Section 5. The Efficacy of the Environmental Water Account Implementation

Introduction

This section consists of a summary of the activities of the Environmental Water Account (EWA) and the technical basis for those activities. It is intended to facilitate the re-initiation of Endangered Species Act (ESA) Section 7 consultation to evaluate the efficacy of the EWA. It covers the acquisition, management and uses of the EWA assets, evaluates outcomes relative to expectations in the ROD, and describes adjustments made in response to circumstances encountered in the first three years. This report covers EWA implementation in 2001-2003 because it is being completed prior to the conclusion of 2004 EWA operations. Supplemental information on 2004 implementation will be integrated into this assessment when the year ends and data from 2004 are compiled.

Description of the EWA

The Environmental Water Account (EWA), one of the tools within the CALFED Water Management Strategy, was established to provide water for the protection and recovery of at-risk fish species beyond water available through existing regulatory actions related to the operations of the State Water Project (SWP) and the Central Valley Project (CVP) (CALFED 2000). It is based on the concept that flexible management of water can achieve fish and ecosystem benefits more efficiently than a completely prescriptive regulatory approach (CALFED Multi-Species Conservation Strategy 2000). The purpose of the EWA is to provide protection to the at-risk fish species of the Bay-Delta estuary through environmentally beneficial changes in SWP/CVP operations at no uncompensated water cost to the projects' water users. This approach to fish protection requires the acquisition of alternative sources of project water supply, called "EWA assets," that are to be used to augment stream flow or Delta outflow or to modify exports, to provide fish benefits, and to replace the regular project water supply interrupted by the changes to project operations for EWA purposes. The EWA is intended to provide sufficient water, combined with the benefits of implementing the Ecosystem Restoration Program and the environmental protection provided by the regulatory baseline, to address CALFED's fish protection and restoration/recovery goals.

The agencies implementing the EWA (EWA Agencies) are the California Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation), referred to as the "Project Agencies"; and the California Department of Fish and Game (DFG), the US Fish and Wildlife Service (USFWS), and the National Marine Fisheries Service (NOAA Fisheries), referred to as the "Management Agencies."

The EWA Operating Principles Agreement (Attachment 2 of the 2000 CALFED Record of Decision) sets forth the general operating principles and describes the water purchases and operational tools available to acquire assets for the EWA. These include:

- Annual water purchases of 185,000 acre-feet (AF), initially 35,000 AF from north of the Delta and 150,000 AF south of the Delta
- One-time acquisition of 200,000 AF of stored water (or its functional equivalent) with related storage capacity intended to function as long-term storage space to be managed over time for the EWA.
- 500 cfs of dedicated pumping capacity at Banks Pumping Plant in July-Sept
- Access to excess capacity at Banks Pumping Plant
- A share of Central Valley Project Improvement Act 3406(b)(2)/CALFED Ecosystem Restoration Program (ERP) water pumped by the SWP
- Water pumped above the "allowable percent of inflow diverted" standard (E:I ratio flexibility), at Management Agencies' discretion
- Source shifting[1]

CALFED ROD Commitments Related to the EWA

The 2000 CALFED Record of Decision (ROD) provided a commitment, subject to specified conditions and legal requirements, that for the first four years of Stage 1 of the CALFED program, there would be no reductions, beyond existing regulatory levels, in CVP or SWP Delta exports resulting from measures to protect fish under Federal or State endangered species acts. This "regulatory commitment" is based on the availability of three tiers of protection:

- Tier 1 is the set of regulatory requirements applicable to SWP and CVP operations (referred to in the ROD as "baseline water"). The regulatory baseline consists of the winter-run salmon and delta smelt biological opinions for CVP and SWP operations, 1995 Bay-Delta Water Quality Control Plan, and 800 TAF of CVP Yield pursuant to CVPIA Section 3406(b)(2).
- Tier 2 consists of the assets in the EWA combined with the benefits of the Ecosystem Restoration Program (ERP), which obtains water to improve salmon spawning and juvenile survival in upstream tributaries, and is an insurance mechanism that will allow water to be provided for fish protection and recovery when needed, without reducing deliveries to water users.
- Tier 3 is based upon the commitment and ability of the State and Federal Agencies to make additional water available should it be needed for further modifications of project operations in order to avoid jeopardy to a listed species. In March 2002, the State and Federal Agencies prepared an implementation strategy for Tier 3, establishing a timely scientific panel process to

[1] Source-shifting is used when the EWA has a water debt owed to the projects in San Luis Reservoir that will not be repaid until the fall or winter in order to prevent the unpaid EWA debt from causing (or worsening) water quality problems in San Luis Reservoir that occur when late-summer low-water levels are less than 300 TAF. Source shifting means a project contractor defers taking part of his water supply in the summer and temporarily shifts to another source, allowing the deferred delivery amount to be retained in San Luis Reservoir. Water left in San Luis increases the minimum summer storage level. Options for source shifting are paid for in advance and called upon only if needed, in which case the EWA pays the participating contractor an additional amount for each acre-foot of source shifting. The contractor accepts increased deliveries after San Luis Reservoir storage has increased above the problematic low point. EWA still has to repay its original debt with water from EWA sources.

advise the agencies and identifying tools and funding should implementation of Tier 3 prove needed.

Each year EWA Agencies must determine whether the three tiers of protection listed above are in place, including an "operational EWA" as defined in the Operating Principles Agreement and funding for implementation of ERP projects at the agreed upon average annual funding of $150 million. Regulatory commitments to ensure fish protection and water supply reliability described in the ROD are affirmed annually by an exchange of letters wherein the Project Agencies describe the assets that are in place in that year and the Management Agencies concur that the requisite assets or their functional equivalents are sufficient to sustain the regulatory commitment.

Summary of the First Three Years of EWA implementation

Administrative Overview

Environmental Water Account Team. The EWA Team (EWAT) is responsible for the coordination of all EWA activities, including a wide range of activities involved in acquiring, managing and accounting for assets, completing environmental review requirements, and preparing documents for CALFED and the EWA review panel. The EWAT was formed as a team under the CALFED Operations Group process, and consists of representatives from the five EWA implementing agencies. Agency representatives meet regularly to discuss and resolve administrative and technical issues related to water operations, management, and accounting of the EWA. Key policy issues identified by the EWA Team that require attention by agency managers are presented to the Water Operations Management Team (WOMT) for discussion and resolution.

Interim Protocols for Operation of the EWA**.** A set of EWA protocols was developed by staff and approved by EWA agency managers to clarify the rules for EWA implementation that were not adequately covered in the 2000 EWA Operating Principles Agreement (CALFED ROD Attachment 2). The Interim Protocols document was written in 2001 and revised in subsequent years as needed to augment and clarify the rules for management and accounting of the EWA. The Protocols cover topics such as storage, conveyance and pumping priorities, borrowing, release of EWA assets to the Projects, energy and facilities services, incidental take, carriage/conveyance/storage losses, the relationship to Delta Cross Channel gate operations, and the definition of functional equivalent.

Coordination with Management of Central Valley Project Improvement Act (b)(2) Water. EWA decision making is closely coordinated with management of water provided by CVPIA Section 3406(b)(2) through the EWAT and the (b)(2) Interagency Team with many participants in common on both teams, in order to maximize biological benefits from use of these two pools of environmental water.

NEPA / CEQA and ESA / NCCPA Compliance for EWA Implementation. The first years of EWA implementation was undertaken with a series of one-year water purchase agreements, consistent with applicable State and Federal laws, policies and procedures. An appropriate NEPA and/or CEQA document was prepared for each acquisition by the acquiring agency unless the action was either categorically excluded from NEPA or categorically exempt from CEQA.

The EWA agencies completed environmental review of implementing the EWA through 2007, the anticipated end of Stage 1 of the CALFED Bay-Delta Program, by finalizing an environmental impact statement/environmental impact report (EIS/EIR) and an action-specific implementation plan (ASIP), and prepared a Record of Decision/Notice of Determination in March 2004. The EIS/EIR provided environmental coverage for EWA implementation in 2004 and may be used to continue implementation through 2007.

The EWA Agencies completed consultation under Section 7 of the Endangered Species Act, culminating on January 15, 2004 in the issuance by the USFWS of a Biological Opinion on the effects of EWA implementation on delta smelt and giant garter snake. The USFWS concluded the project was not likely to adversely affect the delta smelt. The USFWS concluded that a "typical year" implementation of the EWA (including up to 100,000 AF of water obtained from crop idling in the Sacramento Valley) was not likely to jeopardize the continued existence of the giant garter snake but may adversely affect the snake. The incidental take statement included Reasonable and Prudent Measures and Terms and Conditions to implement them, including eleven conservation measures and a reporting requirement on projects accomplished under the CALFED ERP giant garter snake strategy.

NOAA Fisheries concluded ESA consultation for species under its jurisdiction by concurring with Reclamation's assessment that the EWA was not likely to adversely affect the federally-listed threatened or endangered salmonids in the Central Valley of California.

DFG is preparing a Natural Community Conservation Plan (NCCP) approval for the EWA program to comply with the NCCP Act with respect to covered species.

Environmental analysis of implementing the EWA for a longer period of time and potentially with some different tools and additional water sources will begin in 2004.

Asset Acquisition

EWA Budget and Expenditures. Table 1 shows the EWA budgets and expenditures in 2001 – 2003. The total amount budgeted over three years averaged $48.8 million. The ROD anticipated that EWA funding would be $50 million per year. Actual expenditures for water ranged from $60.1 million in 2001 to $28.3 million in 2002 and averaged $38.9 million. Other costs of implementing the program averaged $2.7 million and covered expenditures for power purchases, water conveyance and storage fees, environmental documentation, and support for some agency staff assigned to EWA implementation.

Table 1. EWA Budget and Expenditures for Water Acquisition and Other Functions in Water Years 2001, 2002 and 2003

Budgeted	2001	2002	2003
• State	$ 57.5 M	$ 28.3 M	$ 38.2 M
• Federal	$ 10.0 M (1)	$ 12.5 M	$ 0 M
• Total	$ 67.5 M	$ 40.8 M	$ 38.2 M
Actual expenditures			
• Fixed and Forward costs	$ 6.6 M	$ 1.0 M	$ 0.6 M
• Water Purchase	$ 60.1 M	$ 28.3 M	$ 31.0 M
• Acquisitions	336 TAF	240 TAF	215 TAF
• Average Price	$179/AF	$118/AF	$ 144/AF
(1) Amount paid for water purchased by Reclamation initially for CVP purposes and subsequently provided to the EWA.			

Water Purchases and Accounting. The ROD called for purchasing 35 TAF north (upstream) of the Delta and 150 TAF south of the Delta (export service area) in the first year. Purchase amounts are in south of Delta equivalent units, meaning that conveyance and/or carriage losses[2] of water obtained from north of Delta sources must be accounted for. The ROD indicated that higher amounts of north of Delta purchases were anticipated in subsequent years. Actual purchases have departed from the initial north/south mix in order to take advantage of less expensive NOD sources and, with available funding, to purchase more water than the 185,000 AF identified in the ROD.

Water Year 2001. Purchases in water year (WY) 2001 totaled 336 TAF and substantially exceeded the ROD quantities (Table 2). Purchases using State funds included 105 TAF from sources upstream of the Delta and 159 TAF from sources in the export service area. The total also included 72 TAF of water purchased by Reclamation initially for CVP purposes that was later provided to the EWA. North of Delta water was subject to conveyance/carriage losses of 17 TAF, reducing the amount of purchased water available for fish actions to 319 TAF. The higher purchases in 2001 partially compensated for the fact that another EWA asset, the initial 200 TAF of stored water, was not provided. Operational tools (see next section) produced 48 TAF for the EWA, bringing the total amount of EWA water available in 2001 to 367 TAF. Two hundred ninety (290) TAF was used for EWA actions in 2001; 77 TAF of EWA assets not used in WY 2001 were carried forward to WY 2002.

[2] Conveyance loss is water that is lost to seepage and evaporation in transport from the source and through the State and Federal conveyance systems; carriage loss is defined as the amount of additional water that must be released to allow for exporting an explicit amount of water from sources north of the Delta without affecting salinity in the Delta.

Table 2. EWA Accounting in Water Years 2001, 2002 and 2003[1],

includes water purchased, losses during conveyance to and across the Delta, water obtained but not used for EWA actions due to inability to store the water until it was needed, quantities used for fish actions and quantities unused and carried into the following year.

	2001	2002	2003
ASSETS ACQUIRED	**(TAF)**	**(TAF)**	**(TAF)**
- PURCHASED ASSETS			
Upstream of the Delta			
State	105	135	70
Federal	0	7	0
South of the Delta			
State	159	37	145
Federal	72	61	0
SUBTOTAL	336	240	215
Carriage/Conveyance/other losses	-17	-31	0
NET SUBTOTAL	319	209	215
- OPERATIONAL ASSETS			
Gains	48	83	91
Losses		-20[2]	-16[3]
TOTAL NET ASSETS	367	272	290
- CARRYOVER FROM THE PREVIOUS YEAR		77	58
TOTAL ASSETS AVAILABLE FOR WY	367	349	348
FISH ACTIONS			
- EXPORT REDUCTIONS			
State	290	215[4]	322
Federal		72	26
SUBTOTAL	290	287[4]	348
- INSTREAM HABITAT		4	
TOTAL OF FISH ACTIONS	290	291[4]	348
Carryover to 2002	77		
Carryover to 2003		58	
Carryover to 2004			0
SOURCE SHIFT ACTIVATION	50 of 100	0 of 100	0 of 100

[1] Asset accounting is maintained by water year (October 1 – September 30), except that assets purchased in one water year and delivered to the projects in the following water year are credited in the year of purchase. The EWA agencies keep detailed accounts of all EWA asset transactions; however, some quantities in this table have been adjusted by 1,000 acre-feet (TAF) so that the rounded numbers add properly within the table.

[2] A 2:1 Exchange Program between the SWC and EWA occurred between 3/30/02 and 4/8/02 at a cost of 20 TAF. About 20 TAF of EWA water was preserved for later use when otherwise all of the 40 TAF of EWA water would have been displaced from San Luis Reservoir with a concurrent pumping curtailment.

[3] The SWP was able to "back" water for the EWA from San Luis Reservoir into more secure storage in Lake Oroville between 9/14/02 and 10/6/02. Unfortunately, this water later spilled during flood control operations. SOD equivalent = 16 TAF (accounting for carriage water costs).

