A Brief Description of Some Highlights of the 2002-2003 EWA Year: October 2002 through June 2003

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Introduction

The third fish-related operational year of the CALFED Environmental Water Account (EWA) commenced on October 1, 2002, when juvenile winter and spring Chinook salmon can be expected to start entering the Sacramento-San Joaquin Delta (Delta). The season ended June 30, 2003, when most delta smelt were distributed below the confluence of the Sacramento and San Joaquin rivers. This period also encompasses the time when juvenile steelhead and Sacramento splittail are in the Delta and subject to the effects of the State and federal water project operations. By means of the EWA, CALFED and resource agency managers may take actions to protect these four fish species – mostly in the Delta, but also on streams above the Delta such as the American River.

Activities associated with the EWA – arranging water purchases, moving the water and reconciling the EWA water budget – continue throughout the year but in this report we focus on such fish-related information as flows, fish movement, pumping from the Delta by the State and federal water projects, salvage and loss of fish at the project intakes and EWA actions taken to protect fish. We do not attempt to quantify the benefits of these actions, although we do show the reduction in direct losses of winter Chinook salmon at the project intakes that can be attributed to EWA actions.

We do not describe the EWA itself, fish life histories or the Central Valley and estuarine ecosystem. Readers seeking such descriptions are referred to Brown and Kimmerer 2001a (available online at: http://198.31.87.66/pdf/2001_Delta_Smelt_Workshop.pdf), Brown and Kimmerer 2001b (http://198.31.87.66/pdf/2001_Salmonid_Workshop.pdf), Brown and Kimmerer 2002 (http://198.31.87.66/pdf/2002_Salmonid_Workshop_Summary.pdf), White et al. 2001 (http://198.31.87.66/pdf/2001_EWA_Science_Review_Workshop.pdf) and White et al. 2002 (http://198.31.87.66/pdf/EWAReviewFinal_1-27-03.pdf). We should mention that the general EWA process for developing fish actions this past year continues to involve data collection and reporting and Data Assessment Team (DAT) conference calls at least weekly. Any recommendations for changes in project operation are developed by the DAT. The CALFED Water Operations Management Team (WOMT) meets weekly to consider DAT recommendations and modify project operations as needed. DAT members use salmonid and delta smelt decision trees to help develop their recommendations. The decision trees evolve each year as new information is gained.

This report is written by us, the EWA science advisors, to the CALFED Lead Scientist to provide a brief description of EWA fish year. The data and information in this report are collected by various agencies. We are indebted to many people for the data, but in particular to Erin Chappell (DWR), Tracy Pettit (DWR), Kevin Fleming (DFG) and Steve Foss (DFG) for compiling the raw data into informative summary tables and graphs. Sheila Greene (DWR) made the calculations to estimate the numbers of Chinook salmon that were not lost at the project intakes because of temporary pumping reductions called for by EWA fish actions. We have included a map of the San Francisco Estuary (Figure 1) to help identify some of the geographic locations mentioned in the text.

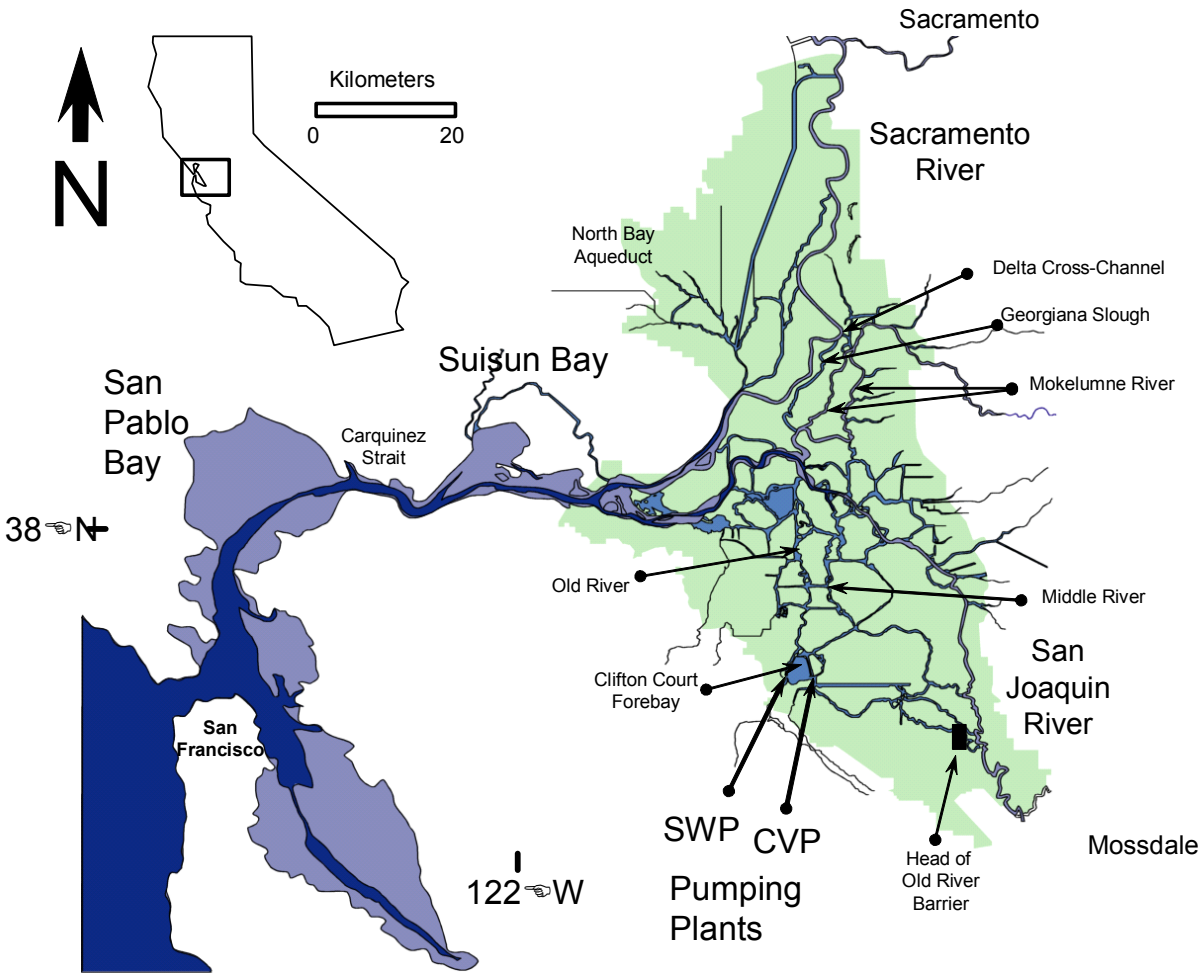


Figure 1 Map of the San Francisco Estuary

Flows

We use two flows – combined flows from the Sacramento and San Joaquin rivers and Delta outflow – to illustrate flow patterns in the 2002-2003 EWA year. Two caveats to keep in mind when considering these flows:

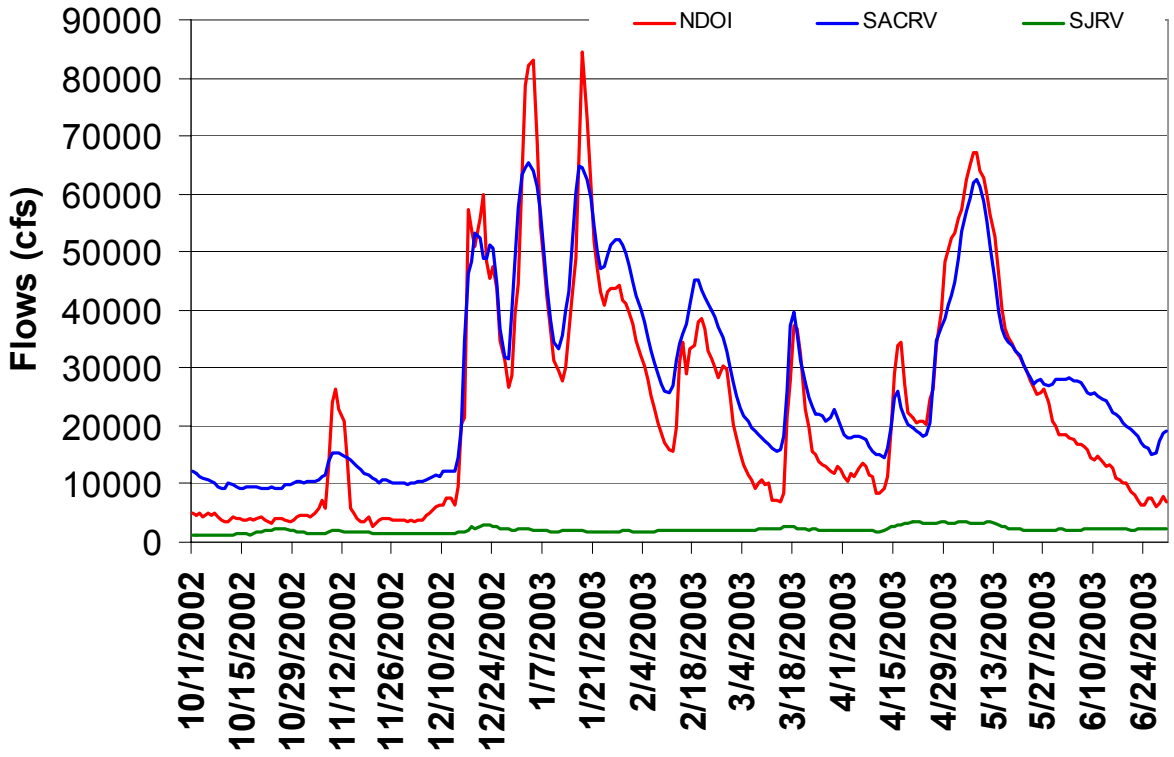
- Flows from the Sacramento and San Joaquin valleys are the result of natural hydrology (direct precipitation and snow melt) and artificial conditions caused by operations of the numerous reservoir operations in both valleys. Reservoir operation in turn is affected by flood control considerations, forecasted precipitation, in-stream flow requirements and agreements for water quality and fish protection, and, in the case of State Water Project and Central Valley Project reservoirs, Delta protection and water supply needs. The upshot is that during much of the year inflows to the Delta are controlled.

