

# Environmental Water Account Expenditures for the Protection of the Delta Smelt in Water Year 2005

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## Introduction

The purpose of this document is to summarize the expenditure of Environmental Water Account (EWA) assets for the protection and recovery of the federally-listed delta smelt (*Hypomesus transpacificus*). Because this is the fifth in a series of reports written with the same general purpose and audience in mind<sup>1</sup>, significant background information has been omitted and some prior knowledge of the operation of the State Water Project, Central Valley Project and the EWA is assumed. This report also summarizes the status of delta smelt, the activities of the Delta Smelt Working Group, and environmental conditions in the Delta during water year (WY) 2005. A brief, general discussion of the performance of the EWA is presented.

Over the five years of EWA implementation, the use of EWA assets has shifted to reflect changes in understanding of species biology and of the ecology and physical processes operating in the Delta. Management of winter-run Chinook salmon is based upon a more accurate adult abundance estimate that led to an updated decision process. Use of assets for delta smelt focuses on SWP and CVP Delta export curtailments timed to protect spawning and pre-spawning adults and/or to promote young-of-the-year emigration from the Delta to Suisun Bay. Use of EWA for delta smelt is driven not so much by incidental take *per se* as by an assessment of overall trends in delta smelt abundance and distribution, reproductive potential and other relevant factors. Implementation of the 2005 Biological Opinion for the Operations Criteria and Plan (OCAP) (USFWS, 2005) is intended to monitor trends in delta smelt abundance and distribution and Delta conditions such as hydrology, risk of entrainment, spawning readiness, and water temperature, so that science-based recommendations for modifications to Project operations can be made proactively, to avoid instances of elevated incidental take.

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<sup>1</sup> Previous years' reports may be found on the web at [http://science.calwater.ca.gov/workshop/past\\_workshops.shtml](http://science.calwater.ca.gov/workshop/past_workshops.shtml) and clicking on "EWA Review"

## Delta Smelt Status

The delta smelt was listed as a threatened species effective April 5, 1993 by the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act (ESA) of 1973, as amended. On March 31, 2004 the Service completed a five-year status review for the delta smelt as a partial settlement for two lawsuits. The review concluded that the delta smelt population remains relatively low, compared to historical levels, and that many of the threats to the species identified at the time of listing still exist, precluding de-listing of the species (USFWS, 2004). Since that time, the 2004 Fall Mid-Water Trawl survey performed by the California Department of Fish and Game (CDFG) resulted in an index of 74 for delta smelt, the lowest on record. Recently, CDFG's 2005 Summer Tow-Net survey exhibited was 0.3 for delta smelt, also the lowest on record and an order of magnitude lower than the previous year's index of 2.9 (Table 1, Figure 1).

Preliminary estimates of extinction risk suggest that the ESA listing of delta smelt is justified (Bennett, 2005). The species shares many of the characteristics associated with increased risk of extinction, including small population size, restriction to a small geographic area, dependence on a narrowly-defined habitat, and relatively low fecundity (Williams et al., 2005, Bennett, 2005). Most of the postulated threats to the species, such as the presence of toxic contaminants, disease, changes in abundance and composition of food, and introduction of exotic species, are not readily remediable through the regulatory process, making the abatement of these threats problematic. This has resulted in a potentially inflated expectation for threat abatement via the modification of water project operations to reduce incidental take of delta smelt at the export pumps. However, the effects of entrainment losses, particularly in the south Delta, were implicated in the population collapse of delta smelt (Moyle et al. 1992, USFWS 1996). South Delta exports may be a factor limiting delta smelt recovery (Sweetnam and Stevens 1993). Entrainment loss may limit delta smelt populations in years when large numbers of larvae are entrained at the Central Valley and State Water Project plants (Moyle et al., 1992). Yet, the overall effect of exports on the delta smelt population is unknown, and difficult to quantify given the methods currently available (Bennett, 2005). Water operations and other potential causes of the decline are currently being investigated by the IEP's Pelagic Organism Decline Project Work Team (POD PWT), whose Management Team will hold a public workshop on November 14, 2005 to discuss the results of initial studies and plans for 2006. In addition, several other investigators are looking into these issues.