[4] Includes a 38 TAF export reduction that occurred in March 2002 when this amount of water stored in San Luis Reservoir converted to SWP project water. San Luis Reservoir was full and continuation of planned SWP pumping would have displaced the EWA water. No specific need for a fish action was apparent at the time and no recommendation for a pumping curtailment had been made by the Management Agencies.

Water Year 2002. In 2002, water purchases totaled 240 TAF, 142 TAF from north of the Delta and 98 TAF from sources south of the Delta. Conveyance/carriage losses and other losses (total of 3 TAF, part "spilled" from Folsom Lake and part released by a seller as scheduled but not recovered in the Delta due to a brief interruption in pumping) totaled 31 TAF. Operational tools produced 83 TAF but most could not be used to cover fish action costs because it could not be stored until it was needed (see later discussion on Adaptive Implementation of EWA). Of the 287 TAF of export curtailments shown, about 248 TAF was for specific fish actions. An additional 38 TAF reduction from planned SWP pumping occurred in March. Although salmonids and delta smelt were present in the Delta at this time, the reduction in pumping was not the result of a fish action recommendation by the Management Agencies. Concurrently, 38 TAF of EWA water in San Luis Reservoir with a

low storage priority was converted to SWP water as San Luis Reservoir storage would have reached capacity if planned pumping had continued. About four (4) TAF was used exclusively for in-stream habitat improvement upstream of the Delta. Fish actions totaled 291 TAF; 58 TAF of EWA assets remaining at the end of WY 2002 were carried forward to 2003.

Water Year 2003. In 2003, water purchases totaled 215 TAF, 70 TAF north of the Delta and 145 TAF south of the Delta. There were no carriage losses due to the specific conditions in the Delta when the 70 TAF was transferred. Operational tools produced 91 TAF. Of the 58 TAF carried forward from 2002, 16 TAF of EWA water in San Luis that was intentionally backed into Lake Orville (20 TAF in NOD units) in the fall because we believed it was safer there than in San Luis was lost when Oroville storage reached the flood reservation curve went into flood control operations later in 2003. A total of 348 TAF of assets were available in 2003. With 348 TAF of fish actions, the EWA balance at the end of 2003 was near zero with a small amount of assets in Lake Oroville and debt in CVP share of San Luis Reservoir.

The average cost of water purchased in 2001 was about $179 per acre-foot, with a large percentage purchased from south of Delta sources pursuant to the ROD. The first year prices paid for the EWA water were higher partly because of the short timeline to begin implementing the EWA and purchase large amounts of water. Based on our experience and with current purchase strategies which, emphasize use of upstream of Delta sources when Delta conveyance capacity is available, the unit cost for EWA water would likely be lower in the future for a year like 2001. In 2002, the average price paid for water was reduced to about $118 per acre-foot due to more aggressive negotiations by water acquisition staff and obtaining a higher percentage of purchased water from less costly upstream sources. In 2003, the EWA paid an average price of $144 per acre-foot. Late season rains enabled an increase in water allocations to project contractors, reducing the cross-Delta transfer capacity available to the EWA, thus limiting upstream purchases and increasing purchases from higher-priced south of Delta sources

Source Shifting. EWA actions that curtail SWP or CVP pumping in the Delta in the winter or spring can result in a lower storage level in San Luis Reservoir until EWA water purchased upstream of the Delta can be conveyed to the reservoir during the summer and fall. When San Luis storage is drawn down by Project operations to about 300,000 AF, water quality can be impaired for some uses. EWA debt to the projects in San Luis Reservoir cannot be allowed to cause or worsen such problems. When the low point in storage is predicted to be less than 300,000 AF due to an unpaid EWA debt, source shifting is used.

Source shifting is an arrangement between the EWA Agencies and individual project contractors whereby the contractor agrees to meet a portion of their summer demand by shifting to other sources of water and defers taking some (up to 100 TAF) of their allocated project supply, allowing that water to remain in San Luis Reservoir. Options for source shifting are purchased in advance. When storage is predicted to reach a level at which EWA actions would be causing water quality problems in the reservoir, source shifting options are called. The EWA pays the participating contractor a fixed rate for each AF of water subject to source shifting. The contractor eventually takes delivery of his remaining project water supply allocation for that year after the water level in San Luis has increased. Under these circumstances, source shifting functions as a “bridge loan”, covering

potential EWA-related San Luis Reservoir storage impacts until water from EWA sources can be conveyed to the reservoir.

Options were purchased each year that enabled the EWA agencies to request up to 100 TAF of source shifting if needed. Options were exercised in 2001 for 50 TAF of source shifting. Source shifting was not needed in 2002 and 2003 because at its lowest point the water level in San Luis Reservoir in those years was high enough to avoid water quality problems.

Performance of Operational Tools and Other EWA Assets. The ROD identified the following three operational tools that are available for the EWA to obtain assets, in addition to the water that is purchased. These are (1) a share of "state gain" from pumping (b)(2) water, (2) access to unused Delta pumping capacity, and 3) flexibility in the Export:Inflow standard. The EWA agencies realized from the outset that the amount of assets obtained from operational tools would vary annually because their utility depends on hydrology, fish behavior, project facilities operations, and actions by other programs (e.g. CVPIA, EWP). The ROD described the expected output from these tools in terms of average asset amounts. An annual average of 145 TAF was anticipated from these three tools (Table 3). Instead the tools have produced an average of only 72 TAF, but only about 51 TAF on average could be retained and used for actions to protect fish because we lack the ability to store the water until it was needed. The following sections describe these tools and how they have performed in the first three years.

Table 3. Operational (Variable) Assets in the CALFED ROD Compared to Actual EWA Benefits in 2001, 2002, and 2003

Operational (Variable) Asset	CALFED ROD Average in TAF	2001 Actual in TAF	2002 Actual in TAF	2003 Actual in TAF
Half of (b)(2)/ERP releases pumped by SWP in the Delta	40	46	3	19
Variation of E/I ratio	30	2	79	67
500 CFS dedicated capacity at SWP Banks PP	(50)[1] (Capacity only)	0 (Capacity only)	0 (Capacity only)	0 (Capacity only)
Joint Point Of Diversion (use of excess capacity at SWP Banks PP)	75[2] (pumping excess water in Delta)	0	0	0
ROD Total	195			
Total expected on average and actual total in 2001- 2003	145	48	82[3]	86

[1] Capacity - Represents a quantity expected to be moved using dedicated 500 cfs at Banks from the summer time capability above the 6,680 cfs that is provided in the COE permit, which is valid through the 2004 transfer season. This tool is used to transfer water purchased upstream of the Delta and, unlike the others tools, does not constitute an additional source of water for the EWA except possibly under the very wettest conditions with high Delta flows in the summer.
[2] Capacity - Represents one half of the available excess capacity at the SWP Banks pumping plant. Under balanced conditions, this tool provides only pumping capacity and the EWA must supply water it has either purchased or stored upstream to take advantage of this EWA tool. In normal and wet years, if SWP Article 21 demand is satisfied, this tool can result in the EWA being able to obtain Delta water during excess conditions provided that EWA has either an existing debt in San Luis to repay or a location other than San Luis where it can store this water.
[3] Only 20 TAF was retained past the high point in San Luis Storage and available for later fish actions.

EWA Share of (b)(2)/ERP Water Pumped in the Delta. CVPIA (b)(2) water or ERP water released for upstream purposes may be pumped in the Delta by the SWP after the water has served its (b)(2) or ERP purpose. One half of (b)(2) and ERP upstream releases thus pumped by the SWP becomes an EWA asset. This tool was expected to produce 40 TAF on average each year. Instead the amount obtained was 46 TAF, 3 TAF and 19 TAF in 2001, 2002 and 2003, respectively; averaging less than 23 TAF per year. One reason for the lower than expected average amount of EWA water produced by this tool is the changes in (b)(2) accounting rules made in response to Federal Court decisions that have reduced the amount of (b)(2) water used for upstream releases, thus reducing the amount of (b)(2) water diverted from the Delta. Another reason is that to date no water has been purchased by the ERP Environmental Water Program (EWP) so no water from this source has been available to be diverted in the Delta.

EWA Use of Excess SWP Delta Pumping Capacity (JPOD). This tool, known as Joint point of Diversion (JPOD), consists of access to the available unused capacity at the SWP Banks pumping plant, shared equally by the EWA and the CVP. Although not stated in the ROD, the tool is also understood by the EWA Agencies to include access to unused capacity at the CVP Tracy PP, shared equally by the EWA and the SWP. Either party may use more than 50% of available capacity if the other party does not need its full share.

The way in which the EWA acquires water in the export area using JPOD depends on whether the Delta is in excess or balanced condition. When there is excess water in the Delta and unused capacity at the SWP or CVP, the EWA can obtain water only if 1) there is EWA debt in San Luis Reservoir to be repaid or 2) there is a place for the EWA to store the water other than San Luis Reservoir. There is no ability to store water obtained with this tool in San Luis Reservoir because, by definition, the entire capacity of the reservoir is filled with the combination of project water and EWA debt. If there were excess water in the Delta and room in San Luis Reservoir, the project would use all of its pumping capacity to continue diverting water for its own purposes and the JPOD opportunity for the EWA would not exist.

If the Delta were in balanced conditions (i.e. no excess water in the Delta - projects are releasing water from upstream reservoirs to satisfy in-basin requirements and exports) when unused capacity at the SWP or CVP became available, EWA could use JPOD only if it provided water in the Delta that was either purchased from an upstream source or had been previously stored upstream as part of another EWA transaction.

EWA use of excess SWP Delta pumping capacity (JPOD) was expected to have an annual average yield to the EWA of 75 TAF, primarily by pumping excess water from the Delta in the winter or spring to repay ("spill") EWA debt in San Luis Reservoir or elsewhere south of the Delta. Conditions for using this tool have not occurred in the first three years of EWA implementation. Either capacity has not been available because dry hydrology has precluded the Projects from early filling of San Luis Reservoir or, when it has filled, the demand for Article 21 water by SWP contractors has taken up all the usable capacity to divert additional water at Banks Pumping Plant. (Under Article 21 of the SWP contracts, water in addition to current year allocations can be made available to the contractors when there is excess water in the Delta and San Luis Reservoir is assured of being filled. Contractors must use or store the water in their own facilities.) This use of the

pumping capacity comes before the EWA. SWP contractors' ability to use Article 21 water has been greater in the last three years than the amount we assumed they could use when the EWA tools were being determined, to the point where all opportunities for this tool to function for the EWA as expected have been precluded. More recent modeling with higher Article 21 demand assumptions suggests this tool may help the EWA erase debt in about one third to one half of years in the future with Banks authorized capacity at 8,500 cfs, however, even this assessment depends on numerous other assumptions and is subject to the limitations of a monthly time-step model.

JPOD was also expected to be available in the summer and fall, in addition to the 500 cfs of Banks capacity dedicated exclusively for EWA use, to move water the EWA had purchased from upstream sources. In practice, JPOD at Banks Pumping Plant has been used on limited occasions in the summer and fall (June, October and November) to convey EWA water purchased from upstream sources. Annual amounts of purchased water conveyed with this tool ranged from 0 to 38 TAF and averaged 16 TAF per year. Again, this does not constitute a new source of water for the EWA.

E:I Standard Flexibility. The 1995 Bay Delta Water Quality Control Plan includes a limit on the percent of Delta inflow (I) that may be exported (E) by the SWP/CVP, the so-called E:I ratio standard. This standard is 0.65 from July 1-January 31 and 0.35 from February 1-June 30, except in February following a dry January when the standard may increase up to 0.45. The WQCP provides for flexibility in this standard to allow pumping a larger proportion of the inflow, if agreed to by the USFWS, NOAA Fisheries and DFG. Any water exported by pumping a larger proportion of inflow than specified in the E:I standard becomes an EWA asset.

This flexibility was used aggressively in two years (2002 and 2003) producing an average of 49 TAF, more than the expected average of 30 TAF per year. However, the lack of ability to store water acquired by this means until it is needed to pay for fish actions reduces the value of the water for the EWA. In 2002, 38 TAF of water that had been pumped from the Delta in February using E:I relaxation and stored in San Luis Reservoir was converted to project water over several days in March because it would have been displaced by project water when San Luis Reservoir filled if planned project pumping had continued. The concurrent pumping curtailment occurred at a time when there was no particular pumping-related fish concern in the Delta. If it could have been stored elsewhere, this water could have been put to better use for fish protection at a later time.

Another 40 TAF of water obtained by flexing the E:I standard and stored in San Luis Reservoir also would have been displaced in spring 2002. Instead of converting it into another 40 TAF pumping curtailment, the EWA Agencies and some project contractors agreed to a 2:1 exchange whereby project contractors took delivery of the 40 TAF in late-March to early April and used it. They later returned 20 TAF to the EWA after San Luis storage drawdown began. Through this exchange, the EWA managers retained control of the use of 20 TAF for fish actions later when they were most needed, instead of having the 40 TAF pumping curtailment occur in March by default. The exchange ratio reflected the fact that the water taken by the contractors was less valuable to them in the winter before the high point in San Luis Reservoir storage than it was later in the summer. Inability to store water until needed caused the EWA to lose 20 TAF of water obtained using an operational tool.

Banks Pumping Plant Capacity Dedicated to EWA Use. Another EWA tool is the dedicated use of 500 cfs of Banks PP capacity in July – September, described in the ROD as a tool expected to annually produce an average of 50,000 AF of EWA water. Presently, use of this increment of Banks pumping (above 6,680 cfs) is authorized by the US Army Corps of Engineers for fish-related purposes only and cannot be used by the Project Agencies to augment SWP or CVP water supply.

This tool does not actually produce any water for the EWA, except in rare circumstances described below. Instead it provides the pumping capacity to move water purchased for the EWA from sources upstream of the Delta to the export area. It also may be used to pump water that was held back in an upstream project reservoir during an earlier curtailment of project pumping. The amount of water that can be moved depends on making the water available in the Delta and on various Delta conditions (tides, weeds at the diversion facilities, etc.) that affect the ability to operate the SWP diversion facilities. In light of these anticipated constraints, it was expected that an average of about 50 TAF could be transferred annually with this dedicated capacity. Actual quantities of water transferred annually between July 1 and September 30 ranged from 52 to 94 TAF. The theoretical maximum that can be transferred during this 92 day period with the 500 cfs of dedicated capacity is about 92 TAF. Any amount less than 92 TAF might be considered to have been transferred using the 500 cfs; amounts over 92 TAF clearly were pumped using additional available capacity. In practice this distinction would be difficult to determine. The three-year average amount transferred during July-September is about 68 TAF, substantially more than an expected 50 TAF annually using the 500 cfs. Understanding how much EWA water can be transferred with the 500 cfs and how much is pumped with other available Banks capacity is important because in some years the 500 cfs will be the only capacity available for EWA transfers in these months.