- Delta outflow is a calculated value derived from inflows, direct precipitation on the Delta, estimated net in-Delta water use and project pumping from the South Delta. The values used

in this summary are from the water project operations office. DWR's DAYFLOW program also provides estimated Delta outflow but these values are not available on an operational basis. From a ecosystem perspective the biggest limitation to the estimated outflow values is that they do not take tidal flows into account. On short term basis – from one to several days – this limitation may be important: for example when evaluating the effects of flow on the fate of tagged salmon released in the Delta at a particular tidal stage.

The 2002-2003 EWA year included a relatively wet December followed by dry conditions during the typically rainy months of January through March. April and early May were again wet (Figure 2). These early flows and resulting forecasts are used to help determine how much water will be delivered by the State and federal water projects. Delta smelt take limits at the pumps are also determined by water year classification.

A wet spring helped lift the water year to a below normal water year classification.



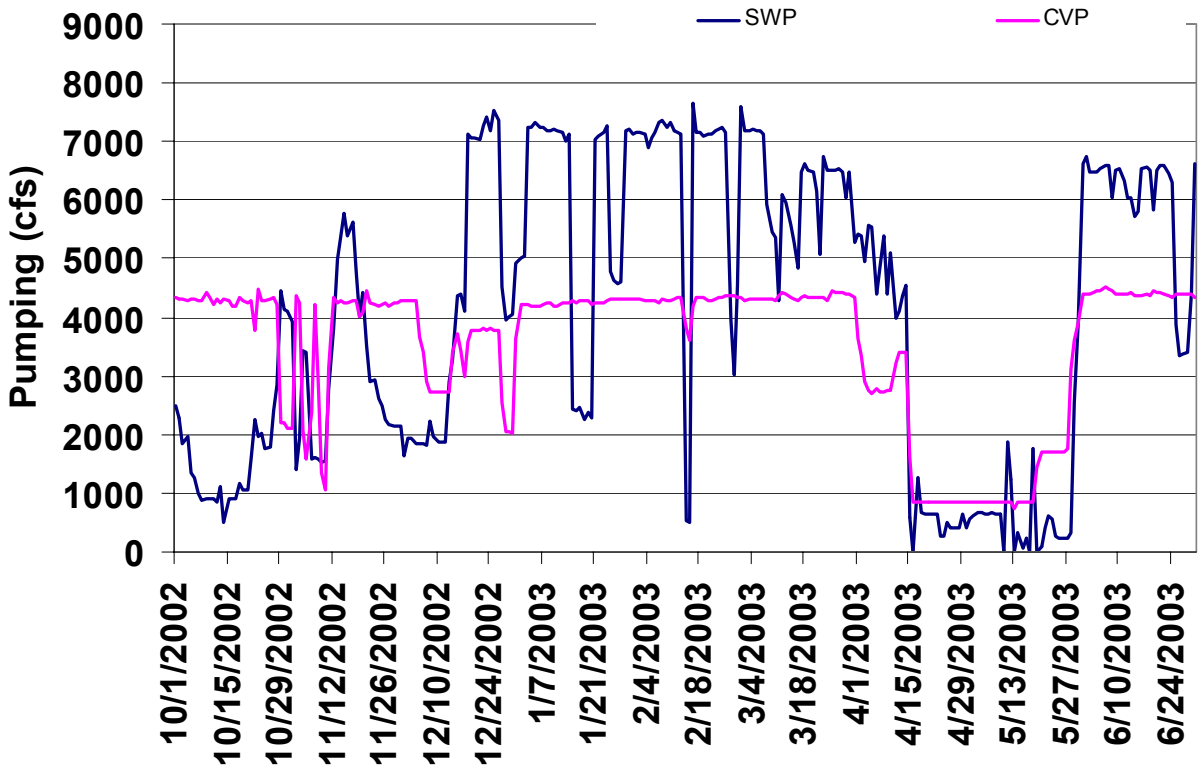
*Preliminary data from DWR O&M

Figure 2 Sacramento River, San Joaquin River, and Net Delta Outflow, October 2002 - June 2003

Project Pumping

As has been mentioned in previous reports, project pumping is a complex function of reservoir storage (upstream and downstream of the Delta), precipitation (including snowpack), demand, flood control considerations, water quality and environmental considerations (including Export:Inflow ratio, X2 and outflow requirements) and pumping capacity itself. In general, and all things being equal, the Central Valley Project (CVP) tends to pump near capacity 24 hours a day, 7 days a week. Because of greater pumping capacity, thus operational flexibility, State Water Project (SWP) pumping is typically more variable on a daily and weekly basis.

Project pumping in the 2002-2003 EWA year (Figure 3) illustrates the expected pumping patterns. Pumping increased in November and December to capture some of the early inflow, and the CVP remained at near capacity until the start of the Vernalis Adaptive Management Plan (VAMP) experiment on April 15. The SWP pumping was more variable, in part due to EWA related curtailments, and was also reduced on April 15 for VAMP. Although the VAMP experiment terminated on May 15, and river flows were relatively high due to the wet spring, at the request of the management agencies, the project operators ramped up pumping over the period from May 15 through June 1, 2003. This fish action to protect delta smelt is described in more detail later in this report.



*Preliminary data from DWR, O&M

Figure 3 State Water Project and Central Valley Project pumping, October 2002 - June 2003

Juvenile Production Estimate, Fish Abundance, and Take

In 2002-2003 most of the EWA water was allocated to reducing the direct and indirect effects of the project exports from the Delta on Chinook salmon and delta smelt and to support VAMP and post VAMP pumping reductions. Although information on the numbers and sources of salvaged steelhead rainbow trout (hatchery versus naturally produced) was also considered when making EWA related decisions, steelhead protection was never the overriding factor. Salvage of Sacramento splittail, listed by the U.S. Fish and Wildlife Service (FWS) as threatened until September 22, 2003, was also monitored, but EWA water was not allocated specifically to protect splittail. (On September 22, the FWS decided to delist the Sacramento splittail.) One of the overall considerations in use of EWA water is that pumping curtailments and flow increases have general benefits to the biological community, including steelhead and splittail.

Chinook Salmon

All four Central Valley Chinook salmon races are considered in the allocation of EWA resources, although much of the attention focuses on the two listed races: spring and winter Chinook. Fall run protection may come into play when large numbers of fingerlings begin showing up in the Delta (and at the pumps) – San Joaquin fall Chinook protection is a major VAMP goal. Releases of late fall hatchery Chinook are used as surrogates for yearling spring run. Finally, the category of older juveniles, as used by the DAT, can include all four races.

The 2002-2003 Juvenile Production Estimate (JPE). For the second year in row the management agencies used a revised method to estimate the numbers of naturally spawned and hatchery winter Chinook that would be expected to enter the Delta during their fall through spring outmigration. The JPE is in turn used to calculate the take limits at the project intakes. See Brown and Kimmerer 2002 for a discussion of the changes made in calculating the JPE. Please note that both the original and revised methods are based on several assumptions and the estimates should be viewed as just that – estimates. Table 1 contains the values used to develop the 2002-2003 JPE.

It may be worth making a few observations about the data in this table.

- The total estimated escapement – using carcass survey methods – was one of the highest in recent years and shows the continued adult winter Chinook recovery from less than 200 fish in 1989.

- The percent females and grilse are from the carcass surveys.

- The number of eggs per female is from females taken into the Livingston Stone National Fish Hatchery.

- Egg to smolt survival is based on experimental data from FWS studies at the Tehama-Colusa experimental spawning channel

- Estimated survival to the Delta is the average survival noted of six years (1994-1999) of differential ocean recovery rates of paired hatchery juvenile late fall Chinook releases from Battle Creek and the lower Sacramento River.

- The 2002-2003 hatchery production was the highest on record.

- The bottom line for naturally spawning winter Chinook was DAT would be using about 20,000 and 40,000 as the yellow and red lights respectively when contemplating EWA actions. Note also that the percentages used to calculate yellow and red lights differ between hatchery and wild fish.

