into production as a result of the Joint POD alternatives. Therefore, there will be no impacts from changes in agricultural practices due to the alternatives. Any deficiencies in surface water deliveries are expected to be made up to some degree by ground water pumping. In reality, the joint points of diversion project will allow for lower deficiencies than would otherwise be imposed on CVP users.

Changes will occur in the minimum pool elevations at all of the reservoirs between Alternative 1 (base case) and Alternatives 2 through 8. Therefore, the assessment of new impacts to cultural resources at the subject reservoirs is limited to comparing the minimum reservoir pool elevations of Alternative 1 to the minimum reservoir pool elevations of the other alternatives (the Area of Potential Effects). The differences between Alternative 1 and the other seven alternatives in minimum pool elevations for the affected reservoirs vary significantly (see Tables XIII-47 and XIII-48). These differences range from a minimum pool lowered by 53 feet at Folsom Lake under Alternative 8 to a minimum pool raised by 46 feet at New Melones Reservoir under Alternative 6. The reason for the unique, significant upward increase at New Melones Reservoir is described in Section C (description of alternatives) of this chapter.

An analysis of the minimum and maximum pool elevations for San Luis Reservoir is not included because under normal operating procedures, water elevations already fluctuate about 250 feet a year. The range of fluctuations under the alternatives is expected to be similar to normal fluctuations. Therefore, no new impacts are anticipated at San Luis Reservoir. Furthermore, extensive mitigation was conducted at the site of San Luis Reservoir during construction of San Luis Dam. Surveys and a great deal of excavation were completed in the 1960s. Additional surveys have been conducted since then, including one in the early 1980s when the reservoir was drawn down to conduct repairs. A National Register district at San Luis Reservoir includes about eight sites, several of which are within the fluctuating reservoir pool.

For the purpose of this analysis, minimum simulated reservoir pool elevations for Alternative 1 are used as an impact threshold instead of historic reservoir elevations. The analysis uses simulated reservoir elevation from DWRSIM model output for the 73-year hydrology. It should be noted that short-term flood events are not captured in the monthly operation studies. It also must be noted for all of the alternatives, minimum pool elevations occur under very

Table XIII-47
73-Year Minimum Annual Reservoir Elevations, (ft)

	Lake Shasta	Lake Oroville	Folsom Lake	New Melones Reservoir
Alternative 1	879	589	286	759
Alternative 2	866	587	286	718
Alternative 3	867	576	286	718
Alternative 4	874	577	287	718
Alternative 5	872	584	287	718
Alternative 6	883	561	268	805
Alternative 7	875	544	287	718
Alternative 8	876	542	233	718
Historic	839	647	352	721

73-Year Maximum Annual Reservoir Elevation, (ft)

	Lake Shasta	Lake Oroville	Folsom Lake	New Melones Reservoir
Alternative 1	1,067	900	466	1,088
Alternative 2	1,067	900	466	1,088
Alternative 3	1,067	900	466	1,088
Alternative 4	1,067	900	466	1,088
Alternative 5	1,067	900	466	1,088
Alternative 6	1,067	900	466	1,088
Alternative 7	1,067	900	466	1,088
Alternative 8	1,067	900	466	1,088
Historic	1,067	899	469	1,084

Table XIII-48 Difference Between Minimum Annual Reservoir Elevation and Base Case, (ft)				
Comparison	Lake Shasta	Lake Oroville	Folsom Lake	New Melones Reservoir
Alternative 2 to Alternative 1	-13	-2	0	-41
Alternative 3 to Alternative 1	-12	-13	0	-41
Alternative 4 to Alternative 1	-5	-12	1	-41
Alternative 5 to Alternative 1	-7	-5	1	-41
Alternative 6 to Alternative 1	4	-28	-18	46
Alternative 7 to Alternative 1	-4	-45	1	-41
Alternative 8 to Alternative 1	-3	-47	-53	-41

adverse hydrologic conditions, such as occurred during 1976-1977 or 1990-1991. Actual operations in the future under such adverse conditions may be different from those elevations depicted because "real world" decisions at the time may prevent such low drawdowns.

In addition to the data developed for the various alternatives, Table XIII-47 also includes the historic minimum and maximum pool elevations at the four reservoirs. It can be seen that at Lake Shasta, the actual minimum pool elevation is below that which would occur under any of the alternatives. Thus, no lands in the reservoir basin will be exposed that have not already been exposed under historic operating conditions. At Lake Oroville, Folsom Lake, and New Melones Reservoir, the opposite condition exists; the historic minimum pool elevations are higher than the simulated minimum pool elevations under most alternatives. This indicates that the drawdowns would expose lands normally inundated within the reservoir basin.