This tool has the potential to actually produce water for the EWA only in an extremely wet year when the Delta is out of balance and there is water available to pump in the Delta in excess of in-basin and project needs in July, August or September (e.g. July 1983, 1995, 1998). The rare circumstance when excess water is available to be pumped in the summer allows EWA debt to be paid with water for which the EWA had to pay only pumping costs. However, when there is excess water in the Delta, purchased water cannot be transferred, potentially creating a problem with managing upstream supplies purchased before the hydrological conditions were known. Some purchase contracts limit EWA's obligation to pay for water it cannot capture in the Delta or for water that spills from Oroville Reservoir. (The YCWA agreements provide for "release during balanced conditions," and have related provisions that may be subject to interpretation if the Delta were to be out of balance for an entire transfer season. The OWID (now Feather River Water and Power) agreement provided that EWA did not pay if the transfer water was spilled from Oroville Reservoir before it could be transferred; however, if the OWID water escapes spill in Oroville, DWR pays for it regardless of Delta conditions.)

Stored Water Equivalent. The ROD described the initial one-time acquisition of 200 TAF of stored water or its equivalent, to function as collateral for borrowing and to be managed over time (i.e. used as collateral, drawn upon if necessary, replaced, used again). An unstated assumption was that no more than 100 TAF of this water would be extracted in any year. Although this asset was never obtained, in WY 2001 water exceeding the ROD purchase amounts by 113 TAF was made available to the EWA south of the Delta (53.5 TAF of NOD water delivered SOD above the 35 TAF ROD requirement plus 59.5 TAF delivered SOD above the 150 TAF ROD requirement), providing the

same capability that the stored water equivalent would have provided to support EWA operational curtailments that year. Assets were carried over from 2001 into 2002, but lack of storage began to constrain EWA asset management in 2002. It could be argued that some of the 113 TAF of additional assets delivered in 2001 comprised part of the 200 TAF of stored water equivalent. The assets were provided as water without storage in 2001 and were expended by the end of 2002 as there was no means to conserve them. This would leave less than 200 TAF of this asset going forward. Without actual storage space, there is no way to replenish this asset.

Beginning in 2002, in place of this stored water equivalent tool, the SWP provided the ability for EWA to borrow up to 100 TAF from the project in any year to be repaid such that SWP allocations in that year are not affected or, if the debt is carried forward, that allocations in the next year are not affected. This substitute asset is not entirely functionally equivalent to stored water, because repayment must be made before contractors' deliveries are affected as opposed to when the EWA has obtained water that is surplus to its current year needs.

In summary, the operational tools have not functioned exactly as intended in some cases. The hydrology in the first three years and escalation in the demand for SWP Article 21 water have both affected the performance of JPOD in particular. In addition, when assets have been obtained using the operational tools, the inability to store the water has prevented the EWA managers' from turning the assets into fish protection actions. While three years is a relatively short a time to assess the average performance of these tools, indications are that adjustments to the tool mix may be necessary to restore the functional capability of the EWA.

Use of the EWA – Fish Actions

Fish Action Rationale. The Environmental Water Account (EWA) acquires and manages assets (primarily for curtailments in export pumping) for the purposes of protecting fish by reducing incidental take at the SWP/CVP diversions in the south Delta and providing general ecological benefits that contribute to the recovery of listed species (CALFED 2000). The implementation of "fish actions" using EWA assets can augment stream flow and Delta inflow and/or reduce the rate of export pumping when at-risk native species appear in high numbers at or in the vicinity of the SWP/CVP diversion facilities, where continued pumping would put them at risk.

Stream flow augmentation, which primarily benefits salmonids, is achieved by timing the movement of EWA assets to coincide with in stream flow needs, to the extent practicable. For example, in October and November of 2001, EWA assets were released from Folsom Reservoir to provide in-stream habitat benefits (increased wetted area and lower water temperature) for spawning Chinook salmon. To date EWA water has been released for the singular purpose of in-stream habitat improvement very infrequently because either those needs have been met though other means or there was no EWA water available on the streams with unmet flow needs.

Pumping curtailments in the Delta may be undertaken either at the SWP Banks Pumping Plant, the CVP Tracy Pumping Plant or at both plants simultaneously. Curtailments may last for a few days or, in the case of April-May-June (Vernalis Adaptive Management Plan (VAMP) and post-VAMP period), for a month or more. Often EWA is used for a curtailment at the SWP at the same time as

Central Valley Project Improvement Act (CVPIA) Section 3406 (b)(2) water is used to reduce pumping at the CVP. Export pumping curtailments are intended to protect at-risk fish species from being entrained at the SWP and CVP export facilities.

When export pumping is curtailed less water is diverted and fewer fish are drawn into the diversion facilities, reducing mortality directly attributable to the pumping. By reducing the flow of water to the pumps, curtailments reduce the area within the Delta where channel flows are affected, reducing the chance of fish from the central Delta responding to false hydraulic cues and moving off their intended westerly migration pathway into closer proximity of the SWP and CVP diversion facilities where they become increasingly vulnerable to direct entrainment. By reducing direct entrainment mortality and minimizing disruption of their migration, pumping curtailments increase the likelihood that juvenile salmon and steelhead moving through the Delta will survive.

Reducing pumping in the winter when adult delta smelt are in the vicinity or are being entrained can reduce the number of smelt entrained and increase the chances these fish will survive until they spawn. In the spring when larval delta smelt are present in the southern and central Delta, the conceptual model is that curtailments reduce smelt entrainment loss during the larval development period and increase their chance of survival until they migrate to the western delta and Suisun Bay. During many fish actions more than one of the species of concern is present and several of the above rationales may apply.

In order to be effective, the use of EWA assets must be based upon an overall understanding of species biology and the ecological and physical processes operating throughout the Central Valley system. Fish actions are taken following discussion involving biologists and project operators and stakeholders (Data Assessment Team, or DAT) using all available information and the criteria outlined in the decision trees for salmonids and delta smelt. The DAT considers incidental take at the pumps, in-stream and Delta environmental conditions, and the distribution and abundance of the fish species as indicated by a variety of sampling programs and, when appropriate, formulates a recommendation for a fish action. Recommendations are taken to the Water Operations Management Team (WOMT) for discussion and final approval at the management level of the EWA agencies.

Monitoring of Fish Distribution, Abundance and Migration Timing. Various monitoring methods are used to obtain information on the various life-stages of species targeted by the EWA and their abundance and distribution in the Delta and Central Valley rivers and tributaries. Delta smelt monitoring methods include: fall mid-water trawl, spring Kodiak trawl, a springtime “20-mm survey”, and a summer tow-net survey. Salmonid sampling methods include: rotary screw traps in rivers and streams, beach seining in the lower rivers and Delta, and trawling in the Sacramento River near Sacramento, in the San Joaquin River at Mossdale, and in the western Delta at Chipps Island (Tables 4 and 5).

Other information used for EWA management decisions include: observed and forecasted hydrology (water year-type - wet vs. dry), location of the saltwater/freshwater mixing zone (X2), water quality, water temperature, export pumping rate, and fish entrainment rate at the export facilities. Fish facilities information includes “salvage”, the number of fish screened out of the diverted water, and “loss”, the estimated number of fish that die from being entrained into the water diversion facility.

For juvenile salmon, we have estimates of prescreen mortality, screen efficiency and trucking and handling mortality which are used to convert the number of fish salvaged to the number lost. Pumping impacts and incidental take limits for salmon use the loss metric. For steelhead and delta smelt, the fish facility screen efficiency and mortality factors are unknown, hence pumping impacts and incidental take limits for these species use the "salvage" metric. For each metric, both the rate (number of fish salvaged or lost per day) and the density (number of fish salvaged or lost per acre-foot of water diverted) are used to assess conditions relative to fish action decisions. The term salvage is a misnomer because some fish die within the diversion facilities before they reach the fish screens and not all fish that are separated from the diverted water by the fish screens survive. The number of fish to which we apply the term "salvage" is therefore only an indicator of the magnitude of entrainment effects. Use of the term "salvage" does not connote that any or all of these fish actually have been saved from the effects of entrainment.

Some monitoring data are posted on websites on a "real time" basis. Results from the various monitoring activities are used to determine when it is appropriate to take a fish action as well as to try to assess the effects of the action. Because very small fish are not detected, fish facilities "sampling" underestimates both the actual take of larval and early juvenile delta smelt and the overall effect of export pumping on delta smelt. All life stages of delta smelt that are entrained at the CVP and SWP export facilities are assumed to be "taken" because it is thought that few if any survive the fish salvage process. Juvenile salmonids experience higher survival rates from current screening, trucking and handling practices than delta smelt.

Table 4. Period of coverage and objectives of monitoring programs for delta smelt[1].

Monitoring Program[2]	Period of Coverage	Objective
Spring Kodiak Trawl	mid-January through April	Locate areas of highest adult delta smelt relative abundance; estimate proportion of ripe, unripe and spent adult delta smelt
20-mm survey	March through June	Monitor larval and juvenile delta smelt distribution and relative abundance throughout their historical spring range
Summer Tow-net Survey	June through August	Data from this survey, conducted to index relative abundance of age-0 striped bass, also is used to monitor juvenile delta smelt in the Delta
Fall Mid-Water Trawl	September through December	Index relative abundance of several Delta species; Data from this survey is used by USFWS to aid in the assessment of delta smelt recovery
Fish Salvage Facilities	Year-round	Monitor incidental take of listed species by the export facilities of the SWP and CVP

[1] Source: CDFG Central Valley Bay-Delta Branch website, www.delta.dfg.ca.gov. All of these programs are conducted under the auspices of the Interagency Ecological Program (IEP)
[2] With the exception of the Spring Kodiak Trawl, all of these sampling programs provide important data for other species of fish found in the Delta.

Fish Action Decision Making. The EWA was established to provide water for the protection and recovery of fish of the Bay-Delta Estuary beyond that provided by existing regulatory actions related to SWP and CVP operations. EWA has been used almost exclusively to reduce the impact of project operations in the Delta. Fish species listed as threatened (Central Valley spring-run Chinook salmon, Central Valley steelhead, delta smelt) or endangered (Sacramento winter run Chinook salmon) have been the main focus of EWA protection. EWA also is used for actions to simultaneously protect delta smelt and fall run Chinook salmon from both the Sacramento and San Joaquin basins during the April-May period (VAMP and post-VAMP). Besides the fish species typically targeted by EWA fish actions, other fish species in the Delta, both native and introduced, may derive some benefit from reduced pumping directed at protecting salmonids and/or delta smelt if they are present during EWA curtailments and they are adversely affected by pumping.

The Biological Opinions for listed salmonids and delta smelt include incidental take statements pursuant to Section 7 of the federal Endangered Species Act that establish the authorized amount of incidental take which the Project Agencies may incur at the export pumps in the South Delta. When the authorized incidental take limit is reached for any listed species, the projects are required to re-initiate consultation under ESA. Take limits are set for the SWP and CVP operations combined. At any point in time, it is not uncommon for the rate of take for a particular fish species to be higher at one facility than at the other.

Table 5. Period of coverage and objectives of monitoring programs for salmonids.[1]

Measure	Period of Coverage	Objective
Beach Seining	Year-round	Estimate inter- and intra-annual abundance and distribution of all races of Chinook salmon fry using the lower Sacramento River/Delta for rearing
Chipps Island Trawl	Year-round	Monitor all races of Chinook salmon with increased emphasis during peak emigration period
Sacramento Mid-water Trawl	April through September	Estimate relative abundance and timing of fry and smolts entering the Delta from the Sacramento River basin
Sacramento Kodiak Trawl	October through March	Estimate relative abundance and distribution of larger WR and LFR Chinook
Mossdale Trawl	Year-round	Monitor fall run Chinook salmon and steelhead migrating from the San Joaquin River basin into the Delta
Rotary Screw Traps	Fall through Spring, year-round at some locations	Detect presence of Chinook and steelhead at various locations in the Sacramento and San Joaquin Rivers and their tributaries
Fish Salvage Facilities	Year-round	Monitor incidental take of listed species and entrainment of other fish species at the SWP and CVP export facilities
[1] Source: CDFG Central Valley Bay-Delta Branch website, www.delta.dfg.ca.gov. All of the seining and trawling programs are conducted under the auspices of the Interagency Ecological Program (IEP).		

The incidental take limit for winter run Chinook salmon changes each year and is a function of the estimated annual juvenile salmon production. We have no production estimate for spring run Chinook salmon emigrating in the fall and winter months as yearlings. Instead of a percentage of juvenile production, the incidental take limit for these fish is set as the loss of a percentage of "surrogate" groups of juvenile late-fall run Chinook salmon (Coleman National Fish Hatchery) marked with coded-wire tags and released upriver when the wild spring run Chinook are migrating from the tributaries and downstream to the Delta. The percentage is the same each year, but the number of surrogate fish released varies slightly. The incidental take limit for steelhead is based upon historical salvage at the export pumps and has been a fixed number in recent years. For these salmonid species, the incidental take limits are seasonal totals. "Early warning levels" of take are set at 50% of the authorized seasonal total. For the salmon, take is measured in terms of the calculated number of fish lost at the SWP and CVP, whereas for steelhead it is measured in terms of the number salvaged (screened) because there is no conversion from number salvaged to number lost. (Additional discussion of these take limits is found in a later section.)