Table 1 The 2003 JPE and supporting data

Winter Run Chinook Salmon Juvenile Production Estimate 2002-2003	*Carcass Survey Factors*	*Carcass Survey Estimate*
Total In-river Escapement		7,337
Adult Female Estimate	0.783	5,745
Estimate of Female Spawners	0.013	5,670
Average Fecundity	4923	27,914,334
Egg Loss Due To High Temperature	0.002	55,829
Total Viable Eggs		27,858,505
Estimated Survival - Egg to Smolt	0.1475	4,109,130
Estimated Smolt Survival to Delta	0.52	2,136,747
Total Natural Production Entering Delta		2,136,747
Livingston Stone Release - 01/30/03		233,879
Total Hatchery Production Entering Delta	0.52	121,617
Yellow Light Level (1.0% Natural)		21,367
Yellow Light Level (0.5% Hatchery)		608
Red Light Level (2% Natural)		42,735
Red Light Level (1.0% Hatchery)		1,216

At the Delta project intakes, winter Chinook take is based on calculations described previously by Brown and Kimmerer 2001 and 2002. The principal feature of this method includes use of the length at date system to determine race and to calculate take from salvage using a series of factors to account for pre-screen and other losses as fish attempt to move through the screening system for eventual release of salvaged fish away from the pump intakes.

Salmon Movement and Take. Figures 4 and 5 show the general pattern of the timing of older juvenile salmon movement down the Sacramento River through the Delta and to the salvage facilities. Note that most of the older juveniles have left the upper river by January 1. Figure 6 illustrates movement of spring and fall Chinook from Mill, Deer, and Butte creeks. Finally Figure 7 plots the observed SWP and CVP salvage of all Chinook salmon on fork length and date axes. A caveat about Figure 7 is that the lines used to designate salmon races must be used with caution. For example, the information from hatchery releases of known races demonstrates that most of the fish in the winter run length category are hatchery late fall run. On the other hand, genetic analysis demonstrates that most genetic winter run fall within the winter run lines.

The calculated take of naturally spawned juvenile winter Chinook for 2002-2003 was 6,809 – well under the yellow light limit of about 20,000 fish. On the other hand, there were an estimated 580 hatchery reared juvenile winter Chinook lost at the pumps. For hatchery juveniles, the percent loss reached the yellow light level of 0.25%. The winter run hatchery fish provide an idea of the migration of known fish through the Delta. The fish were released near Redding on January 30, 2003, and the first fish from this release was recovered at the salvage facilities on about one month later on February 24. The last fish from this release group collected at the salvage facilities was on May 6, 2003. More hatchery winter run were collected at the salvage facilities this past year than any previous year. This is likely to due to a combination of the large numbers of fish released in January but, as shown below, perhaps a combination of good downriver survival and flow and pumping conditions also contributed to their arrival at the salvage facilities in greater numbers.

Higher than usual occurrence of juvenile hatchery Chinook in the salvage was not limited to winter run. As in the past few years, hatchery late fall run have been used as surrogates for yearling spring run and take limits developed for releases upstream and in the Delta. Table 2 tabulates the release dates, the numbers released, the calculated losses and the take limits. Of eight releases, take at the salvage facilities exceeded the yellow light on two occasions, and estimated take exceeded the red light values on four occasions. Management agency biologists are looking into the factors that might have caused the high take of these surrogate fish.

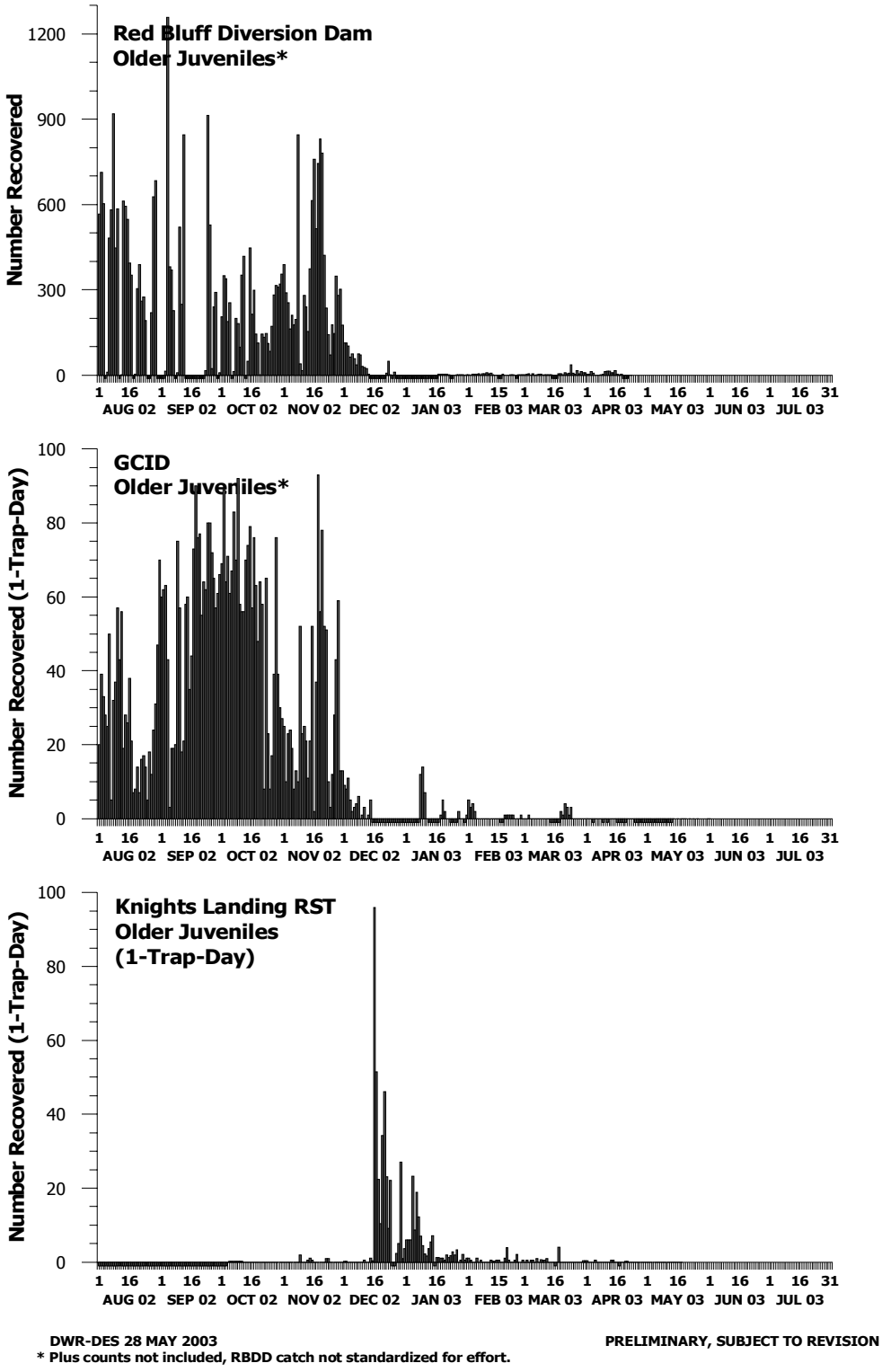


Figure 4 Number of juvenile Chinook recovered in the Sacramento River - rotary screw trap data