The 2004 Recovery Index was 25, the fourth-lowest recorded and well below the 2003 index of 101 (Table 1) and the target abundance criterion of 239<sup>2</sup> specified in the Recovery Plan (USFWS, 1996). The “concern level” of incidental take of adult smelt was set at 892, calculated from the Recovery Index as prescribed by the 2005 OCAP biological opinion (USFWS, 2005). Incidental take of delta smelt at the State and Federal export facilities was very low in WY 2005, relative to most of the previous ten years. Incidental take for December through June since the implementation of the EWA has ranged from 3,746 in WY 2005 to 66,526 in WY 2002 (Table 4, Figure 2).

### Delta Smelt Working Group

The Delta Smelt Working Group (DSWG) met either in person or by conference call eight times in water year 2005. Minutes of the meetings are available at [http://www.fws.gov/sacramento/es/delta\\_smelt.htm](http://www.fws.gov/sacramento/es/delta_smelt.htm). The DSWG’s purpose and charge are described in the 2005 OCAP biological opinion (USFWS, 2005). Please see later sections of this report for detailed accounts of recommended fish actions.

The DSWG members met on October 21, 2004 to discuss study and monitoring plans for WY 2005 and to develop technical criteria for a potential export reduction in late March or early April, prior to the April 15-to-May 15 VAMP period (commonly referred to as a pre-VAMP shoulder). Because the 20-mm Survey does not sample delta smelt larvae well, a pilot larval sampling program was developed to investigate methods and determine the feasibility of such a survey. A significant linear relationship between the 20-mm Survey and Summer Tow-Net Survey abundance indices has led to the hypothesis that the strongest direct effect of exports is the entrainment of larvae too small to be collected effectively by the 20-mm Survey gear (CDFG, unpublished data). The DSWG members planned to emphasize the protection of the larval-to-juvenile life cycle phase in WY 2005. The potential to monitor water temperature to infer the presence of larvae was discussed.

The DSWG met on January 13, 2005 due to concern over the low Fall Mid-Water Trawl index. The California Department of Water Resources (CDWR) management had called for a briefing from staff outlining the problem, its possible causes, and recommendations for further studies (this effort would shortly grow into the IEP’s POD PWT).

The DSWG met by conference call on January 28 to discuss the exceedence of the adult incidental take concern level at the SWP/CVP diversions. The DSWG

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<sup>2</sup> The median of delta smelt fall mid-water trawl indices in pre-decline years

members recommended to the Water Operations Management Team (WOMT) that the Projects reduce exports to a combined level of 1,500 cfs for one week, to begin as soon as possible, with a provision for ramping up exports if incidental take declined. The WOMT considered the recommendation and implemented a modified plan, a reduction beginning February 2 to a combined export level of 3,000 cfs. Following a conference call on February 3 and review of monitoring data which indicated that daily take of delta smelt had declined, the DSWG members informed the WOMT that ramping up exports over three days beginning February 5 was acceptable.

At a March 10 meeting, the DSWG members discussed potential spring actions. The DSWG members believed that a pre-VAMP action could provide protection to newly-hatched larvae, and requested that DWR run particle tracking modeling (PTM) based on a set of input values that they provided. Initial runs were reviewed at a meeting on March 28, with unclear results due to difficulties inherent in the modeling. At a meeting on April 13 the DSWG members reviewed a second round of particle tracking modeling and the latest survey and monitoring data. The DSWG recommended a reduction in combined exports to 50% of the San Joaquin River (SJR) flow at Vernalis, to begin as soon as possible and continue until the scheduled start of the VAMP period on May 1, about two weeks later than normal due to high San Joaquin River flow. Preliminary proposals for VAMP curtailments, while expected to benefit primarily San Joaquin Chinook, were assumed to be adequately protective of delta smelt. No June curtailment was recommended.

On August 16 the DSWG members met to debrief its activities for WY 2005 and begin consideration of delta smelt status in WY 2006. In the future, the DSWG members will endeavor to improve its communications with the WOMT and others by preparing briefing statements for agency managers, sending a delegation to the WOMT when needed, and making its meeting minutes available in a more timely fashion. The DSWG members will clarify to management that it is available for briefings upon request of agency managers. The DSWG members believe that concern will remain high in 2006, and plan to monitor the 90% forecast and be prepared to formulate recommendations to protect delta smelt with minimal impact to Project operations. The DSWG members met again on August 31 to provide recommendations on the Delta Smelt Action Plan drafted by CDWR and CDFG.