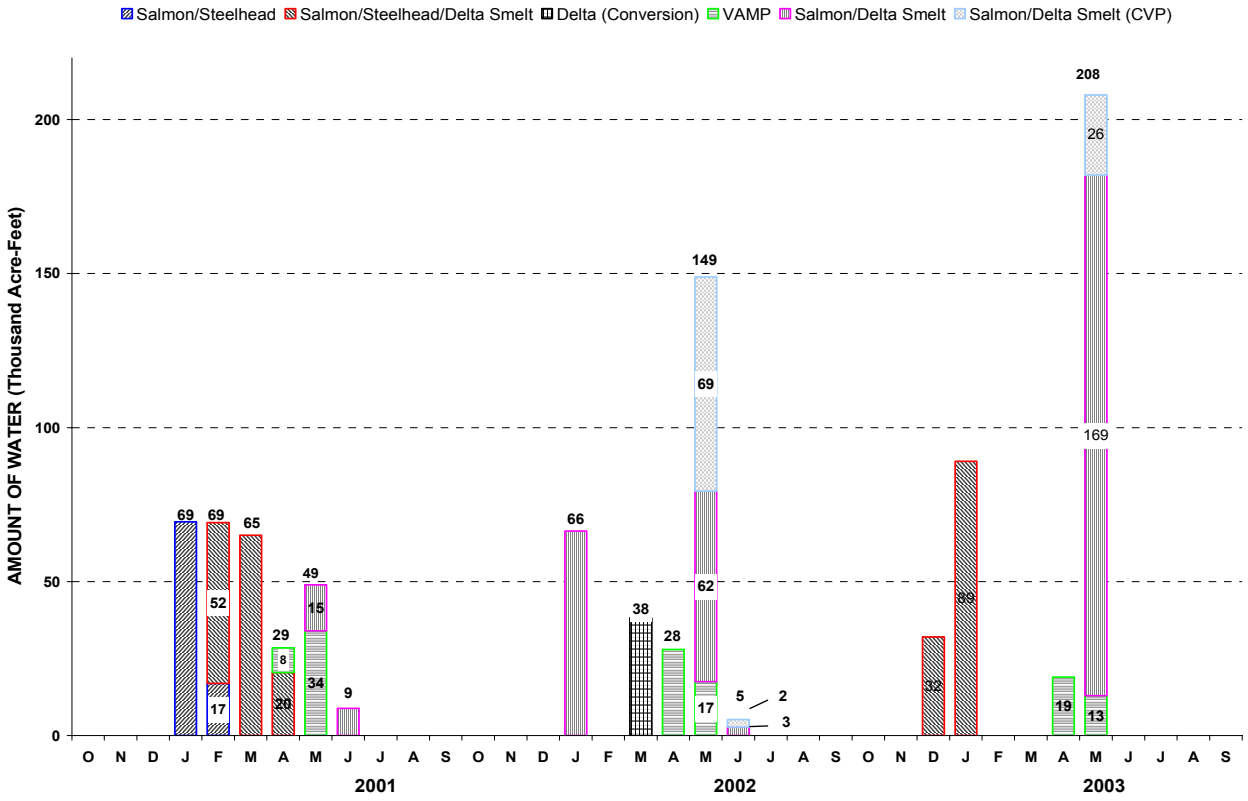
The incidental take limit for delta smelt is based upon historical salvage at the export pumps and varies between wet and dry years. The re-consultation level is a monthly total; the early warning level is a 14-day running average of daily salvage of 400/day.

The EWA provides protection for at-risk species of fish and helps to avoid reaching the re-consultation level of take for listed species by reducing export pumping during periods of peak abundance of these species in the Delta. Prior to reaching the level of impact for listed species that necessitates formal re-consultation, the Project Agencies' and Management Agencies' staff discuss the extent of the take, the relative abundance and distribution of the particular species of concern, and any relevant information on in-stream and Delta conditions. Based on an evaluation of this information, the Agencies may implement a modification of Project operations, referred to as an "operational curtailment" or "fish action." The cost of fish protection actions at the CVP Tracy Pumping Plant are typically charged against the CVPIA 3406 (b)(2), which provides water for that environmentally beneficial purpose. The water cost of fish protection actions at the SWP Banks Pumping Plant are reimbursed with assets from the EWA. If there is no (b)(2) water available, EWA may be used for fish actions at the CVP.

The Agencies use a "decision tree" for the older juvenile Chinook (those emigrating in the fall and winter months, including spring run yearling and winter run Chinook) and a structured decision process for delta smelt (attached). Each incorporates the physical and biological factors to be considered in evaluating the need for operational modifications whereby impacts to the respective species are reduced, take is minimized and the need for re-consultation may be avoided. There is no explicit "decision tree" for juvenile salmon migrating through the Delta as young of the year in the spring months. These fish are afforded protection by the E:I standard, the VAMP conditions and the post-VAMP period curtailments. If despite the (b)(2) and EWA fish protections actions that are carried out the incidental take limit for any of these species is exceeded, the Project Agencies are required to re-initiate consultation with the appropriate Management Agencies.

Fish Action Chronology. Figure 1 shows the use of EWA assets for fish actions in water years 2001 – 2003 and the fish species that were the primary targets of those actions. In nearly every case the individual EWA fish actions reduced entrainment and other pumping-related impacts on more than one of the at-risk species. Delta actions (pumping curtailments) in December-March typically were targeting yearling spring run Chinook, winter run Chinook, steelhead, and/or adult delta smelt. Actions in April – June provided benefits for juvenile delta smelt and spring run and fall run Chinook smolts. For 31 days in mid-April to mid-May, pumping is reduced for the juvenile salmon Delta survival experiment conducted for the Vernalis Adaptive Management Plan. EWA reimburses the SWP for the part of their pumping curtailment during the VAMP period that is beyond the regulatory baseline requirement. [CVPIA 3406(b)(2) water is used for the VAMP pumping curtailment at the CVP.] Each year pumping has been kept at or near the VAMP pumping rate for some or all of the last two weeks in May, a pro-active step to reduce the effects of pumping on rearing delta smelt and on emigrating Chinook salmon smolts (referred to as the post-VAMP "shoulder").

Figure1. Monthly Water Amounts and Target Species for SWP and CVP Operational Curtailments using EWA in Water Years 2001 – 2003.



The sequence, purpose and cost of individual fish actions implemented in 2001 through 2003 are described below (see Table 6).

Table 6. Synopsis of fish protection/recovery actions and other EWA water management actions in the first three years of EWA implementation (2001-2003).

Water Year 2001			
EWA Action	Species Targeted	Assets Used	Action/Purpose
1-01 (January)	WR and SR Chinook	24 TAF	Curtail SWP exports to reduce entrainment and increase survival
2-01 (January)	WR and SR Chinook	45 TAF	Curtail SWP exports to reduce entrainment, increase survival
3-01 (February)	FR Chinook, Steelhead	N/A [1]	Supplement Lower American River flow for spawning
4-01 (February)	WR and SR Chinook, Steelhead	17 TAF	Curtail SWP exports to reduce entrainment, increase survival
5-01 (February)	WR Chinook, Steelhead, Delta Smelt	35 TAF	Curtail SWP exports to reduce entrainment, increase survival, protect spawning delta smelt
6-01 (February, March)	WR Chinook, Steelhead	82 TAF	Curtail SWP exports to reduce entrainment, increase survival, and protect delta smelt
7-01 (April, pre-VAMP "Shoulder")	All Chinook, Steelhead, Delta Smelt	20 TAF	Curtail SWP exports to reduce entrainment, increase survival, and protect delta smelt
8-01 (VAMP) (April – May)	FR and SR Chinook, Steelhead, Delta Smelt	43 TAF	Curtail SWP exports to reduce entrainment and increase survival
9-01 (May) (post-VAMP "Shoulder")	Delta Smelt, FR and SR Chinook	15 TAF	Curtail SWP exports to reduce entrainment and increase survival
10-01 (June) ("Ramping")	Delta Smelt, FR and SR Chinook	9 TAF	Curtail SWP exports to reduce entrainment and increase survival
Total EWA Assets Expended		290 TAF	

Table 6, continued

Water Year 2002			
EWA Action	Species Targeted	Assets Used	Action/Purpose
1-02 (October, November)	FR Chinook, Steelhead	[20 TAF] [2]	Supplement Lower American River flow for spawning
2-02 [3] (November)	FR Chinook, Steelhead	Power replacement only	River level outlet releases at Folsom Dam to reduce water temperature in the Lower American River
3-02 (January)	Delta Smelt, SR Chinook	66 TAF	Curtail SWP exports to reduce entrainment, increase survival and protect spawning delta smelt
4-02 [4] (February)	N/A	(76 TAF)	Relaxation of E:I standard to obtain EWA water
5-02 [5] (March)	N/A	[20 TAF]	2 for 1 (40 TAF for 20 TAF) water exchange
March	N/A (Not a requested fish action but TAF included in total)	38 TAF	SWP exports curtailed and EWA water converted to SWP water as San Luis Reservoir would have filled if all planned SWP pumping occurred
6-02 (VAMP) (April - May)	All Chinook, Steelhead, Delta Smelt	45 TAF	Curtail Project exports to reduce entrainment and increase survival
7-02 (May) (post-VAMP "Shoulder)	Delta Smelt	132 TAF	Curtail Project exports to reduce entrainment and increase survival
8-02 (June "Ramping")	Delta Smelt	5 TAF	Curtail Project exports to reduce entrainment and increase survival
Total EWA Assets Expended		286 TAF	

Table 6, continued

Water Year 2003			
EWA Action	Species Targeted	Assets Used	Action/Purpose
1-03[6]	N/A	(20)	EWA water in San Luis moved to L. Oroville
2-03 [3] (October, November)	FR Chinook, Steelhead	Power replacement only	Decrease water temperature in the Lower American River
3-03 (September, December)	FR Chinook, Steelhead	5 TAF	Supplement Lower American River flow for spawning, not recovered for EWA in Delta
4-03 (December, January)	SR Chinook	41 TAF	Curtail SWP exports to reduce entrainment and increase survival
5-03 (January)	Delta Smelt, SR Chinook	60 TAF	Curtail SWP exports to reduce entrainment, increase survival, protect spawning delta smelt
6-03 (January)	SR Chinook, Delta Smelt	20 TAF	Curtail SWP exports to reduce entrainment, increase survival
7-03 (VAMP) (April May)	FR Chinook, Steelhead, Delta Smelt	32 TAF	Curtail SWP exports to reduce entrainment, increase survival, protect delta smelt
8-03 (May) (post-VAMP "Shoulder")	Delta Smelt	195 TAF	Curtail SWP and CVP exports to reduce entrainment and increase survival
Total EWA Assets Expended		353 TAF	

[1] Water costs associated with Fish Action 3-01 were initially back-stopped by EWA but ultimately accounted for by CVPIA §3406(b)(2)
[2] 20 TAF released from Folsom Reservoir, 16 TAF was pumped for the EWA by the SWP and later used for fish actions in the Delta; 4 TAF carriage water costs.
[3] This Fish Action utilized EWA power credits only, not water.
[4] This EWA Water Management Action was a relaxation of the export-to-inflow standard which enabled higher pumping and obtained assets for the EWA later used for fish protective actions
[5] This EWA Water Management Action exchanged 40 TAF of EWA assets that could no longer be stored in San Luis Res.; 20 TAF was returned to EWA later.
[6] This EWA Water Management Action moved 16 TAF of EWA water from San Luis Reservoir to Oroville Reservoir; after backing out carriage water cost, the equivalent amount was 20 TAF.

Water Year 2001. In 2001, nearly equal amounts of EWA assets (65-69 TAF) were used for fish actions (pumping curtailments) in January, February and March, initially for winter and spring run Chinook and steelhead and, in the latter two months, for adult delta smelt as well. Early April actions (20 TAF) were for all three species. Mid-April to mid-May EWA costs were 43 TAF for the VAMP at the SWP and 15 TAF in late May for continuing to curtail pumping at the VAMP pumping rate in late May for juvenile delta smelt and fall run Chinook smolts (post-VAMP "shoulder"). A small amount of EWA water (9 TAF) was used to ramp up to higher baseline pumping rates over three days in June

Water Year 2002. In 2002, a single January pumping curtailment (66 TAF) for Chinook salmon and delta smelt adults. A relaxation of the 0.35 E:I standard yielded 76 TAF of water for the EWA in

February. But most of this water could not be retained under control of the EWA and was either exchanged with contractors (not shown in Figure 1, see explanation in later section on asset management) or was converted to project water in San Luis Reservoir with a concurrent 38 TAF reduction in Delta pumping in March. Although there were salmonids and delta smelt in the Delta when the 38 TAF reduction in pumping occurred, no serious fish problems were apparent at the time and this pumping reduction was not requested by the Management Agencies. While fish in the Delta may have benefited during the period of lower pumping, another characterization of the event is that EWA managers lost control over use of the 38 TAF of EWA assets because they had no place to store it. EWA costs for the VAMP period (45 TAF) were similar to 2001 (43 TAF). Cost of the post-VAMP period curtailment ("shoulder"), although maintaining pumping at 1500 cfs as in 2001, was much higher (62 TAF) in 2002 than in 2001 (15 TAF) because the SWP base case pumping rate was much higher in 2002 than in 2001. EWA also paid for the CVP pumping curtailment during the "shoulder" action (69 TAF) because no (b)(2) water was available.

Water Year 2003. In 2003, December and January curtailments (121 TAF) for adult smelt also benefited emigrating Chinook salmon and steelhead. No fish actions were taken in February or March. EWA VAMP costs were even lower (32 TAF) than they had been in 2001 (63 TAF) and 2002 (45 TAF). Maintaining relatively low pumping at the SWP in late-May for delta smelt and emigrating Chinook was very costly to the EWA (169 TAF) because May was very wet and base case pumping without the action would have been high under the prevailing conditions. Furthermore, the EWA again paid for the CVP curtailment during the "shoulder" (26 TAF) because there was no (b)(2) water available. In consideration of these higher costs (195 TAF), the target pumping rate during the "shoulder" was not as low as the VAMP pumping rate and the action was further scaled back during the last 4 days of the month. Pumping was allowed to increase from 1500 cfs by 500 cfs per day beginning May 19 until it matched the flow rate in the San Joaquin River at Vernalis (about 2,200 cfs) and then to increase in steps beginning on May 28 to approximately 10,000 cfs on June 1.