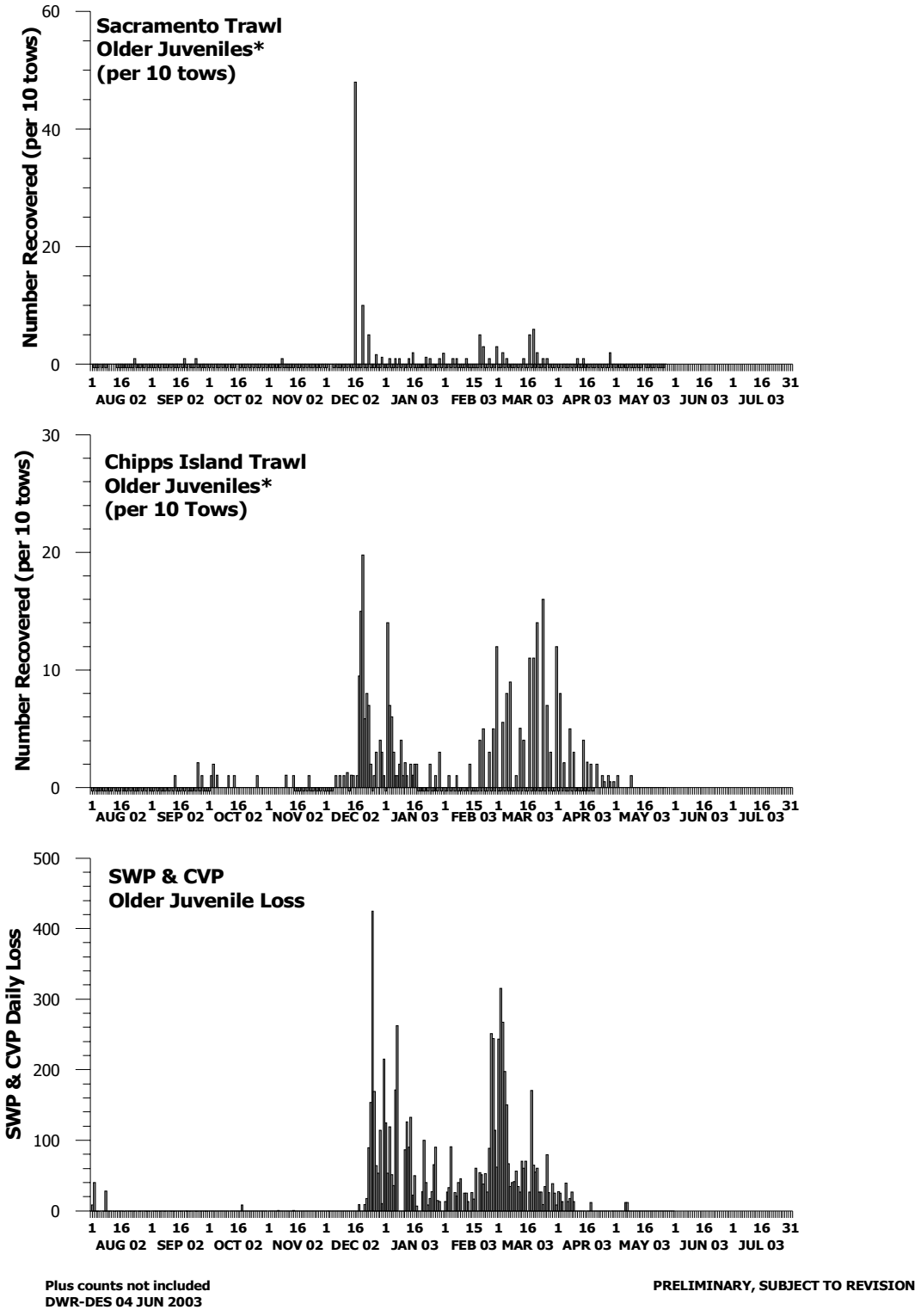


Figure 5 Number of juvenile Chinook recovered in the Sacramento River and Delta

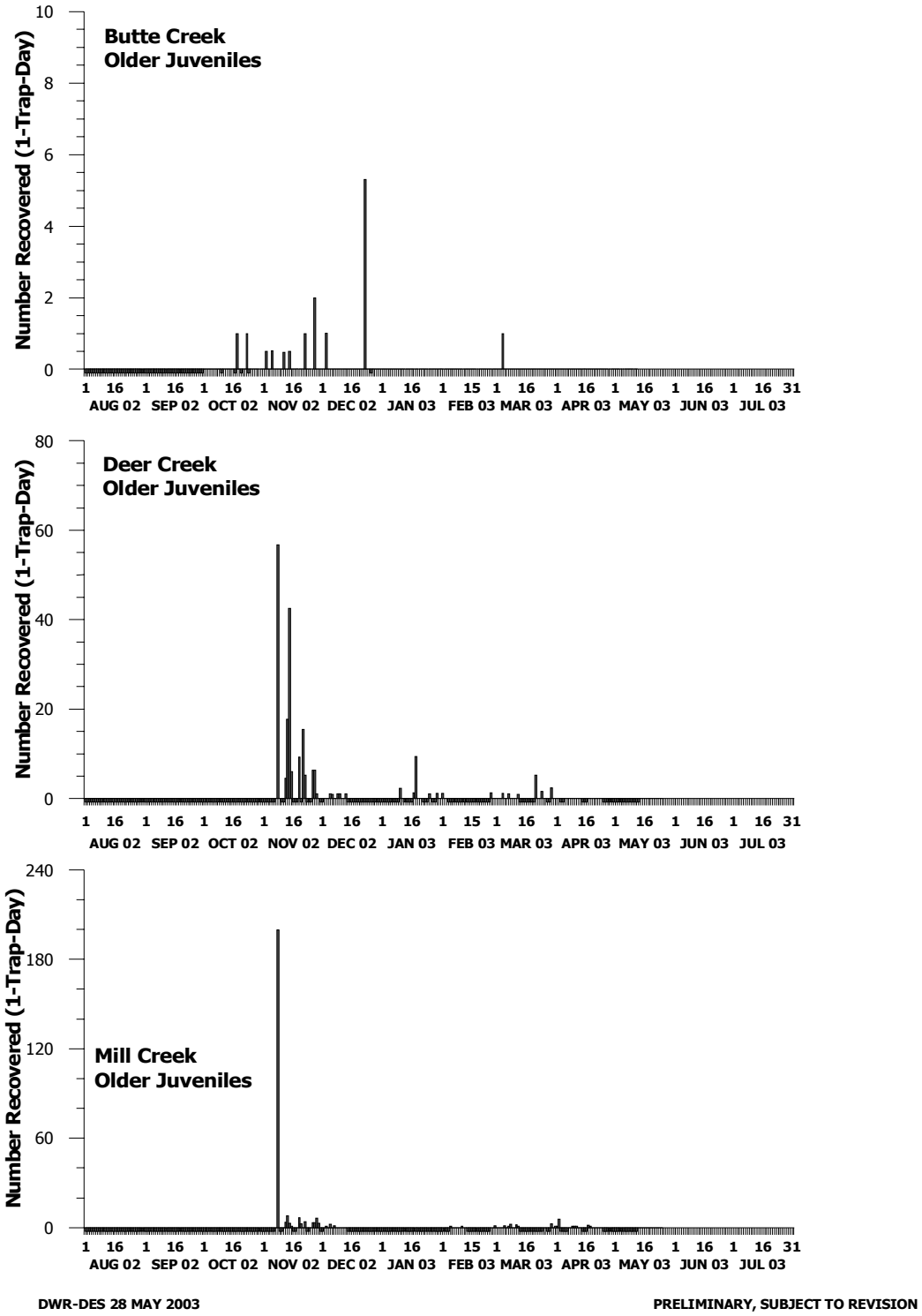


Figure 6 Number of juvenile Chinook recovered in the Sacramento River tributaries, rotary screw trap data

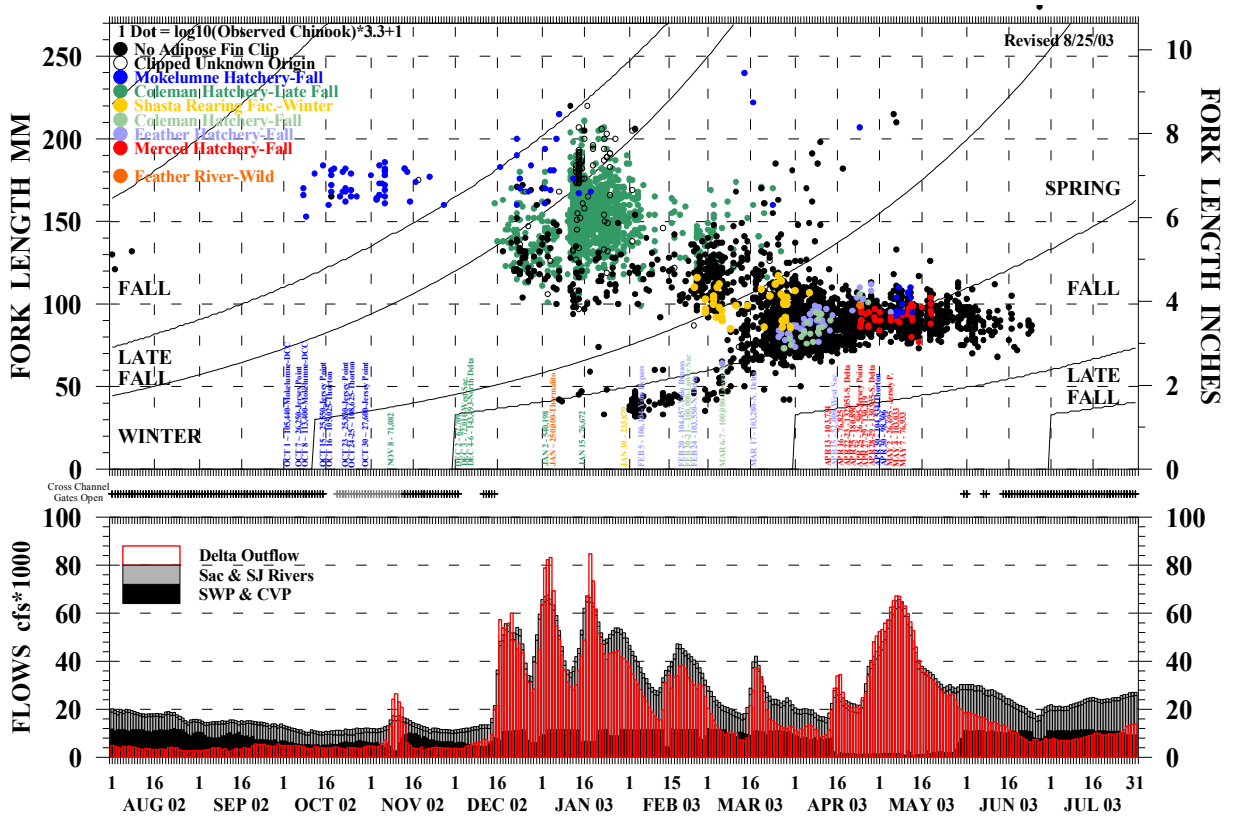


Figure 7 Observed Chinook salvage at the SWP and CVP Delta Fish Facilities, 8/1/2002 - 7/37/2003

Table 2 Coleman National Fish Hatchery tagged late releases and losses in 2002-2003. Underlined text indicate the releases where either the yellow or red light take was exceeded.