Table XIII-49 shows the minimum and maximum annual river stages along the American, Feather, and Sacramento rivers. As can be seen on the table, there is little variation in both minimum and maximum river stages. Therefore, no new impacts to cultural resources are expected to occur.

The impact mechanisms related to reservoir operations that could potentially affect different types of cultural resources under the Joint POD alternatives are described in Chapter VI (impact mechanisms). These mechanisms include changes in reservoir pool elevations and changes in recreation, including unauthorized activities (i.e., intentional vandalism and amateur collecting). Studies on the effects of reservoir inundation on archaeological sites have concluded that the nature and extent of the effects depend on several factors, most notably the location of a cultural property within the reservoir basin. Sites within the zone of seasonal drawdown suffer the greatest impacts, primarily in the form of erosion/scouring, deflation,

Table XIII-49
73-Year Minimum Annual River Stage, (ft)

Alternative	Natoma	Feather	Red Bluff	Verona
Alternative 1	1.9	1.4	4.3	5.9
Alternative 2	1.9	1.4	4.3	5.4
Alternative 3	1.9	1.4	4.3	5.9
Alternative 4	1.9	1.4	4.3	6.0
Alternative 5	1.9	1.4	4.3	5.9
Alternative 6	1.9	1.4	4.3	5.9
Alternative 7	1.9	1.4	4.3	5.9
Alternative 8	1.8	1.4	4.2	5.9

73-Year Maximum Annual River Stage, (ft)

Alternative 1	8.5	8.0	14.3	23.2
Alternative 2	8.4	8.1	14.2	23.1
Alternative 3	8.4	8.1	14.3	23.0
Alternative 4	8.5	8.1	14.2	23.0
Alternative 5	8.5	8.1	14.3	23.0
Alternative 6	8.5	8.1	14.3	23.1
Alternative 7	8.5	8.1	14.3	23.2
Alternative 8	8.4	8.2	14.3	23.2

Difference Between Minimum Annual River Stage and Base Case (%)

Comparison	Natoma	Feather	Red Bluff	Verona
Alternative 2 to Alternative 1	0.0	0.0	0.0	-8.4
Alternative 3 to Alternative 1	0.0	0.0	0.0	0.0
Alternative 4 to Alternative 1	0.0	0.0	0.0	1.6
Alternative 5 to Alternative 1	0.0	0.0	0.0	0.0
Alternative 6 to Alternative 1	0.0	0.0	0.0	0.0
Alternative 7 to Alternative 1	0.0	0.0	0.0	0.0
Alternative 8 to Alternative 1	-5.2	0.0	-2.3	0.0

hydrologic sorting, and artifact displacement caused by waves and currents. Sites located lower in the reservoir, within the deep pool, were more likely to be covered with silt, which sometimes formed a protective cap. Sites at or near the high water line and sites during drawdown suffered both erosion and vandalism (Waechter et al 1994).

Due to incomplete cultural resource inventories of all reservoirs, the actual effects of water fluctuations to sites are unknown but could possibly be adverse to any cultural resources present. Of all the reservoirs, New Melones has been the most comprehensively surveyed. A number of surveys have been completed there, beginning with the Smithsonian River Basin Survey in 1949. To date, more than 627 historic and prehistoric sites have been identified within the New Melones Recreation Area. These sites range from ancient hunting camps to 19th century gold mining boom towns, together representing approximately 10,000 years of human activity. More than 106,000 pre-historic and historic artifacts, records, photographs, and other data have been recovered from more than 42 sites as part of cultural resource mitigation programs. In the permanent pool zone below 808 feet amsl, which would include the area of potential effect, 122 sites have been identified. The greatest number of documented sites (232) occur in the fluctuating pool zone between 808 and 1088 feet amsl (USBR, 1996).

As of 1994, there were 123 known prehistoric sites within the Folsom Reservoir basin (Waechter et al 1994). No additional surveys have taken place since then. The recorded sites occur between elevations 330 feet and 466 feet amsl, well above the minimum pool elevation of any of the alternatives. Of the recorded sites within the reservoir basin, only two had been excavated and documented. Undoubtedly, other sites exist that have not been recorded especially within the area of potential effect.