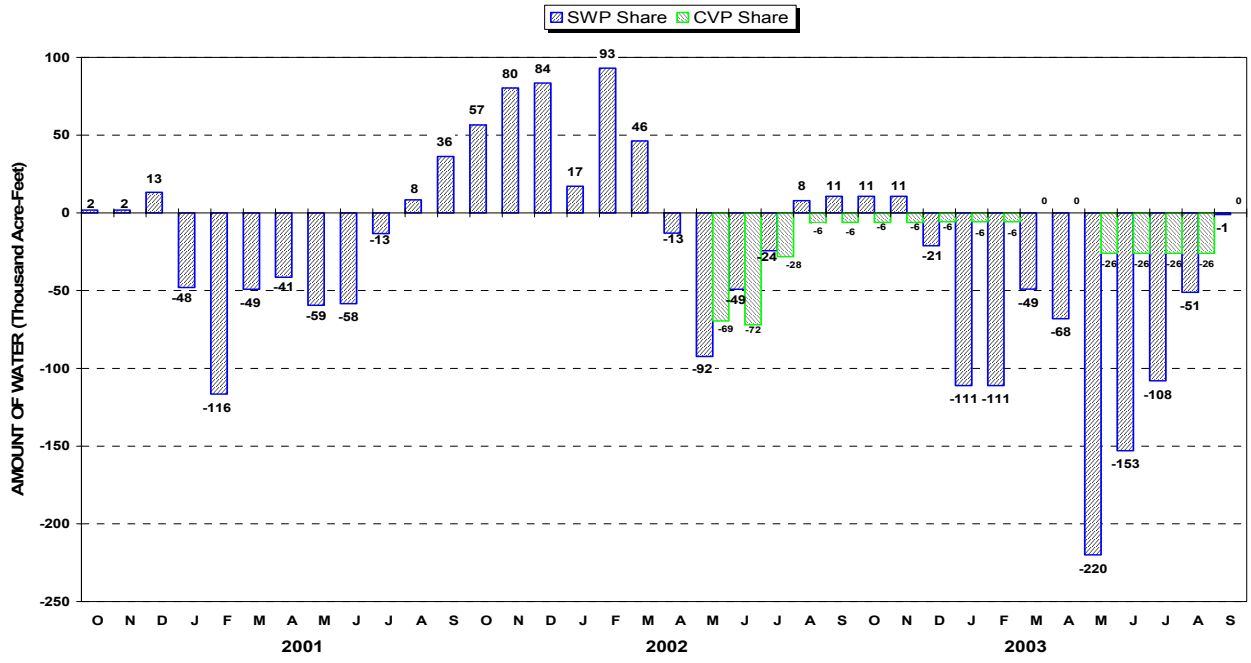
Figure 2 shows the cumulative status of the EWA as indicated by the asset balance in San Luis Reservoir at the end of each month in water years 2001 through 2003. Bars extending above the zero line represent assets held by the EWA in San Luis. Bars extending below the line are debts owed to the projects for previous fish actions. Decreases in assets occur when EWA actions reduce export pumping and the EWA either replaces the foregone water supply with water it has in San Luis already or incurs a debt, i.e. an obligation to replace the water before it is needed by the projects. Increases in assets (including reduction in debt) can occur when EWA water is obtained from the Delta using operational tools, when water purchased upstream of the Delta is transferred to San Luis, or when water purchased in the export area is made available to the EWA in San Luis Reservoir. Bars above the line in fall/winter 2001-2002 represent the combination of assets carried over from WY 2001 and assets obtained using operational tools in excess of fish action costs in the winter months. Minimal assets were carried from WY 2002 to WY 2003.

Together, Figures 1 and 2 reveal some major challenges for EWA managers. In general, the EWA accumulates debt in the winter and spring when most fish actions are taken and pays the debt off in the summer when purchased assets are actually obtained from the willing sellers and conveyed to the export area. The quantity of EWA water that will be needed each year is not known until the end of the spring whereas the decisions about how much to purchase must be made much earlier in the

season. Option contracts with later call dates help managers accommodate this mismatch in timing, nevertheless the risk of buying too little or too much water remains.

Figure 2. Cumulative monthly EWA asset balance in San Luis Reservoir for Water Years 2001 - 2003.

Bars extending below the zero line depict EWA debt to the projects while bars above the line indicate EWA has water stored in San Luis Reservoir. Changes from month to month may be the combined result of several transactions within a month producing both debits and credits for the EWA.



EWA managers always recognized that the need for and costs of action to protect fish would vary annually. We have been able to carry unspent money into the next year, but saving unused water until it was needed has been more difficult. Some water, mostly obtained using operational tools, has been lost before it could be turned into a fish protection action. EWA management could be greatly enhanced by having access to temporary storage dedicated to the EWA where water can be safely kept until it is needed.

Adaptive Implementation of the EWA program

The ROD (Attachment 2: EWA Operating Principles Agreement, August 2000) describes the tools initially available to the EWA and the potential for other tools that may be developed as appropriate to acquire functionally equivalent assets. This section evaluates the performance of the EWA tools in years 1-3 relative to expectations in the ROD, describes how the concept of functionally equivalent assets has been applied and explains new asset management approaches that were used when existing mechanisms provided in the ROD were inadequate.

Water Purchase Strategies

- Larger quantities of water were purchased from sources upstream of the Delta (annual average = 106 TAF compared to 35 TAF specified initially in the ROD). Both greater availability and lower price of water from upstream sources dictated this adjustment from the ROD description. Access to pumping capacity to move EWA water from upstream sources to locations south of the Delta establishes a limit on use of upstream purchases. EWA has exclusive access to 500 cfs of Banks capacity in July through September. Access to additional capacity varies primarily as a function of SWP allocations to south of Delta contractors which in turn depend on upstream project reservoir carryover storage and current year hydrology. Access to capacity for the EWA also is constrained when project contractors respond to low SWP allocations in dry years by acquiring additional water supplies from non-project sources. Moving this water south of the Delta has a higher priority than moving the EWA's water.

- Options contracts have been used to allow the EWA Agencies to defer decisions about water purchase amounts until later in the year when the amount needed and Delta pumping capacity are more apparent.

- Purchases have been limited to annual transactions because funding and environmental compliance were on a year-to-year basis. The EWA Agencies recognize the substantial economic and administrative advantages of multi-year water purchase agreements.

- Functionally equivalent assets have been substituted when it was infeasible to obtain some of the assets described in the ROD. For example, potential for borrowing water from the SWP has been substituted for the "stored water."

- The cost of the EWA purchases has been reduced through more effective negotiations by water acquisition staff. Future prices will reflect hydrologic conditions and competition for limited supplies of water as new buyers enter the market.

Multi-year option contracts to purchase water from various sources could be effective for the EWA. However, option fees must be reasonable and dates for calling options must be late enough in the season so that the water need is reasonably well known when decisions are made.

Asset Management Strategies

- For EWA management, each year is different due to the interaction of variable hydrology and fishes behavioral response. This variability has the potential to create a mismatch between the annual water acquisitions and annual EWA expenditures. In some cases unused EWA assets have been carried into the following year. In 2003, the EWA agencies intended to carry debt into 2004; the lack of Delta carriage costs offset that debt, and the EWA ended 2003 essentially even. (The EWA carried 103 acre-feet of assets into 2004.) Although it has not happened yet, if fish action costs exceed asset availability, debt may be carried forward into the following year. Neither situation is inherently bad, however, the lack of a secure

place to store surplus assets and the infrequent opportunities to repay debt with operational tools make it more difficult to accommodate the annual variation in the need for and cost of EWA fish actions.

- Not having a place to store EWA assets south of the Delta was a serious constraint on EWA management affecting our ability to make optimal use of purchased and operational assets. For example, in February 2002, E:I relaxation yielded a substantial amount of water for the EWA in San Luis Reservoir. EWA water has a low priority in San Luis Reservoir. Consequently, before it was needed, some of this EWA water was effectively displaced from San Luis Reservoir and converted into project water, concurrent with a Delta pumping curtailment (38 TAF), when San Luis would have been filled if all planned pumping had continued. As an alternative to this combination of water conversion and default pumping curtailment, another 40 TAF of EWA water that was about to be displaced in San Luis was provided to project contractors for their use, with no concurrent reduction in pumping. In exchange, the contractors returned 20 TAF to the EWA after the high point in San Luis storage, thus preserving that amount to pay for spring fish actions.

- Another example of within-year asset management challenges involved banked groundwater purchased in Kern County in 2002. Storing the water until the following year when it was not needed for 2002 fish actions would have been expensive for the EWA. A creative three-way exchange involving the EWA agencies, sellers of banked groundwater in Kern County, and Metropolitan Water District (MWD) provided a solution that benefited all parties. Kern provided the water to MWD who later returned it to the EWA. Kern saved pumping costs when it delivered the groundwater purchased by the EWA to MWD in the fall instead of the summer. MWD used this good quality water to blend with other supplies and realized water quality benefits for its customers. MWD returned the full amount of water to the EWA in San Luis the following winter, saving the EWA groundwater storage charges that would have been incurred if the water were carried over through the winter in the groundwater basin.

Risk management with respect to EWA assets has been particularly challenging and there have been some failures. The EWA agencies and partners have been able to partially solve some EWA water management problems, however, deficiencies in EWA management tools and capabilities provided for the EWA constitute a continuing impediment to effective use of EWA assets.

Adjustments in EWA Fish Action Decisions to Improve Effectiveness. Over time, there have been changes in the decisions made by the Management Agencies about when to use the EWA. Reasons for these changes have varied and include new biological information and changed conditions that affected our perception of biological needs. The following section explains items that affected how decisions to allocate EWA resources were made.

Winter Run Chinook Salmon. Adjustments were made in the use of EWA water for winter run Chinook as a result of the apparent increase in abundance of winter run in recent years as well as the use of a more accurate adult salmon abundance estimate to estimate juvenile winter run Chinook production.

Winter run Chinook spawn in the upper Sacramento River in the summer. The juveniles occur in the Delta late in the same year and in the first 3-4 months of the following year. About 200 TAF of

EWA was used in January-March, 2001 to reduce impacts to juvenile winter run Chinook from brood year 2000 when loss of winter ruin-size salmon at the SWP/CVP approached and then exceeded the authorized limit of 7,404. Even with these actions, the SWP/CVP winter run take for the year totaled about 20,000. The take limit each year is based on a calculated juvenile winter run production estimate (JPE), i.e. the number of juvenile winter run Chinook expected to safely reach the Delta. The JPE was calculated starting with an estimate of the spawner abundance extrapolated from the number of adult salmon counted at Red Bluff Diversion Dam (RBDD). The SWP/CVP take limit for juvenile winter run Chinook is set at 2 percent of the JPE.

There was great concern about exceedance of the winter run take limit in 2001 by such a wide margin. This concern stimulated an ongoing effort to assess the status of the winter run Chinook population. An accurate count of adult winter run was possible when essentially all salmon had to use the fish ladder at RBDD. In recent years, gates at the RBDD have been raised during the fall, winter and early spring months to minimize the impact of the dam on migration of both adult and juvenile winter run Chinook. With the gates up, counting salmon passing RBDD is not possible, so today salmon are counted during only a relatively small segment of the adult migration season. A carcass survey for winter run on the spawning grounds was started in 1996. After comparing estimates from RBDD counts and carcass survey methods for several years, biologists concluded that, while both methods revealed the increase in winter run spawner abundance in recent years, the more accurate estimate comes from the carcass survey. The carcass survey data produced a higher estimate of winter run abundance in 2000 than did the RBDD counts and would have resulted in a higher take limit for WY 2001 operations (approximately 52,000) than the one that was in place (7,404). If the higher take limit had been applied in 2001, the Management Agencies may have made different decisions about using EWA. If the actions had been the same, actual loss would have been about 40% of the authorized level and the outcome would have been viewed differently.

Beginning with brood year 2001 (emigrating in the winter and spring of WY 2002), the winter run JPE and incidental take limit for SWP/CVP operations have been based on the carcass survey estimate of spawner abundance. Since then the annual winter run Chinook loss at the SWP/CVP has been below the authorized level and little EWA water has been applied specifically for winter run Chinook protection.

It should be noted, however, that in any single year the carcass survey estimate may be either higher or lower than the RBDD estimate and thus the JPE and SWP/CVP take limit may also be higher or lower than one based on RBDD data. The number of adult females that return to spawn is more important to annual production (the JPE) and to take limit calculations than is the total escapement of winter run. Even in 2003 when the carcass survey estimate of total winter run returns was lower than the RBDD-based estimate, the carcass survey data indicated a higher abundance estimate for adult females than did the RBDD counts, leading to a higher JPE.

Other minor changes were made to the method for calculating the JPE, however, there are still other factors in the JPE calculation for which better information is needed. Potential sex ratio bias in the carcass survey is being investigated and, in the meantime, data from the fish trap at Keswick Dam is used for this purpose. Understanding how river conditions may affect migration timing and cause annual variation in juvenile winter run salmon survival during rearing in the Sacramento River and emigration to the Delta is particularly needed. Increased monitoring of juvenile salmon movement

from the upper Sacramento River and emigration to the Delta is particularly needed. The calculated index of juvenile winter run reaching the Delta (JPE) is correlated to the estimate of juveniles from rotary screw trap sampling in the upper river at RBDD (Juvenile Production Index, JPI) (Alice Low, DFG, personal communication). However, the estimate of winter run leaving the Delta based on trawl catch per cubic meter at Chipps Island is more closely related to the estimate of salmon entering the Delta based on catches in the Sacramento River trawl at Sacramento (Pat Brandes, FWS, personal communication). How this and other sampling can be used to better understand juvenile salmon migrations and survival needs to be further investigated. All aspects of this JPE methodology will be examined continually and refined whenever possible.

Spring Run Chinook Salmon. Based on observations in the last few years, questions have arisen regarding the use of surrogates to assess the impact of SWP/CVP diversions on yearling spring run Chinook

Spring run Chinook life history is more complex than that of winter run, making it infeasible to use the approach described for winter run to set a take limit for spring run Chinook. The first reason is that a variable and in some years a substantial proportion of spring run fry produced in some of the Sacramento River tributaries do not migrate to the ocean in the spring as young of the year smolts. Instead they remain in the natal stream through the summer and migrate to the ocean the next fall or winter as yearlings. Because the proportions of young-of-the-year smolt migrants and yearling migrants varies annually from stream to stream, and is virtually impossible to measure, estimating the juvenile production reaching the Delta and calculating an incidental take limit based on that estimate is even more difficult than for winter run. Instead, the relative impact of SWP/CVP entrainment on spring run yearlings is estimated by the recapture of coded-wire-tagged late-fall run hatchery salmon (from Coleman National Fish Hatchery) released into the Sacramento River when we detect spring run yearlings leaving the tributaries. The spring run yearling take limit at the SWP/CVP is a fixed percentage (1 %) of the number of tagged fish in any of several surrogate groups. We assume the surrogate salmon will behave similarly, survive at a similar rate and will be affected by conditions in the Delta in the same way as the naturally-produced yearling spring run salmon. The main difficulty with this approach is determining the degree to which these assumptions hold true.