Release date	*Release site*	*Number released*	*Estimated loss*	*% Loss*	*Yellow light*	*Red light*
11/08/02	Battle Creek	71,082	202	0.28	0.5%	1.0%
12/02/02	Battle Creek	62,709	756	1.21	0.5%	1.0%
12/03/02	West Sac	72,010	1261	1.75	1.0%	2.0%
12/04/02	Georgiana Sl.	35,244	425	1.21	1.0%	2.0%
12/05/02	Georgiana Sl.	56,013	1689	3.01	1.0%	2.0%
12/06/02	Ryde	52,236	97	0.19	1.0%	2.0%
1/02/03	Battle Creek	540,198	17,784	3.29	1.0%	2.0%
1/15/03	Battle Creek	76,672	1037	1.35	1.0%	2.0%

Delta Smelt

Since most of the EWA actions affecting smelt are geared to limiting take at the pumps, we first show the take limits by month and year type (Table 3). These limits are based on historical salvage and unlike salmon, the numbers are defined as salvage, not calculated smelt losses. This difference is due to the lack of information on predation losses in Clifton Court Forebay, screen efficiency, and smelt losses during the handling and hauling process. In addition, larval and post-larval smelt readily pass through the louver fish screens and thus don't show up in the salvage.

Table 3 Monthly delta smelt take limits at CVP and SWP intakes

Month	*Above Normal*	*Below Normal*
Jan	5,397	13,354
Feb	7,188	10,910
Mar	6,979	5,368
Apr	2,378	12,345
May	9,769	55,277
Jun	10,709	47,245
Jul	9,617	35,550
Aug	4,818	25,889
Sep	1,329	1,978
Oct	11,990	6,440
Nov	3,330	2,001
Dec	733	8,052

There is no JPE for delta smelt – year class strength (abundance) is tracked by a variety of gear types which sample the animals at different life stages from larvae (the 20-mm survey) to pre-adults (the fall mid-water trawl). The CVP and SWP salvage estimates also provide some idea of year class strength, although the salvage numbers severely under-represent the early life stages and do not reflect the smelt numbers when most of the animals are located downstream of the confluence of the San Joaquin and Sacramento rivers. The fall mid-water trawl index (an index developed from separate sampling runs taken in September through December each year) may be the most reliable indicator of year class strength and the FWS delta smelt recovery criteria are based on this index.

For purposes of this brief report, we will show data from the 20-mm survey, the combined salvage at the CVP and SWP intakes and the summer townet surveys. At the workshop the California Department of Fish and Game should be able to present the results of the first two months of fall mid-water trawl surveys.

20-mm Survey. This Interagency Ecological Program survey is designed to provide bi-weekly snapshots of the abundance and distribution of larval and post-larval delta smelt at numerous locations throughout the Delta, Suisun Bay, Montezuma Slough (in Suisun Marsh), and near the mouth of the Napa River. This survey was initiated specifically to provide near real-time data to help determine if project operations should be modified to protect smelt. The samples are sorted, identified and posted to the web within a couple days of collection. The DAT considers these data on their weekly conference calls. There is no index of smelt abundance developed from these data.

We thought it might be informative to simply display the series of maps showing early life stage delta smelt distribution from around the first of April through the first of July 2003. The main points to be gained from these 2003 maps are that larval and post larval smelt are in the system for an extended period of time, during much of this time the fish are vulnerable to south Delta pumping, and that the center of smelt distribution moves north and west until, in most years, it is below the confluence of the San Joaquin and Sacramento rivers. Note that these distributions were probably affected by a relatively dry late winter and a wet April and May.

Although not apparent in the data from one year, the numbers of delta smelt seen in the 2003 delta smelt surveys was low relative to other years and was cause for concern among fish biologists. As will be seen later, this concern resulted in fish actions to protect smelt.

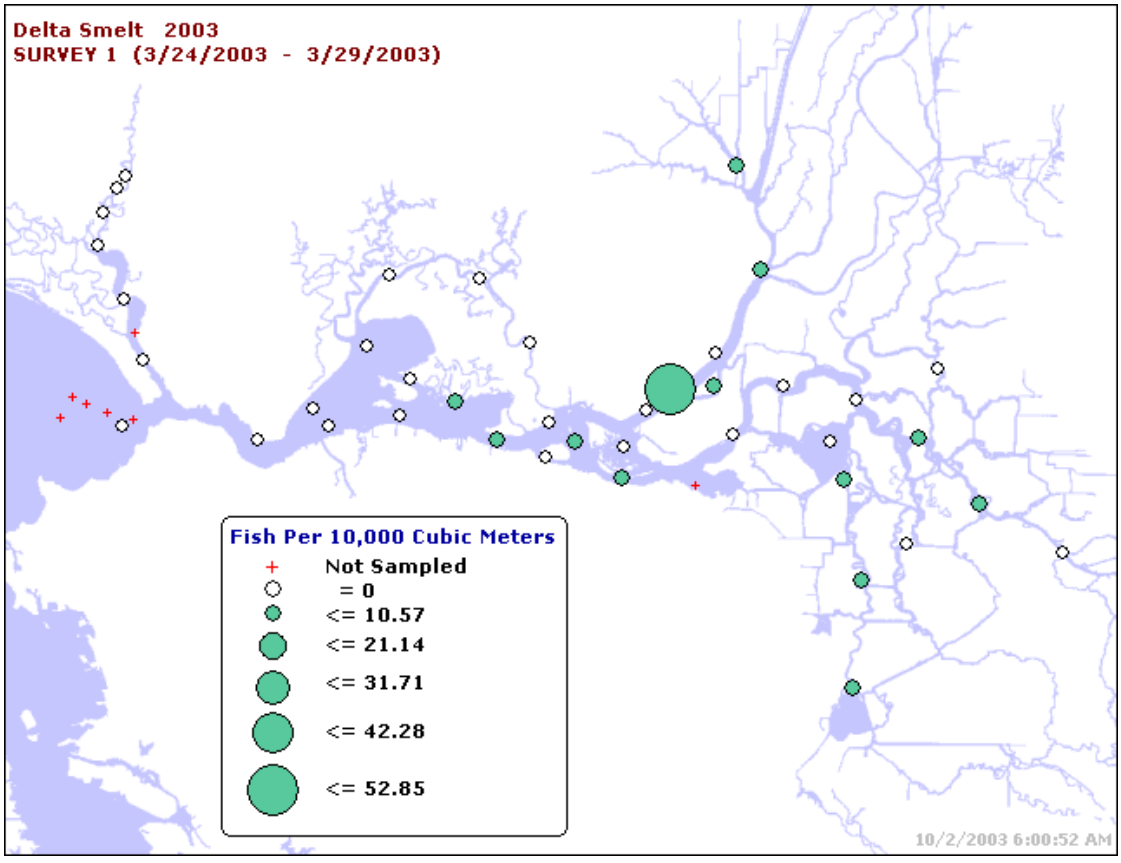


Figure 8 20-mm Survey 1 (3/24/2003 - 3/29/2003)

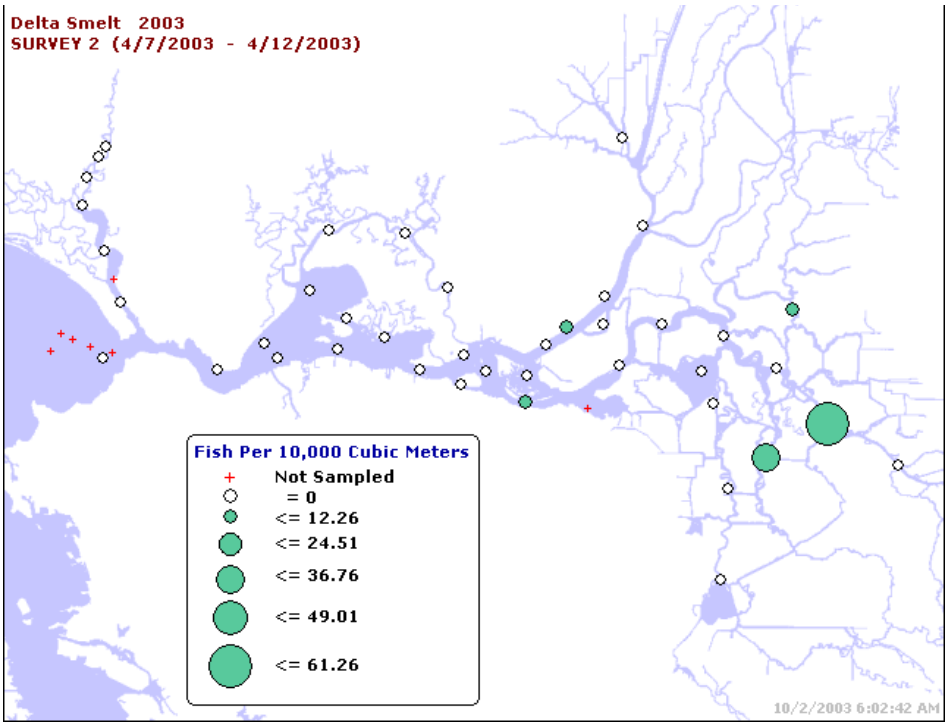


Figure 9 20-mm Survey 2 (4/7/2003 - 4/12/2003)