Lake Shasta, although never comprehensively surveyed, has had several individual surveys beginning in 1941-1942 during the dam construction period. The most extensive survey was conducted by the U.S. Forest Service between 1976-1978 when the reservoir reached its historic low of 839 amsl. feet during a drought, which resulted in the exposure of more than three-fourths of the total pool area. As of 1986, there were a total of 115 recorded sites within the Shasta Lake pool area. These sites are located between elevation 700 feet and 1080 feet amsl (above high-water level). Only two of the sites are located within the area of potential effect (Henn and Sundahl 1986).

Considerable cultural resource surveys have also been conducted at Oroville Reservoir. An intensive archaeological program was carried out for the DWR at the Oroville Reservoir area in conjunction with construction of the reservoir. Between 1960 and 1967 when the reservoir was filled, 225 sites were recorded in the project area. At least 145 of these sites were inundated. While much information was obtained, the entire project area was not surveyed. In particular, no survey work was done at the recreation areas. Since then, some additional cultural resources survey work has been undertaken. In the early 1990s, a whole series of sites were resurveyed during low water levels. These included sites along the reservoir periphery as well as some in the basin.

C-032311

b. **Continuing Effects**. Under any of the alternatives, sites within the reservoir pools will be subject to the same impacts as they have been historically. These impacts would include inundation and exposure during drawdowns with the resulting effects to cultural resources.

c. **Impact Analysis**. Overall, based on a comparison of the predicted minimum pool elevations under all alternatives against the historic ones, it appears that the greatest new impacts to cultural resources are likely to occur at Oroville, Folsom, and New Melones reservoirs. As stated above, this is because the predicted minimum pools at these three reservoirs would be below the actual historic minimums during the worst case scenarios. Significant new impacts at Lake Shasta are less likely because the minimum pool elevations under all alternatives are higher than the historic minimums, and the fluctuation in simulated minimum pool elevations is not that great.

Alternative 1. Alternative 1 is the base case against which Joint POD Alternatives 2 through 8 are compared. Alternative 1 would be implemented in the absence of a water rights decision. The 1978 Bay/Delta Plan objectives are in effect and are implemented through D-1485.

Alternative 2. Alternative 2 represents the conditions that would exist when the 1995 Bay/Delta Plan flow objectives are fully implemented. Minimum pool elevations would be lower at Lake Oroville, Lake Shasta, and New Melones Reservoir; there would be no change at Folsom Lake. At Lake Oroville, the drop in pool minimum elevation would be only 2 feet; at Lake Shasta, the drop would be 13 feet; and at New Melones Reservoir, the drop would be 41 feet. These minimum pool elevations would occur between September and November. Visitation drops off significantly after Labor Day. The potential for hydrological and recreational impacts, including unauthorized activities, would likely be greatest at the latter two reservoirs.

Alternative 3. Under Alternative 3, minimum pool elevations would be lower at Lake Oroville, Lake Shasta, and New Melones Reservoir; there would be no change at Folsom Lake. At Lake Oroville and Lake Shasta, the change would be 12 and 13 feet, respectively, while at New Melones Reservoir, the minimum pool elevation would drop 41 feet. These minimum pool elevations would occur between September and November. Hydrological and recreational impacts, including unauthorized activities, could occur at these three reservoirs, with the greatest impacts likely occurring at New Melones Reservoir.

Alternative 4. Under Alternative 4, minimum pool elevations would be lower at Lake Shasta, Lake Oroville, and New Melones Reservoir; at Folsom Lake, the minimum pool elevation would increase by only 1 foot. The greatest change in minimum pool elevation would occur at New Melones Reservoir, where it would drop 41 feet. At Lake Oroville, the minimum pool elevation would drop 12 feet; at Lake Shasta, it would drop 5 feet. These minimum pool elevations would occur between September and November. Hydrological and recreational impacts, including unauthorized activities, could occur at Lake Shasta, Lake Oroville, and New Melones Reservoir, with the greatest effects likely occurring at New Melones Reservoir.

C-032312

Alternative 5. Under Alternative 5, minimum pool elevations would be lower at Lake Shasta, Lake Oroville and New Melones Reservoir; at Folsom Lake, the minimum pool elevation would increase by only 1 foot. The greatest change in minimum pool elevation would occur at New Melones Reservoir, where it would drop 41 feet. At Lake Shasta, the minimum pool elevation would drop 7 feet; at Lake Oroville, it would drop 5 feet. These minimum pool elevations would occur between September and November. Hydrological and recreational impacts, including unauthorized activities, could occur at Lake Shasta, Lake Oroville, and New Melones Reservoir, with the greatest effects likely occurring at New Melones Reservoir.