In 2003 the loss of fish from three out of four spring run yearling "surrogate groups" exceeded the authorized level. Data on the SWP/CVP loss of both the wild spring run yearling size salmon and the surrogates was then used to formulate recommendations on whether to use EWA to curtail pumping. Several short-term EWA fish actions were implemented in January 2003 to reduce losses of wild emigrating salmon when the loss rate of both unmarked older juvenile salmon (yearling spring run among them) and the tagged surrogate salmon was relatively high. No further actions were taken later in February because the number of wild "older juvenile" salmon at the SWP/CVP had declined. The Bureau of Reclamation re-initiated consultation with NOAA Fisheries. (Note: Re-consultation levels of surrogate losses were exceeded again in 2004.) NOAA Fisheries has suggested several modifications to the surrogate approach. The use of surrogates is currently being re-evaluated as part of the ongoing CVP OCAP consultation. Improvement in our ability to identify spring run Chinook using genetic markers will help us determine if there is a consistent seasonal pattern of occurrence of spring run Chinook among the "older juvenile" Chinook that emigrate in the winter months. Even when we can identify spring run Chinook using genetics, it may not be

possible to use the take management approach now being used for winter run unless we can accurately estimate the production of spring run juveniles emigrating as yearlings. Presently we have no way to make this estimate.

Decision Tree Criteria for "Older Juvenile" Chinook. "Older juvenile" Chinook is a term we use to describe the juvenile salmon emigrating to and through the Delta in the fall and winter seasons (October-March). Salmon decision tree criteria for evaluating data from juvenile salmon monitoring in and near the Delta (catch or catch rate in trawls, rotary screw traps and fish facility sampling) help us identify peaks in juvenile Chinook emigration and periods of relatively high exposure to SWP/CVP operations-related impacts in the Delta and decide whether to initiate protective fish actions at these times. We used recent historical catch data when we established these catch rate criteria in the late 1990s. The abundance of winter run Chinook and tributary spring run Chinook (Butte Creek and to a lesser extent Mill and Deer creeks), has increased since the late 1990s, making the old criteria, designed to identify peaks in fish occurrence at specific locations, too sensitive to be useful for their intended purpose. Overly sensitive criteria could result in misidentification of significant peaks in fish movement and in fish protection actions being initiated prematurely, before most fish arrived in the Delta. Even before the criteria were formally modified in 2002, decision makers were conscious of the changed species abundance context and decisions may have been influenced by this knowledge. Decision tree catch criteria for the older juvenile Chinook emigrating in the fall and winter months have been increased based on more recent data so that in the future more fish would need to be seen in monitoring near and in the Delta and at the SWP/CVP fish facilities to trigger fish protection actions. Additional modifications to these criteria may be made as warranted. Of course if abundances were to decline in the future, decision criteria would be adjusted downward accordingly.

Protection of Adult Delta Smelt Prior to Spawning. All life stages of delta smelt are vulnerable to entrainment loss at the CVP and SWP export facilities. Low abundance indices in recent years have led to a heightened concern for the species, which has been reflected in the recommendations of the Delta Smelt Working Group and Data Assessment Team for fish actions believed to be protective of critical life stages of the species. Fish actions to protect delta smelt consist of export pumping curtailments, which directly reduce incidental take at the time and are thought to reduce the take of smelt for the season overall. Pumping curtailments from December through March protect pre-spawning and spawning adult delta smelt, which are considered the most critical life-stages, particularly for a low- abundance annual species, since they represent the individuals that successfully avoided risk occurring at earlier life stages and achieved reproductive maturity. EWA assets were used to provide export curtailments to protect pre-spawning adult delta smelt in February and March of 2001 and in January of both 2002 and 2003, when levels of incidental take became a concern.

Protection of Juvenile Delta Smelt with Post-VAMP Curtailment. Particle tracking modeling results suggest that positive (downstream) Central Delta flows may benefit delta smelt larvae hatched in the Central Delta by reducing entrainment at the export pumps and increasing their chance of moving west toward Suisun Bay. The purpose of reducing pumping, along with increased San Joaquin River flows during the VAMP period, is to improve the survival of delta smelt, as well as to create conditions for the VAMP experiment to evaluate factors affecting the survival of emigrating San Joaquin tributary salmon smolts. Extending export curtailments beyond the VAMP spring pulse

flow period, often referred to as the post-VAMP shoulder, is intended to improve their overall survival by reducing the likelihood of delta smelt larvae being entrained and affording young smelt an increased opportunity to grow and move north and west toward rearing areas in Suisun Bay, Suisun Marsh and the lower Sacramento River. When the post-VAMP shoulder is implemented, the temporary fish barrier at the head of Old River normally is removed and tidal operation of the South Delta temporary barriers is suspended to maximize migration opportunities for young delta smelt. Export reductions are maintained until incidental take of delta smelt declines, 20-mm surveys indicate that delta smelt distribution is primarily north and west of Franks' Tract, or South Delta water temperatures warm to a point at which delta smelt survival there is substantially diminished. Continued low pumping in the last two weeks of May, sometimes extending into June, also has potential benefits for the juvenile Chinook salmon emigrating from the San Joaquin River tributaries.

EWA for Experiments. Experiments involving the use of EWA assets are problematic for several reasons. First, experimentation is not a stated purpose of the EWA, as it is described in the CALFED ROD. More importantly, the EWA must function with limited fiscal and water resources requiring the EWA agencies to prioritize the use of EWA assets in order to protect fish and maintain the regulatory commitment regarding water supply. With few exceptions, EWA assets have not been used expressly for experimentation. Commitment of EWA assets to experimental purposes could limit the ability of the EWA agencies to respond to situations involving high levels of incidental take at the export pumps and constrain our ability to minimize incidental take as required or to avoid exceeding incidental take limits established in biological opinions.

Based on a pre-ROD agreement, EWA assets are used for part of the VAMP experiment evaluating the interrelationships among river flow and export rate and San Joaquin Basin salmon smolt survival with the head of Old River barrier in place. However, as this use supports a reduction in exports for 31 days during a key time period for both juvenile Chinook salmon emigrating from the San Joaquin River tributaries and delta smelt, it is considered a protective fish action.

The EWA Agencies try to take advantage of opportunities to carry out scientific investigations in conjunction with actions to protect fish and to evaluate actions when possible. An example is the tracking of radio-tagged juvenile Chinook in the southern Delta first during high exports and later during relatively low exports that were facilitated as part of an EWA fish action. Experiments involving no net water cost or increase in incidental take could be undertaken, but experiments have not been considered high priority uses of limited EWA assets.

EWA for Upstream Habitat Improvement. In the fall of 2002 and 2003 EWA power credits (energy saved during Delta pumping curtailments, offset by costs of pumping EWA water) and EWA funds were used to cover the cost of replacement power when generation facilities were bypassed by making river-level releases at Folsom Dam to lower water temperature in the lower American River. EWA upstream habitat benefits have been viewed as a collateral benefit of moving water from upstream sources to the Delta for export. Only a small amount of water purchased on the American River (a negligible percentage of total EWA upstream purchases) was released to provide in-stream habitat benefit when it could not be recaptured for the EWA in the Delta. Potential uses of EWA water for upstream habitat benefits are being examined; however, because of the mismatch between streams with in-stream need and those with willing sellers of water, opportunities may be limited.

Another consideration is that although upstream EWA actions may be beneficial for salmonids, no benefits would accrue for delta smelt or other fish in the Delta.

The CALFED Environmental Water Program (EWP) is working to obtain water on selected streams to provide this type of in-stream habitat benefit. When the program begins implementing acquisitions, we will pursue opportunities to coordinate EWA and EWP activities.

Effectiveness of the EWA

The CALFED Program identified many factors that may have contributed to the decline of Bay-Delta-dependent biological resources and developed an Ecosystem Restoration Program Strategy and a water management strategy, the EWA, to address these factors. The agencies have focused their collective restoration strategies on the reduction of the most critical and/or persistent stressors affecting the living resources of the Bay-Delta watershed.

Quantifying the results of EWA implementation in terms of biological benefits is difficult. Assessing the effectiveness of the EWA actions in the context of the full suite of past and ongoing habitat restoration and other species management activities also is a substantial challenge.

Salmonids. With respect to Chinook salmon and steelhead, the CALFED program has begun implementing the Ecosystem Restoration Program (ERP) intended to restore ecosystem function and ecological processes and reduce stressors in upstream habitats as well as in the Bay-Delta. The ERP focuses on ways to improve access to habitat and the quality of that habitat. One ERP element, the Environmental Water Program, intends to obtain water to augment stream flow where doing so can improve in-stream habitat.

The EWA has been used primarily to help reduce entrainment losses of these salmonid species at the SWP and CVP diversions and to otherwise improve the survival of juvenile salmon and steelhead in the Delta. The resulting benefits of fish actions for anadromous species depend on the magnitude of the action and the proportion of the population present during the action. Reduction in entrainment loss of Chinook salmon has been estimated by multiplying the reduction in the volume of water pumped during a curtailment by the density of fish in the water being pumped, assuming the density is the same during a curtailment as it was when it began. Even with actions taken during periods of relatively high density of the target species at the fish facilities (e.g. winter run size juvenile Chinook salmon in January-March 2001) and with a relatively large proportion of EWA assets expended for the purpose, the magnitude of entrainment loss reduction was estimated to be about 5,000 juvenile winter run, compared to the estimated actual loss of 20,000 winter run, or a 20 percent reduction from the assumed direct loss of 25,000 that would have occurred without the fish actions. One analysis estimated that survival through the Delta increased by one percent due to the EWA actions. Putting these numbers in context is difficult, but the estimates of the population of juvenile winter run entering the Delta and leaving the Delta ranged from 2.8 million to 440,000. The significance of the action would vary depending on which estimate of abundance is more indicative of the number of winter run in the Delta at the time the losses at the SWP/CVP facilities is occurring

Available data suggest direct entrainment loss for juvenile Chinook from the Central Valley watershed north of the Delta is typically less than one percent, based on SWP/CVP recoveries of fish from groups of tagged fish released in the Sacramento River or tributaries upstream of the Delta (unpublished data from SWP/CVP fish facilities, summarized by B.J. Miller and Tom Mongan and presented at IEP Conference at Asilomar in 2002). (The percent loss due to entrainment is typically higher for groups released in the San Joaquin basin or in the Delta.) From 1993-2002, percent loss for most of the groups of late fall run Chinook from Coleman National Fish Hatchery released in Battle Creek was less than one percent. However in 2003 (and again in 2004) for most of these Battle Creek release groups SWP/CVP recoveries exceeded one percent and for several groups, especially the more numerous "production" release groups, were three percent or greater (Erin Chappell, DWR, personal communication). These results suggest potentially increased SWP/CVP impact rate on salmon in the Delta. Substantial mortality of released fish would be expected to occur during the more than 200-mile migration to the Delta. An increase in SWP/CVP percentage loss could be due to improved survival of the tagged fish during downriver migration to the Delta so that more fish are exposed to entrainment risk in the Delta. The extended period of gates-up operation at Red Bluff Diversion Dam and screening Sacramento River water diversions are two actions that have been taken which were expected to increase salmon survival. RBDD gate operations would not seem to explain results in the last two years because the gates–up operation in the winter months has been required for much longer than that. New or improved screening of a substantial percentage of the water volume diverted from the Sacramento River has been accomplished more recently. Further investigation of factors affecting in-river juvenile salmon survival, including additional analysis of these data from recent years, is warranted to help further refine our knowledge of factors affecting salmonid production and help us determine the magnitude of export pumping impacts and, hence the value of pumping curtailment for salmon.

Mortality through direct entrainment into the SWP and CVP diversions is not the only impact of export pumping on juvenile salmon. Biologists have hypothesized that Delta pumping alters flow patterns and may cause migrating salmon to be disoriented and suffer higher mortality while trying to negotiate the complex migration routes through the interior Delta to the ocean. The mechanisms responsible for these so-called "indirect effects" of export pumping on salmon migration success are difficult to quantify. Experiments tracking radio-tagged smolts in the southern Delta at relatively high and low pumping rates provide some evidence suggesting migrating juvenile salmon respond to flow. Using a survival model developed using data from mark-recapture studies with coded-wire tagged juvenile salmon, export-related salmon mortality through the Delta for winter run Chinook at prevailing pumping rates in 1996-2003 was estimated to be in the range of 2 percent to 13 percent, averaging 7 percent (Pat Brandes, FWS, personal communication, corrected from results presented to the EWA Review Panel in October 2003), an impact rate that could be a potentially significant impediment to recovery of an endangered species. Note, however, that although the adverse impact of exports on salmon can be reduced by EWA pumping curtailments, the EWA is too small to make a large difference in the pumping rate for a significant interval, in total pumping or in the overall effects of pumping. Another analysis using a multi-factor regression model of juvenile salmon survival in the Delta estimated these 2001 curtailments for winter run Chinook improved survival in the Delta by one percent, from 66 percent to 67 percent (Pat Brandes, FWS, presentation to EWA Review Panel, 2001).

In addition to those fish actions undertaken specifically when authorized take levels for listed salmonids was either approached or exceeded, EWA water is used for SWP curtailments in pumping for 31 days in mid-April to mid-May during implementation of the VAMP, a multi-year experiment designed to measure salmon smolt survival at various combinations of San Joaquin River flow and SWP/CVP export pumping rates with a barrier at the head of Old River. EWA water also is used for a post-VAMP period pumping curtailment as salmon smolts continue to emigrate from the San Joaquin tributaries through the Delta in late-May. The benefit of these uses of EWA will be better understood when the 12-year VAMP experiment is completed.

Upstream salmonid benefits have accrued in some instances as EWA water was released to streams for transfer through the Delta at times when the increase in flow provided needed habitat improvement (for example, transfer of water purchased on the Merced River in fall). EWA managers work closely with sellers to schedule the release of purchased water to provide benefits when possible and to avoid unintended adverse effects on spawning (e.g. redd dewatering) and rearing (e.g. juvenile fish stranding) salmonids in the rivers.