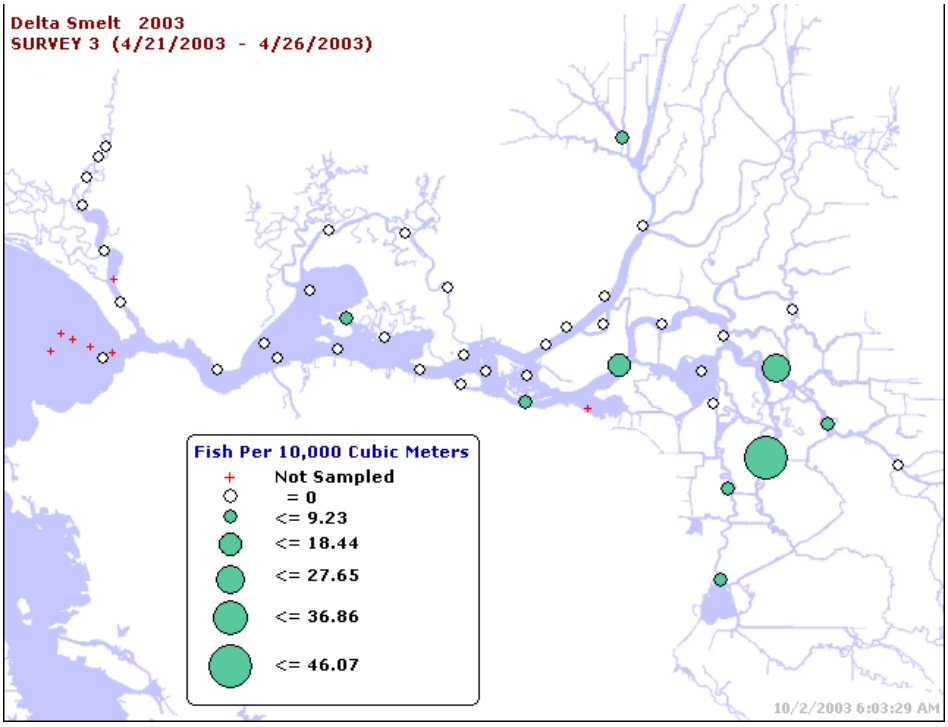


Figure 10 20-mm Survey 3 (4/21/2003 - 4/26/2003)

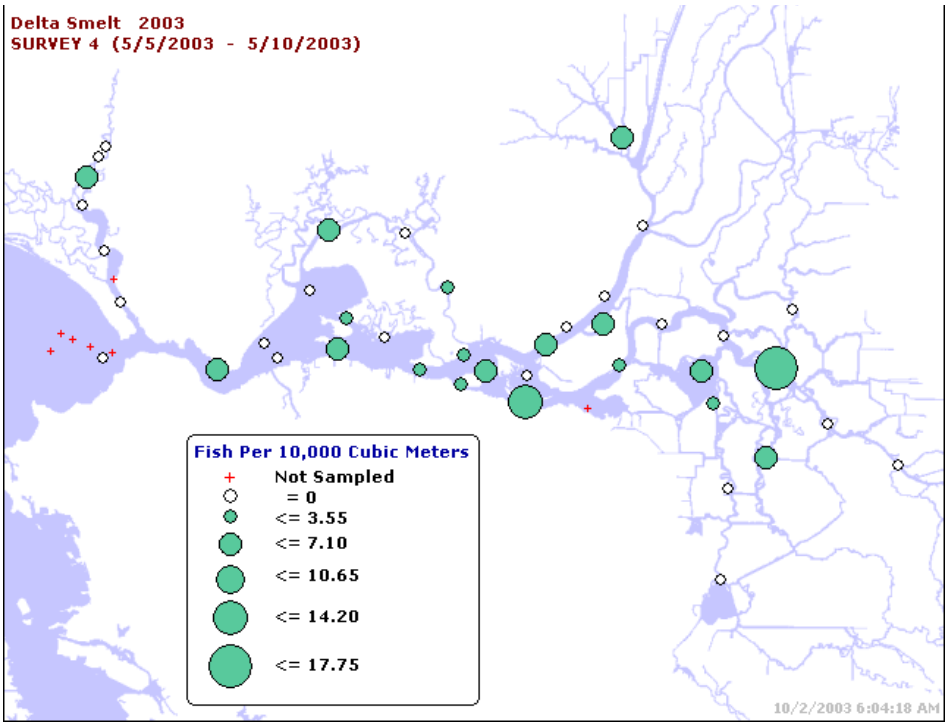


Figure 11 20-mm Survey 4 (5/5/2003 - 5/10/2003)

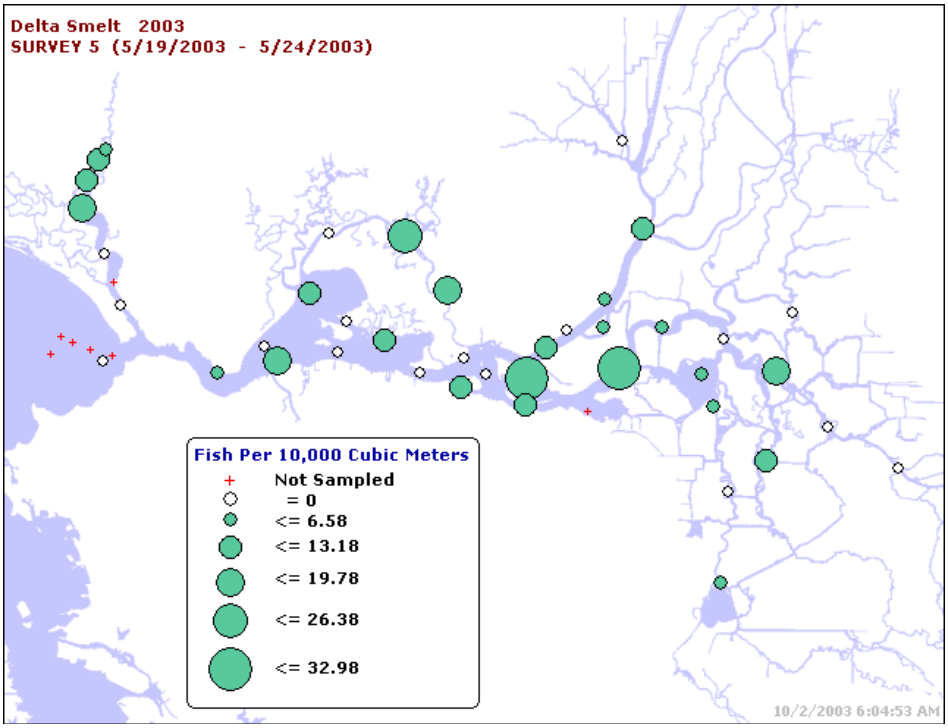


Figure 12 20-mm Survey 5 (5/19/2003 - 5/24/2003)

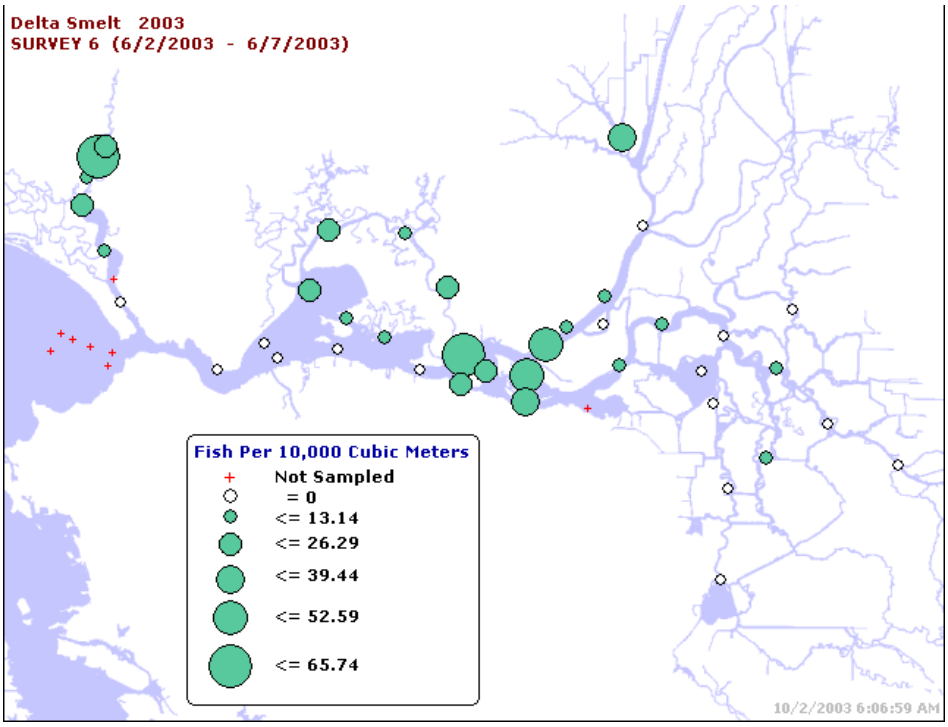


Figure 13 20-mm Survey 6 (6/2/2003 - 6/7/2003)