Alternative 6. Under Alternative 6, minimum pool elevations would drop at Lake Oroville and Folsom Lake and increase at Lake Shasta and New Melones Reservoir. The greatest changes would occur at Folsom Lake, where the minimum pool elevation would drop by 18 feet, at Lake Oroville, where the minimum pool elevation would drop by 28 feet, and at New Melones Reservoir, where it would increase by 46 feet. This minimum pool elevation is significantly different than that for the other alternatives and is a result of the hydrology assumed for the San Joaquin River (so-called Letter of Intent hydrology, see Flow Alternative 7, Chapter II), which is different than for all the other alternatives. At Lake Shasta, the minimum pool elevation would increase by only 4 feet. These changes would occur between September and November, with the exception of Folsom Lake, where the minimum pool elevation would be reached in August. Hydrological and recreational impacts, including unauthorized activities, could occur at all four reservoirs, with the greatest effects likely at Lake Oroville, Folsom Lake, and New Melones Reservoir.

Alternative 7. Under Alternative 7, minimum pool elevations would drop at Lake Shasta, Lake Oroville, and New Melones Reservoir; the minimum pool elevation would increase by only 1 foot at Folsom Lake. The greatest differences would occur at Lake Oroville and New Melones Reservoir, where minimum pool elevations would drop by 45 and 41 feet, respectively. At Lake Shasta, the minimum pool elevation would drop by only 4 feet. All of these minimum pool elevations would occur between September and November. Hydrological and recreational impacts, including unauthorized activities, could occur at Lake Shasta, Lake Oroville, and New Melones Reservoir, with the greatest effects likely at Lake Oroville and New Melones Reservoir.

Alternative 8. Under Alternative 8, minimum pool elevations would drop at all four reservoirs, with the greatest decreases occurring at Lake Oroville (47 feet), Folsom Lake (53 feet), and New Melones Reservoir (41 feet). At Lake Shasta, the decrease would be only 3 feet. All of these minimum pool elevations would occur between September and November, with the exception of Folsom Lake, where the minimum pool elevation would be reached in August. Hydrological and recreational impacts, including unauthorized activities, could occur at all four reservoirs, with the greatest effects likely at Lake Oroville, Folsom Lake, and New Melones Reservoir.

In summary, all alternatives have the potential to impact cultural resources at one or more reservoirs. These impacts are based on the worst case scenario (i.e., drought conditions) and would occur infrequently. Average conditions at the reservoirs would not create these new impacts.

d. Consultation with the California State Historic Preservation Officer. Under any alternative involving a federal undertaking, USBR will consult with the California State Historic Preservation Officer (SHPO) about meeting the requirements of 36 CFR 800. At present, it is not known which federal, state, and local agencies will be responsible for the different undertakings required to implement each of the proposed Joint POD alternatives. Consultation by USBR with the California SHPO will address cultural resources identification, evaluation, effects, and possible mitigation needs.

7. Economic Analysis

a. Introduction. This section summarizes the economic impacts of the Joint POD alternatives. The analysis consists of the estimation of economic impacts to agriculture, municipal and industrial (M&I) water, and recreation under the various Joint POD alternatives. The analysis was limited by the following assumptions:

- Water shortages are assumed to accrue only to agriculture. It is assumed that shortages of M&I water would be addressed by water transfers from irrigated lands.

- Economic losses are based on average water losses over the historic timeframe, rather than on a range of losses reflecting high, medium, and low water deliveries.

- No distinction is made between the economic value or productivity of various irrigated agricultural lands in the CVP. Rather, an average value based on marginal net revenue is applied to all irrigation water.

- No attempt was made to quantify impacts of water shortages on regional economies. Regional impacts due to reduced agricultural water deliveries are briefly addressed in narrative. No attempt was made to estimate impacts of costs of water transfers to urban users.

- Impacts on agricultural land use are briefly addressed in narrative.