EWA power credits and funds were used in 2002 and 2003 to replace energy generation foregone when river level outlets at Folsom Dam were used in the fall to enable release of the only cold water left in the reservoir, providing improved (lower) water temperature in the Lower American River for spawning fall run Chinook salmon. These actions reduced the period during which temperature-related pre-spawning mortality of adult Chinook salmon was occurring and provided temperatures suitable for spawning sooner than would have occurred due to ambient air cooling alone. In November 2001, river level outlet releases reduced the water temperature in the river from 65^0 F to 60^0 F. A similar operation in October-November 2002 reduced water temperature at the Watt Avenue Bridge from 63^0 F to 57-59^0 F through November 19 when it was determined continuing the power bypass operation would not provide further benefit. There is no quantitative estimate of pre-spawning mortality of adult salmon that was avoided or of the benefit that accrued by providing suitable temperature at an earlier date for salmon that were ready to spawn. However, each increment of change when temperature is above the optimal range helps to reduce the adverse temperature-related impacts.

Benefits of EWA actions for salmon populations are hard to quantify and to distinguish from effects of multiple factors acting concurrently. Most salmon populations, including the populations that are targeted for protection, are more abundant than they were a decade ago and have been relatively stable or increasing during the time the EWA has been operational, however, favorable inland and ocean conditions, other restorations actions, and harvest restrictions have all contributed to this trend. The 3-5 year life cycle of the anadromous salmonids in the Central Valley further delays and complicates the assessment of population level results. It means that the population benefit of EWA actions and other actions taken concurrently are not realized until 3-5 years after the actions are taken. Only one cohort of Chinook salmon that could have been the beneficiary of EWA actions has returned to freshwater as adults. Even with this information, it will not be possible to attribute trends in abundance to individual restoration actions. The best approach to defining the benefits of EWA for salmonids seems to be through seeking improved understanding the magnitude of, and if possible the mechanism behind, the proximate effects of the actions we take on the species we intend to protect and recover. With comparable information about the benefits of other actions intended to

help restore these populations, a comparison of relative effectiveness among the various actions can be made.

Data on steelhead populations and our ability to quantify the effects of EWA actions on steelhead is more tenuous than for Chinook salmon. There have been no studies of steelhead survival in the Delta and entrainment impacts are not fully documented due to the lack of information about pre-screen losses, particularly losses in Clifton Court Forebay.

Delta Smelt. With respect to the stressors implicated in the decline of the delta smelt, the EWA was designed primarily to contribute to the abatement of entrainment losses at the SWP and CVP export pumps. Any evaluation of the effectiveness of the EWA must be based upon whether or not the actions taken have reduced the impact of this stressor to the species. This type of estimate cannot be made for delta smelt at present, because of a lack of reliable information on the indirect effects of export pumping, pre-screen mortality at the export facilities, entrainment impact on delta smelt larvae that are too small to be screened and counted, and population size. However, by providing the ability to respond immediately to situations in which incidental take at the export pumps is or may become an issue, EWA fish actions have likely contributed to the avoidance of take levels that require re-initiation of consultation. During periods of increased take of delta smelt, fish actions (pumping curtailment) have been implemented that we believe have resulted in the decrease of overall take. This conclusion depends on the premise that during a curtailment fewer smelt are entrained and fewer are drawn closer to the SWP/CVP diversions where they become increasingly vulnerable to being entrained and that some of the fish that are neither entrained nor drawn closer to the pumps during the curtailment will be out of the zone of influence of the export pumps by the time pumping is increased. Factors that influence the risk/magnitude of delta smelt entrainment have not been definitively described. All that can be said with certainty is that, in the three years in which the EWA has provided a post-VAMP shoulder, incidental take of delta smelt has not reached the re-consultation level specified in USFWS' 1995 Biological Opinion. Review of delta smelt distribution data from the 20 mm survey during and subsequent to EWA fish actions suggest progressively decreased delta smelt densities in the areas in which they would be most vulnerable to entrainment. When adult smelt have migrated into the southern Delta, curtailments were intended to reduce the number of delta smelt entrained prior to spawning. When spawning has already occurred and larval smelt the western Delta and Suisun Bay. During extended periods of spawning, both are in the southern Delta, curtailments are intended to reduce pumping impacts while smelt are growing and increasing their chance of survival until they move into spawning adults and young delta smelt, the progeny of delta smelt which spawned earlier in the season, may be present at the same time.

Sampling is conducted seasonally with appropriate gear to determine the distribution of delta smelt (Table 3). However, even with intensive sampling it has not been possible to document the immediate effect of a pumping curtailment on delta smelt. Use of delta smelt distribution data to assess the effects of EWA actions is difficult because of the multiple factors affecting apparent distribution before, during and after the actions, including recruitment, mortality and migration. The Interagency Ecological Program has begun a new investigation of Delta hydrodynamics and fish movement intended to help us better understand how water management may affect fish, including delta smelt, and suggest how better fish protection can be achieved.

During the first three years of EWA implementation, when delta smelt abundance indicators were low and concern for incidental take at the pumps was high, the Management Agencies, Project Agencies and stakeholders were able to openly discuss available real-time data on Delta conditions, incidental take at the SWP/CVP fish facilities and distribution and abundance of delta smelt, and work together to achieve consensus and implement protective actions in a timely manner. The ability to modify Project operations in real time, rather than relying solely on prescriptive standards, provided protective intervention before take levels required re-consultation. The ability to analyze trends as they were developing enabled the EWA agencies to identify situations in which incidental take could become important and to tailor a specific response, which in turn allowed the Projects to modify exports, generally within a three-day lead time. In addition to EWA fish action in response to real-time assessment of need, EWA is used to curtail pumping during the VAMP period which typically coincides with a period of high vulnerability of newly hatched larval delta smelt to pumping impacts.

EWA has been used for operational curtailments intended to be protective of delta smelt. We believe smelt entrainment has been reduced by these actions. Average May-June delta smelt salvage was lower in 2001-2003 than in 1996-2000, however, variability in salvage was high and the difference was not statistically significant (Zach Hymanson, CBDA, personal communication). The type of late season take exceedance problems we had in June and July 1999 did not occur in the years we used the EWA to curtail pumping in April, May and early June, but absent a "without action" case to compare to, no cause/effect relationship can be demonstrated.

Has the EWA helped contribute to the recovery of delta smelt? Delta smelt distribution and abundance criteria in the Delta Native Fishes Recovery Plan were met for the 5-year period 1998-2002, even with a very low index in 2002. In 2003, despite a higher annual index than in 2002, the 2-year average fell below 84, thus beginning a new 5-year period of evaluating distribution and abundance. The FWS concluded that delta smelt abundance does not appear to be increasing, is highly variable and has not yet achieved pre-decline levels (FWS 5-Year review for delta smelt, March 2004). They further state that three years of EWA implementation is insufficient to reach conclusions about the effect of EWA; however, to the extent flow management affects delta smelt viability EWA actions have contributed to delta smelt conservation.

Regulatory Commitments Regarding Water Supply Reliability

Each year EWA Agencies must determine whether the three tiers of protection listed above are in place, including a functional EWA and funding for implementation of the ERP at the agreed upon annual funding level of $150 million. Regulatory commitments regarding water supply described in the ROD are affirmed by an exchange of letters between the Project Agencies and the Management Agencies. The first exchange occurred on January 11, 2001. In 2002 and 2003 this exchange occurred on April 12 and April 8, respectively. In each of these latter two years there was a concern about the status of both Tier 1 and Tier 2 protections. Reinterpretation of (b)(2) implementation as part of the regulatory baseline, lack of storage capacity for the EWA and uncertainty regarding EWA funding were sources of concern. The EWA Agencies worked together through the winter in these two years to obtain and manage EWA assets such that by April each year the Management Agencies were confident that the assets available then would be sufficient to cover the cost of anticipated pumping curtailments and provide Delta fish protection in the remaining spring months. This

affirmation of the commitments achieved the CALFED goal of increased water supply reliability provided by the EWA. In as much as this was an important purpose of the EWA, the EWA in its first three years (now four) must be judged a success.

The future viability of the EWA and the ability to continue to assure water supply reliability and reduce conflict in the Delta depends on the ability to obtain sufficient EWA assets in all water year types. This ability may be called into question if increased competition for dry year water supplies from willing sellers precludes EWA acquisitions in sufficient quantities and at affordable economic and societal costs.

EWA Review

Role of the Science Advisors. The CBDA Science Program relies upon the expertise of program advisors to facilitate communication between technical program staff, managers and the Authority. The science advisors facilitate the annual species workshops and make suggestions to the Lead Scientist on the specific charge for the EWA Review Panel and the agenda for the annual Review Panel session. They may also review, advise or provide technical insight for documents, proposals or EWA program elements. The EWA science advisors assist the Lead Scientist in drafting the agendas and prepare interpretive summaries of EWA-related workshops and other events.

Due to their time constraints, the Science Advisors have not spent as much time on the EWA activities as may have been envisioned. Nevertheless, they have performed an important function in facilitating communication among the EWA agencies, the CALFED Science Program, the EWA Review Panel and the public on scientific issues related to the EWA.

Workshops. The CBDA Science Program convenes annual species-focused workshops for the EWA. Workshops have been held annually for delta smelt and salmonids; summaries prepared by the EWA science advisors are available on the CALFED Science Program website (http://science.calwater.ca.gov/workshop/past_workshops.shtml). Past workshops have focused on species biology, the technical bases for fish actions, and assessment of the effects of fish actions. The 2004 species workshops will be combined into one workshop, to be held in September, and will be shifted away from the individual species biology and management and broadened into a synthesis of the first four years of EWA implementation.

The workshops have been a valuable forum for communication among scientists involved in monitoring and research on the fish species of concern as well as those involved in water management and regulatory decision making. They have also helped the EWA agencies prepare for the annual review sessions each fall. Workshops have become more focused on specific scientific problems each year, a positive trend that would be expected to continue.

Annual Review and the Role of the Review Panel. The CALFED Science Program is responsible for both developing performance measures for the EWA and evaluating the technical aspects of the program. The CALFED Lead Scientist convenes a Review Panel for the purpose of providing an independent technical review of the EWA at the end of every water year. The Panel is an interdisciplinary team comprised of individuals with a breadth of expertise encompassing both local and national relevant-discipline knowledge, but who are not involved directly in EWA

implementation. The general format of these annual reviews is for EWA agency staff to present their information and findings to the Panel, stakeholders and the public, with formal opportunities provided for input from stakeholders and the public. The Panel's general charge is to exchange information with agency staff, stakeholders and the public regarding the state of the science that applies to the EWA concepts, actions and the technical basis for actions. The Panel's specific charge varies from year to year. The Panel does not provide conclusions or findings with respect to the validity of the EWA or judge the actions of the EWA agencies. The Panel does provide a written report to the CBDA Lead Scientist detailing its recommendations on each aspect of the specific charge, including the extent to which EWA actions incorporate established science, ways to incorporate new science, and areas for further work. A Panel Review has been conducted annually for the EWA for each of the last three years; the fourth review will be held in November 2004.

Summaries of the EWA Panel Reviews can be found on the CALFED Science Program website (http://science.calwater.ca.gov/workshop/past_workshops.shtml). Briefly, in their first review of the EWA (2001), the Panel presented their report in five sections (1) positive findings, (2) goals and objectives, (3) scientific credibility and suggestions for additional research, (4) flexibility and adaptive management, and (5) conclusions. The Panel noted that the EWA was able to purchase the needed assets, work together collaboratively, involve stakeholders, and create decision criteria, but that improving species protection would require improved understanding of species biology and Delta processes. Concern was expressed over the availability of Tier 3 funding and the allocation of Tier 2 and Tier 3 resources. To provide a sufficient basis in sound science, the Panel felt strongly that additional resources (personnel and research dollars) should be dedicated to EWA-related research tasks, and provided a set of general science recommendations, including assembling a salmonid data bank, filling in the knowledge gaps in delta smelt biology, evaluating existing monitoring, further analysis of field data, analyzing risk and re-allocating Tier 3 assets, setting aside water for experiments, developing models of Delta processes, quantifying losses of delta smelt, achieving an improved understanding of entrainment events, and further improving the decision-making process (decision trees). The Panel encouraged the EWA agencies to pursue increased management flexibility wherever possible, and to make dedicated, permanent assignments of staff to EWA.

In the second year of EWA review, the Panel noted that, if the EWA was to focus on minimizing incidental take, it would need to improve both its understanding of the ecological significance of take and of the conditions, operational regimes and fish behaviors that lead to entrainment events. The Panel expressed concern that the level of staffing and funding could seriously impact the ability of the EWA to respond to extreme events. The Panel identified five issues for EWA: (1) expanding responsibilities with limited water resources, (2) the need for better program integration, (3) the need for more scientific analysis and synthesis to provide a better foundation for management, (4) the need to establish performance measures, and (5) resource constraints. The Panel also identified six "science challenges" for EWA (1) determining the combinations of physical conditions in the Delta that give rise to "entrainment events" of delta smelt, (2) determining the growth and mortality rates, habitat use and movement patterns of juvenile Chinook salmon in the Delta, (3) developing a quantitative synthesis of the life cycle of delta smelt and Chinook salmon, (4) determining the magnitude of predation mortality in Clifton Court Forebay, (5) optimizing Delta Cross Channel operations, and (6) identifying reservoir management strategies that improve the availability of cold water for in-stream habitat enhancement. The Panel identified inter-annual carry-over of assets and

debt, problems associated with upstream actions, and lack of program integration as constraints on the program. The Panel felt that, if EWA is to maximize its potential, it must secure additional resources for itself, develop appropriate measures of performance and improve its scientific analysis and data synthesis.