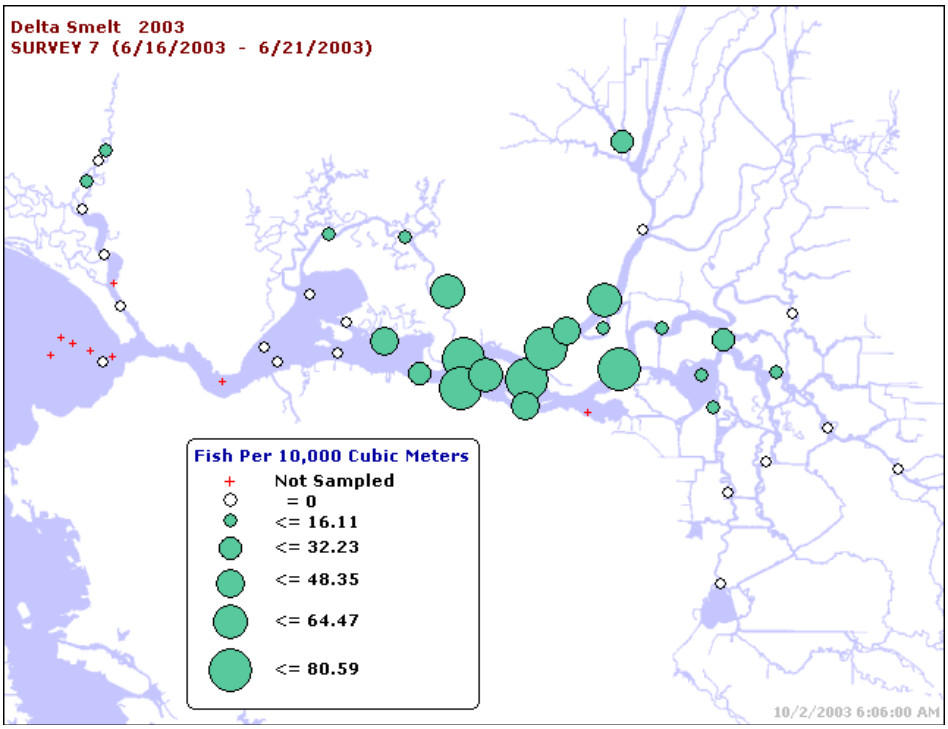


Figure 14 20-mm Survey 7 (6/16/2003 - 6/21/2003)

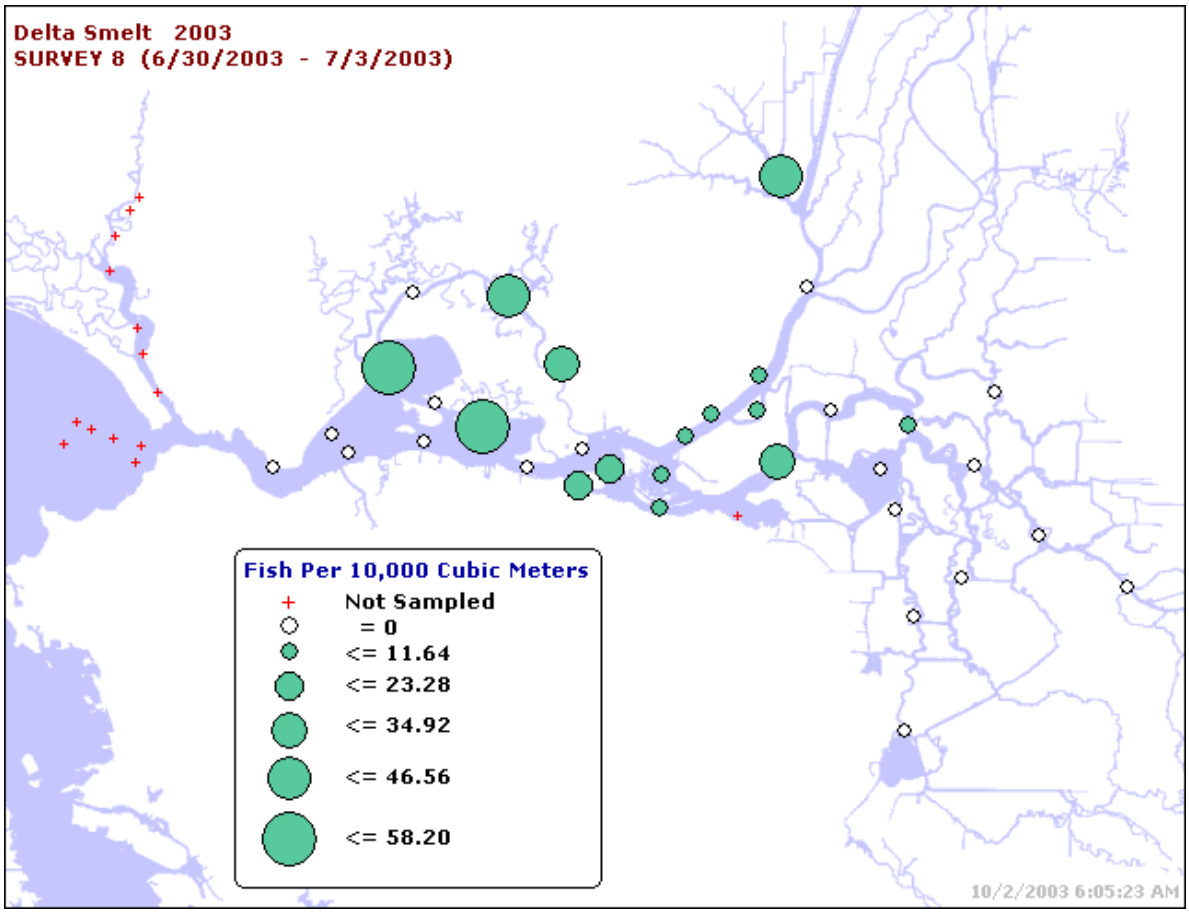


Figure 15 20-mm Survey 8 (6/30/2003 - 7/3/2003)

CVP and SWP Salvage. There are two take-related aspects of salvage that are particularly important to allocation of EWA assets – the 14-running average of combined salvage at the State and federal project intakes and the total monthly combined salvage. A 14-day running average of more than 400 delta smelt is cause for concern (the so-called yellow light) and fish biologists and operators may recommend EWA actions when this level is exceeded. The biologists and operators will generally recommend actions to prevent the monthly take limit from being exceeded. In 2003 the monthly take limit, for a below normal year, was generally not a significant concern, but there were times when the average daily take exceeded the 400 fish limit.

Figure 16 illustrates the 2003 salvage pattern at the State and federal intakes. Perhaps the most striking thing about the data in this graph is the clear difference between salvage patterns at the two facilities, in spite of the fact that the intakes are less than a mile apart. The data again demonstrate the likely importance of circulation patterns in affecting juvenile fish distribution and abundance.

Summer Delta Smelt Townet Index. The 2003 delta smelt townet index is 1.6, one of the lowest on record (Figure 17).