- No attempt was made to quantify recreation impacts. Rather, recreation impacts at major reservoirs are briefly addressed in narrative. It was assumed that end-of-year reservoir water levels are reflective of water levels throughout the year.

b. Irrigation and M&I Water Impacts. According to delivery estimates from the DWRSIM modeling studies, water shortages resulting from the implementation of the 1995 Bay/Delta Plan would primarily accur in areas south of the Delta. Water delivery impacts are shown in Table XIII-50. Average annual diversion under Alternative 1 is 6.3 MAF. Four of the alternatives (Alternatives 2-6) result in annual water reductions of less than 6 percent compared

Table XIII-50. Estimate of Economic Impacts of Irrigation Water Losses under Joint POD Alternatives

Alternative	Average Annual Shortage (TAF)	Economic Value of Water per Acre-foot ($)[1]	Annual Economic Losses ($million)[2]
1			
2	288	70	20.2
3	216	70	15.1
4	209	70	14.6
5	166	70	11.6
6	206	70	14.4
7	118	70	8.3
8	29	70	2.0

[1] When water supplies are 5-10 percent below normal.
[2] Average annual shortage (x) economic value of water per acre-foot.

to Alternative 1, and two of the alternatives (Alternatives 7 and 8) result in comparatively no water reductions.

There are a number of potential reactions to water shortages. For example, irrigators could fallow acreage, change crops, pump additional ground water, or use water transferred from other areas. The initial response of irrigators would probably be to pump additional ground water. Eventually, this response would result in falling water tables, increased pumping costs, increased water quality problems, and land subsidence.

Urban water utilities could address shortages through transfers of water, increased use of recycled water, reduced water use through mandatory conservation programs, or imposition of rationing. Although some potential losses could be addressed by conservation programs, the most likely responses to the majority of the losses would be those of arranging transfers or rationing. However, as stated in Chapter XI of this draft EIR, the costs of water losses (rationing) in an M&I capacity are estimated to range from $1,400 to $2,000 per acre-foot. By contrast, the marginal net revenue attributable to an additional acre-foot of irrigation water in the CVP is estimated to vary from about $50 to $275, depending on the area and on the amount by which water supplies are below the amount normally available (see Chapter XI, section A.2). Also, according to the draft EIR, the cost to urban districts of water transfers from agriculture vary from about $200 to $350 per acre-foot, or an average of about $275. Utility managers will have strong incentives to transfer water from agricultural users rather than ration water. Similarly, irrigators would presumably part with water that provides levels of marginal net revenue below the price municipalities would pay. Thus, the simplifying assumption was made that water shortages will ultimately accrue only to agriculture. The average economic costs of water shortages resulting under each alternative were estimated by multiplying the shortages by the marginal value of irrigation water on lands south of the Delta. That value averages about $70 per acre-foot, on a weighted average delivery basis, when water supplies are 5-10 percent below normal. While this simplified approach provides only a very rough approximation of costs, it should at least provide a consistent comparison of relative costs among alternatives. The estimated annual losses for each alternative, which range from zero to $23 million, are shown in Table XIII-50.

c. Impacts on Regional Economies. Reductions in water deliveries to agriculture have the potential, at least in the short run, to affect all sectors of the economy. Reduced farm production will generally result in the hiring of fewer workers. Unless or until those workers find new employment, consumer spending will fall, affecting retailers and other businesses. In addition, growers will reduce purchases of equipment and materials from suppliers, resulting in reduced income and jobs.

Note that Alternatives 3-6 would result in reduced shortages in comparison to Alternative 2, and none of the shortages under Alternatives 2-6 would exceed 6 percent of total deliveries under Alternative 1. Note also that two of the alternatives essentially result in little or no shortages in comparison to Alternative 1. Potential marginal net revenue losses per acre-foot of water are relatively small at such low levels of water loss. Additionally, these impacts would take place in a dynamic and mobile economy with a capacity for rapid adjustment to economic changes. Therefore, it reasonably can be assumed that impacts to regional economies under any of the alternatives would be minimal, and all alternatives would result in reduced losses as compared to Alternative 1. However, those alternatives that result in higher shortages would have a greater regional impact than the two alternatives that result in little or no loss.

No attempt was made to address the impact on urban water users of the costs of water transferred from agricultural users. However, there presumably would be some increases of costs to users.

d. Impacts on Land Use. The relatively small average water shortages under Alternatives 2-6 could potentially result in some adjustments in land use. These adjustments could take the form of small adjustments in cropping patterns or possibly some fallowing of lands. However, average water losses of around 5-6 percent should require minimal adjustment, and that adjustment would most likely involve, as necessary, small changes in cropping patterns.

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