The third session of the Science Panel review focused not only on EWA activities in water year 2003, but on challenges and concerns facing EWA if it continues into the future. The Panel did not repeat its recommendations from previous years' reports, but indicated that most of them were still relevant to year three and beyond. The Panel acknowledged that progress on previous years' recommendations would be modest and incremental, considering the nature of the challenges facing EWA. The Panel was, however, disappointed with the apparent lack of progress in two specific areas (1) program integration and evaluation, and (2) addressing critical science needs. The Panel commended water acquisition, increased cooperation and EWA workshops and symposia and noted that its previous recommendations had been given serious consideration by the EWA agencies. The Panel called out two new challenges should the EWA be extended (1) the need to manage long-term opportunities and risks, and (2) demands for increased accountability. The Panel recommended (1) continuation of annual science reviews, (2) improved program documentation and program-wide reviews, (3) better integration of EWA with other programs, (4) more effective incorporation of science into the policy and regulatory measures that form the context for EWA implementation, and (5) increased mobilization of resources to address critical science needs.

Staff from the EWA agencies work together in collaboration with Science Program staff and others (e.g. Interagency Ecological Program, stakeholder biologists) to respond to panel recommendations to the extent feasible through modifications to the implementation, documentation and evaluation of the EWA. The EWA agencies have responded to the Panel's recommendations in presentations at subsequent annual reviews and have submitted written responses through the CALFED Lead Scientist. Each review session has been an educational experience for the Panel and the other participants. Where panel recommendations seemed to reflect an incomplete understanding of the EWA scope and purpose, the agencies have followed up with clarifying information. Many of the panel's recommendations have yet to be acted on because they are beyond the capabilities and expertise of the EWA Agencies' staff currently assigned to EWA implementation and related tasks. Assistance from the CALFED Science Program and from the scientific community at large will be required to achieve the advances in Bay-Delta and Central Valley ecosystem science and to satisfy the collective desire of all involved in the EWA to make it an effective component of the CALFED Bay-Delta Program.

Conclusions

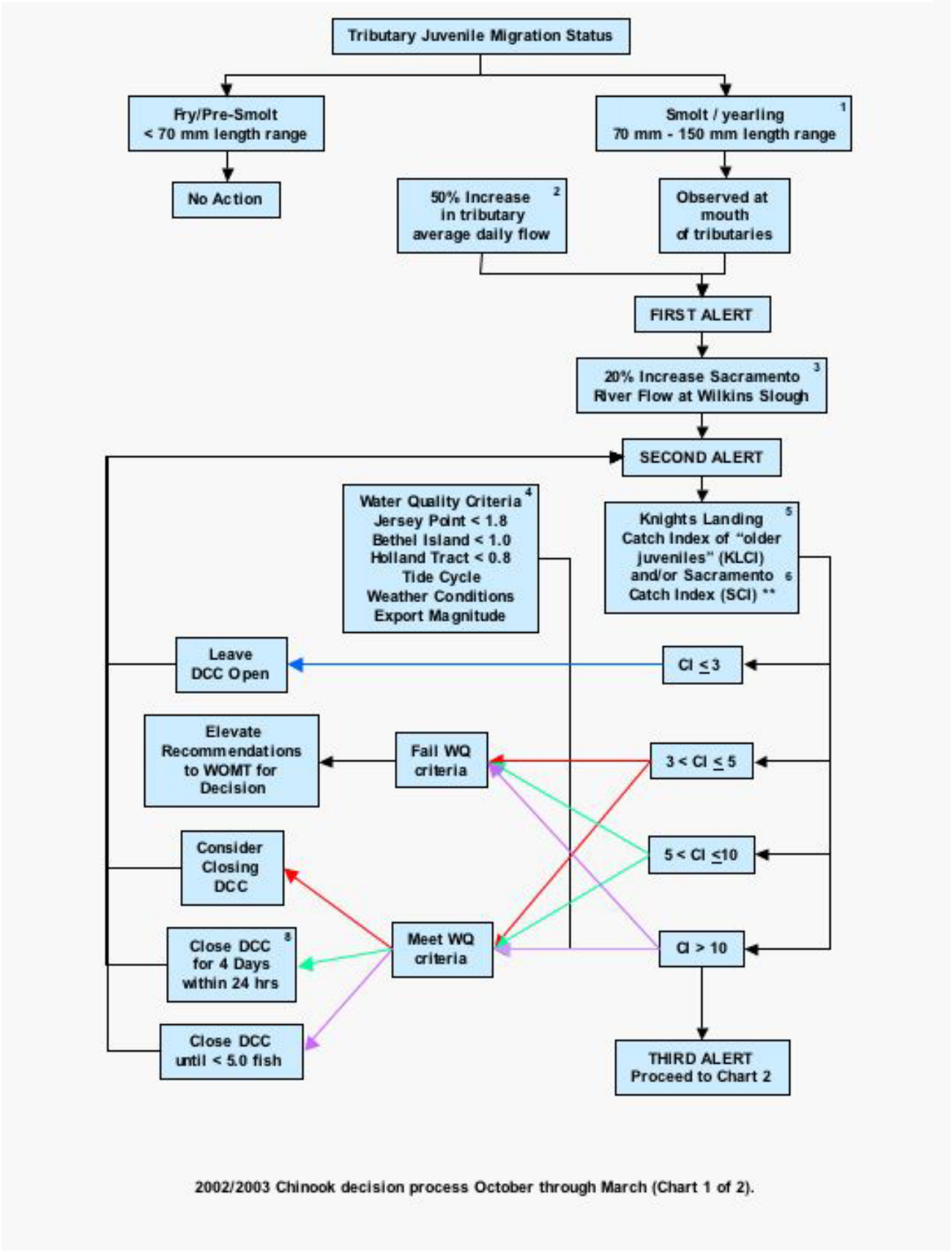
Although the EWA has not achieved the full funding level envisioned in the 2000 CALFED ROD, it has acquired sufficient water to implement most of the desired fish actions in its first three years. EWA actions have taken place predominantly in the Delta. Where a valid technical basis exists, increased funding could potentially allow the EWA to implement more upstream actions and make some water available for experiments. EWA has been successful in creating a forum for broader discussion of fish protection actions, fostering cooperation between Agency staff and stakeholders and decreasing the potential for conflict over limited resources.

EWA has successfully reduced the direct effects of water export on Delta fish and protected the State and Federal projects from supply impacts due to excessive incidental take of at-risk fish species. However, because of the short time period of EWA implementation, insufficient data exists to fully evaluate the efficacy of EWA actions with respect to fish protection and recovery. Additional investigation is warranted, and some is already underway, to answer several remaining questions, including (1) the impact of incidental take on survival, abundance and distribution of fish populations, (2) how much environmental water is needed to accomplish CALFED's recovery goals, and (3) how the EWA can best be used to contribute to fish species recovery.

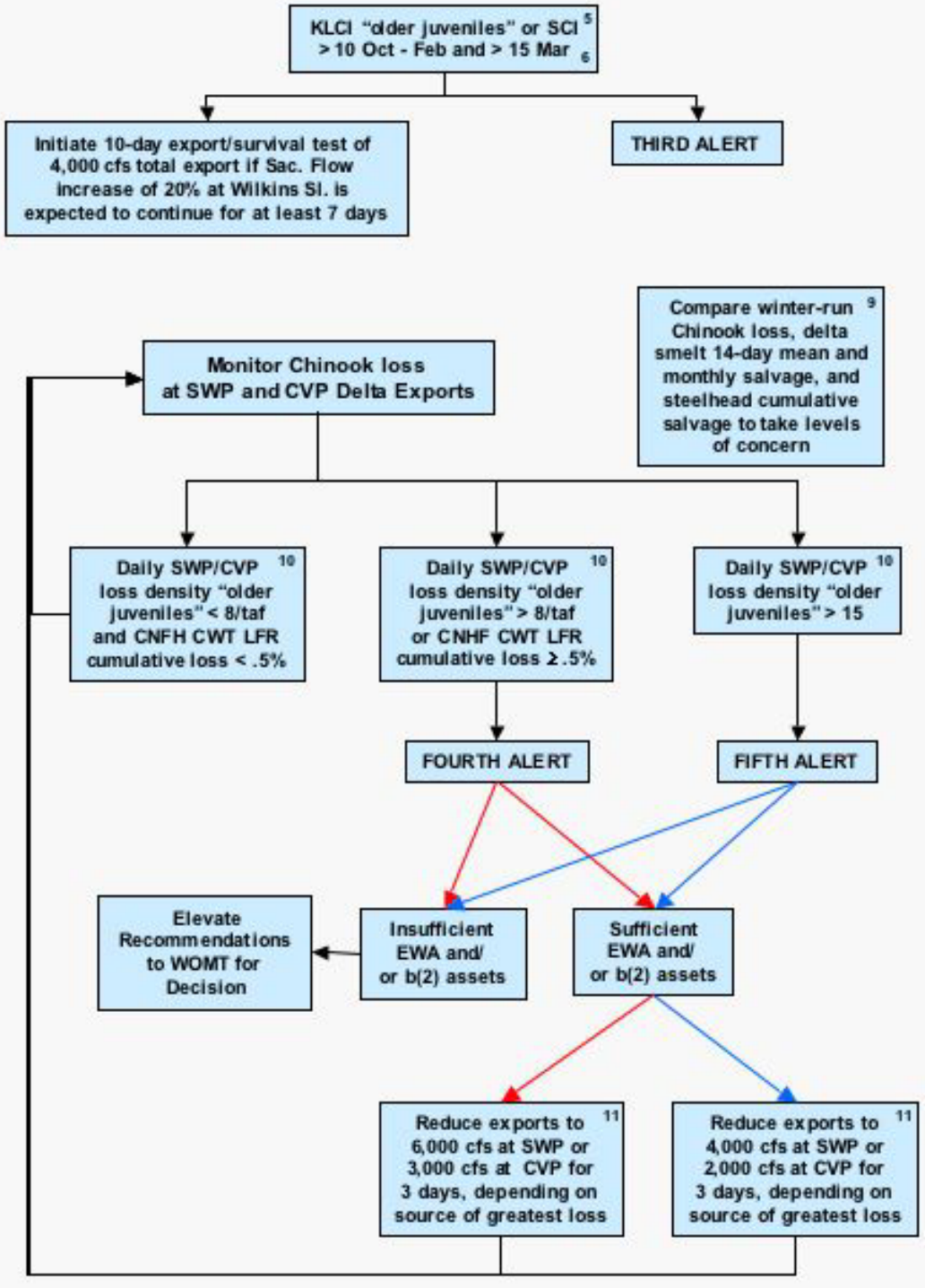
The following elements are needed to improve the management and use of EWA assets to make it more effective as well as to improve our assessment of the efficacy of EWA actions:

- Storage capacity for EWA water that is flexible, reliable and affordable
- Reliable access to conveyance capacity
- Reliable long-term funding with the ability to carry unused funds from year to year
- Long term water purchase contracts including some contracts for firm annual amounts and some with options and call dates as late in the year as possible
- Commitment to continued monitoring and in some instances improved monitoring with real-time reporting as needed, including reliable funding and adequate staff and equipment
- Continued evaluation of decision making processes in light of changing circumstances and new biological information
- Enhanced science effort on the range of factors that may be controlling populations of the various fish species in the Bay-Delta system, enabling better assessment of effectiveness of restoration actions including the EWA
- Development, testing and refinement of conceptual models
- Continued development of population models, identification of weaknesses in the available data and incorporation of new information when it becomes available

Attachment A: Chinook Decision Process



2002/2003 Chinook decision process October through March (Chart 1 of 2).



2002/2003 Chinook decision process October through March (Chart 2 of 2).

Table 2 The Delta Smelt Decision Tree

Life stage	Adults
Timing	Pre-VAMP (February 1 through April 15)
Concerns	1) High relative densities of adults in the south Delta are a concern due to the potential for increase entrainment at the SWP and CVP.
	2) High relative densities of delta smelt in the south Delta also suggest spawning may occur in the south Delta, increasing the chances for exceeding the red light level[a] of incidental take in the late spring and early summer.
Data of interest	Before pre-VAMP, consider fall midwater trawl indices
	Spring midwater trawl
	Salvage
	Beach seine
	Chipps Island trawl
	Hydrology (wet or dry year; placement of X2)
	Water quality conditions and water temperature
	Condition of the fish
Assessment of conditions	Adult distribution in Delta and downstream of the Delta
	Salvage levels/densities, yellow light
	Potential high numbers in juvenile salvage if high numbers of adults are concentrated in the south Delta
Tools for change	Reduction in exports, either concurrently at both facilities or at the facility that is salvaging the most fish
Biological questions using the available data	1) Is the adult distribution broad or not?
	2) Is salvage elevated or not?
	3) Is previous FMWT index high or low?
	4) Are water quality conditions (e.g. water temperatures) conducive to spawning?
	5) Are fish ripe for spawning? (Both of above may help determine if there will be a protracted spawn.)
Questions concerning operations	1) Is there a need to reduce exports at either or both facilities based on either the distribution of adults and/or an increase in the salvage of adult delta smelt?
	2) Is it likely to be a difficult spring or summer? That is, do we expect high levels of delta smelt salvage in the spring or summer?
Assessment of concern	I. If the stated recovery criteria index is lower than 239, then concern is high.
	II. If distribution information shows adults delta smelt are concentrated in the south and central Delta, then concern is high.
	III. If the observed or predicted salvage of adults increases sharply, then concern is high.
	IV. If fish at the salvage facilities are on the verge of spawning and temperatures are conducive to spawning, then concern is high.
Recommendations	A) If concern is high and salvage increases abruptly, then recommendations for action is likely.
	B) If the observed or predicted salvage is at or approaching the red light or at the yellow light, then a recommendation for action is likely.
	C) If assessments II and I are true, then we expect a difficult spring or summer (June and July).
Life stage	**Larvae**
Timing	VAMP (April 15 through May 15)
Concerns	High numbers of larvae in the south Delta will likely result in higher numbers of fish rearing to juvenile stages and higher levels of entrainment.
Data of interest	Light traps surveys
	20-mm survey[b]
	Water temperatures
	Salvage[c]
	Hydrology (wet or dry year; placement of X2)
Assessment of conditions	Spawning distribution
	Percent distribution

[a] Yellow light and red light as defined in the 1995 OCAP opinion.
[b] If fortnightly 20-mm survey is occurring and red light occurs, then effort will increase to weekly sampling.
[c] Salvage levels at this time will likely not reflect the number of delta smelt in the south Delta, since smelt begin to be counted at the salvage facilities at about 25 mm.
[d] The barriers shall be operated as stated in the USFWS biological opinion (1-1-96-F-53), April 26, 1996.
[e] Changes considered under "a" and "b" would aim to increase net positive flows in Old and Middle rivers downstream of the export facilities.