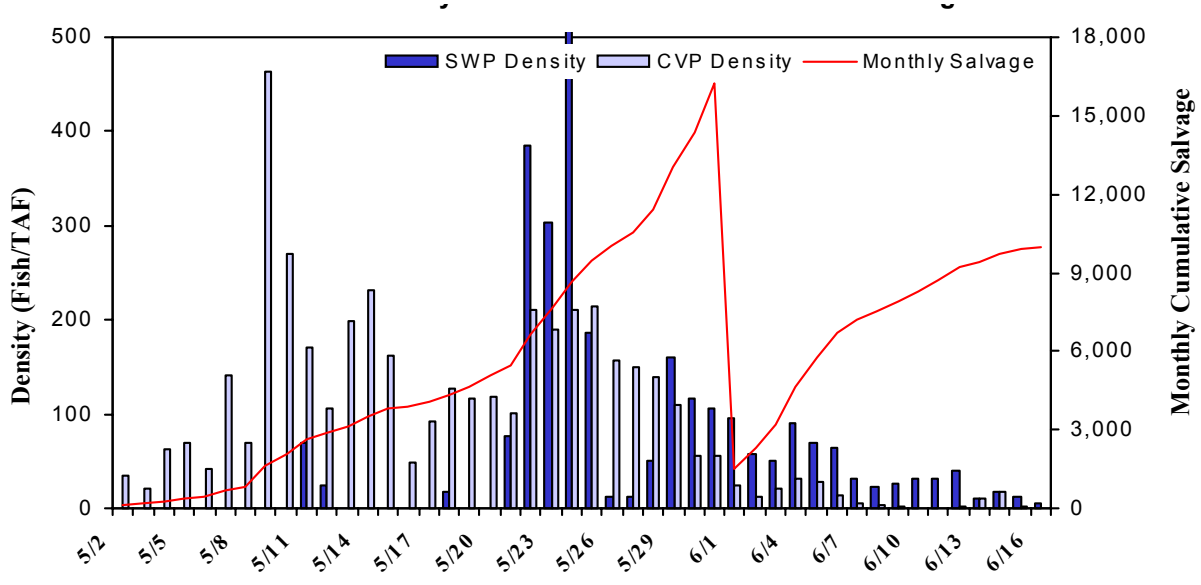


Figure 16 Delta smelt daily densities and cumulative salvage

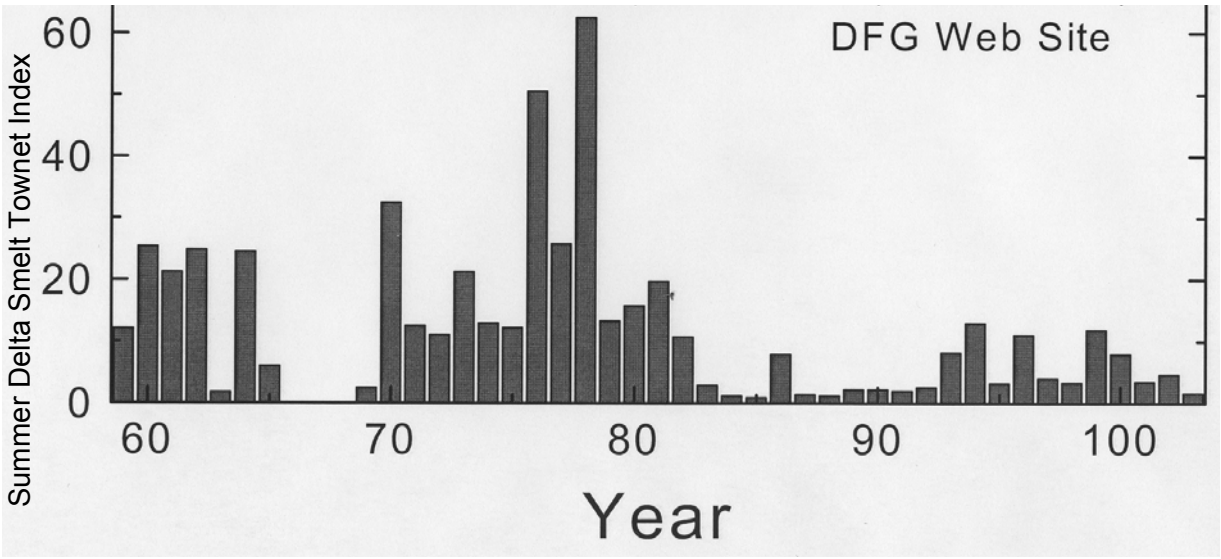


Figure 17 Summer delta smelt townet index

2002-2003 EWA Fish Actions

There were eight EWA fish actions in the 2002-2003 season (Table 4) that used a total of about 374,000 acre-feet of EWA water. As seen in Tables 5 and 6, the amount of water used is about intermediate between the water allocated in the first two years of the EWA. Note that one of the actions, on the lower American River, was a power exchange to provide cold water and did not require EWA water.

Table 4 Environmental Water Account 2001 Actions

EWA Action No.	*Date*	*Location*	*Benefits*	*Amount of Water (AF)*
1	January 17 - 21, 2001	SWP	Salmon/Steelhead	23,988
2	January 27 - 31, 2001	SWP	Salmon/Steelhead	45,468
3[a]	February 1 and 28, 2001	Lower American River	Salmon/Steelhead	21,000
4	February 1 - 5, 2001	SWP	Salmon/Steelhead	16,921
5	February 16 - 23, 2001	SWP	Salmon/Delta Smelt/ Steelhead	34,840
6	February 27 - March 11, 2001	SWP	Salmon/Delta Smelt/ Steelhead	82,410
7	April 5 - 9, 2001	SWP	Salmon/Delta Smelt/ Steelhead	20,492
8	April 20 - May 20, 2001	SWP	VAMP	42,884
9	May 21 - 31, 2001	SWP	Salmon/Delta Smelt	14,517
10	June 1 - 5, 2001	SWP	Salmon/Delta Smelt	8,874
			TOTAL	311,394

a. The cost to the CVP for implementing this action was included as part of the water year 2001 CVPIA 3406(b)(2) account and was determined by comparing the B(2) base case (D-1485) to actual operations.

Table 5 Environmental Water Account 2002 Actions

EWA Action No.	*Date*	*Location*	*Benefits*	*Amount of Water (AF)*
1	October 1 - 5 & October 28 - November 14, 2001	Lower American River	Salmon/Steelhead	20,000
2[a]	November 14 - 26, 2001	Lower American River	Salmon/Steelhead	0
3	January 5 - 9, 2002	SWP	Salmon/Delta Smelt	66,402
4	February 1 - 16, 2002 & February 19 - 26, 2002	SWP		75,952
5	March 23 - 29, 2002 March 30 - April 8, 2002	SWP	Delta/(Conversion) 2:1 Exchange	38,146 40,011
6	April 15 - May 15, 2002	SWP	VAMP	45,4227
7	May 16 - May 31, 2002	CVP/SWP	Salmon/Delta Smelt	69,452 69,915
8	June 1 - June 2, 2002	CVP/SWP	Salmon/Delta Smelt	2,432 2,741
			TOTAL	422,473

a. Folsom Dam bypassed generation between November 10 and 26, 2001. EWA repaid the CVP between November 22 and 30, 2001. The amount of power exchanged was 4,276 MWH.

Table 6 Environmental Water Account 2003 Actions

EWA Action No.	*Date*	*Location*	*Benefits*	*Amount of Water (AF)*
1	September 14 - October 6, 2002	Lake Oroville	Exchange of Assets in San Luis Reservoir	20,000
2[a]	October 25 - November 19, 2002	Lower American River	Salmon/Steelhead	0
3	September 1-2 & 8-9, 2002 December 4, 2002 December 20 - 29, 2002	Lower American River	Salmon/Steelhead	323 622 4,646
4	December 27, 2002 - January 2, 2003	SWP	Salmon/Delta Smelt	41,422
5	January 15 - 20, 2003	SWP	Salmon/Delta Smelt	59,501
6	January 25 - 28, 2003	SWP	Salmon/Delta Smelt	20,428
7	April 15 - May 15, 2003	SWP	VAMP	31,776
8	May 16 - 31, 2003	SWP CVP	Delta Smelt	168,968 25,799

a. Folsom Dam bypassed power generation between October 25 and November 19, 2002. EWA provided funding to Western Area Power Administration to purchase power as reimbursement for foregone power generation between October 25 and November 19, 2002. The amount of energy purchased was 6.52 GWH.

Below is some additional information on the each of the fish actions, as extracted from the reports of the actions prepared by the project agencies. Note that the final accounting for all actions is not complete and there may be minor changes in the amount of water allocated.

Fish Action #1. The SWP was able to back (exchange) 20 thousand acre-feet (TAF) of water for the EWA into Lake Oroville between September 14 and October 6, 2002. This included a 20% carriage water loss. It was not a 1:1 exchange – the South of Delta equivalent is 16 TAF. In April 2003, Oroville made release for flood control purposes and this 20 TAF was spilled.

Fish Action #2. This action was taken to protect fall Chinook spawning in the lower American River. To provide more cold water from Folsom Reservoir, CVP operators bypassed about 13,000 acre-feet around the generators, at an estimated power loss of 6.52 GWH. EWA funds were used to compensate the Western Area Power Administration for the lost power.

Fish Action #3. This action was taken to stabilize base flows and protect suitable spawning conditions and egg incubation for steelhead and fall Chinook in the lower American River.

Fish Action #4. This action was based on a DAT recommendation to reduce pumping for several days to protect older Chinook juveniles, both winter and spring Chinook. Although designed primarily to protect salmon, pumping reduction was expected to benefit pre-spawning delta smelt as well.

Fish Action #5. This seven-day curtailment at the SWP was designed to protect pre-spawning delta smelt and called for when the 14-day salvage exceeded 400. Almost of the fish were being salvaged at the SWP.

Fish Action #6. This five-day curtailment at the SWP was taken when the salvage of surrogate spring run (tagged late fall Chinook from the Coleman National Fish Hatchery) began to approach the take limits. Not all the tags had been decoded at the time of the recommendation, but results indicated that the unread tags would likely result in the limit being exceeded.

Fish Action #7. This action was taken to compensate the SWP for losses of pumping during the one-month study of the effects of flow and pumping on fall Chinook emigrants from the San Joaquin system (The Vernalis Adaptive Management Plan). Although principally a salmon action, reduced pumping is expected to benefit delta smelt as well.

Fish Action #8. This action was based on a Delta Smelt Workgroup Recommendation to ramp up pumping after the conclusion of VAMP – the so-called shoulders on VAMP. Although take at the pumps was below the allowable level for May, the workgroup considered the low numbers of smelts seen in the sampling program and their distribution when making this recommendation.