### Environmental Conditions

Wetter-than-average conditions helped alleviate the drought conditions prevalent in much of the West over the past five years. Weak *El Nino* conditions in the Pacific contributed to the fifth-warmest December in North America on

record. Heavy precipitation from late December into early January and again near the end of January contributed to the heaviest Sierra snowpack in ten years by February 1. Precipitation totaled about 150% of average by January 31, comparing favorably to the 85% of average for the same time in 2004. February saw below-average precipitation, for a seasonal total of about 140% of average by the end of the month. The first half of March was warm and dry, raising concern for a repeat of the dry spring in 2004, but mid-month warming and storms resulted in moderate releases for flood control in some foothills reservoirs. By the end of March seasonal precipitation totaled about 140% of average and reservoir storage was about 105% of average, including San Luis Reservoir, which filled by mid-March. Stormy weather continued into April, slowing seasonal snowmelt in the northern and central Sierra. Precipitation through April 30 totaled about 135% of average, with runoff at about 80% of average, leaving a snowpack of about 150% of average on May 1 (NOAA, 2005; CDWR, 2005).

#### Expenditure of Environmental Water Account Assets/Delta Smelt Situation in WY 2005

The EWA acquires and manages assets to provide water for the protection and recovery of fish beyond water available through existing regulatory actions related to SWP and CVP operations (CALFED 2000b) at no uncompensated water cost to the Projects' water users. The EWA helps to avoid reaching the ESA Section 7 reconsultation level of incidental 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 reconsultation, interagency technical staff including the Data Assessment Team (DAT) and the Delta Smelt Working Group consider incidental take at the export facilities, physical conditions in the Delta, and the distribution and abundance of the species. When appropriate, they formulate a recommendation for a modification of Project operations, referred to as an "operational curtailment" or 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. The SWP and the CVP are later reimbursed for fish actions using EWA assets or other environmental water, such as Central Valley Project Improvement Act (CVPIA) §3406(b)(2) water.

Over its five years of implementation, the EWA has used an annual average of 269.8 TAF of water assets. Asset expenditure varies with Delta hydrology, the level of concern, and the immediate situation as indicated by real-time monitoring evaluated using established decision processes. Fish actions are relatively more costly in terms of assets in wetter years, as the amount of water required to reduce exports from the baseline level to a more protective level is

greater than in drier years. In WY 2005, a wetter year, the EWA used 339.1 TAF of assets, as compared to 290 TAF in 2001, 248 TAF in 2002 and 124 TAF in 2004, all drier years (Tables 2 and 3; Figure 8). The EWA has tended to expend more assets on average in May than in other months (Figure 7), as assets have been used to support the VAMP export curtailment annually and a post-VAMP shoulder in most years.

The implementation of fish actions using EWA assets can occur upstream of the Delta to augment stream flow and Delta inflow, or at the export pumps, to reduce the rate of pumping when at-risk native species appear in daily salvage at high numbers. Flow augmentation upstream of the Delta, which primarily benefits salmonids, is achieved by timing the movement of EWA assets to coincide with instream flow needs, to the extent practicable. Fish actions taken to protect delta smelt consist of export pumping curtailments, which directly reduce incidental take. Pumping curtailments from January through March protect pre-spawning and spawning adult delta smelt; actions taken in March may also protect newly-hatched larvae. Actions taken in April through June may protect late-spawning adults and young-of-the-year. Early life-stages less than 20 mm in length are too small to be identified and counted in daily salvage operations, however, once spawning has begun the take of these individuals is assumed to occur, even though it cannot be quantified or evaluated by existing monitoring programs.

Protection of both adults and young-of-the-year (YOY) delta smelt may be important when abundance indicators are low and density-dependent effects would not be expected to influence annual production. In WY 2005, the need for fish actions was assessed following the delta smelt decision process contained in the revised OCAP Biological Opinion (USFWS, 2005). The Delta Smelt Risk Assessment Matrix (DSRAM) was formulated by the Delta Smelt Working Group, building on the earlier decision process and incorporating more recent science, to better reflect the process used by the DAT in evaluating real-time monitoring data. The 2005 OCAP biological opinion sets a new “concern level” based upon apparent abundance from the Fall Mid-Water Trawl (FMWT) and contains a new incidental take statement based upon historic levels of incidental take of delta smelt by the Projects (Table 4).

### January

The EWA began WY 2005 with a debt to the Projects of approximately 15 thousand acre-feet (TAF), and Delta Action 8 (December) required less than 10 TAF of EWA assets to implement. At the beginning of January, flows were high, water quality was good and the Delta Cross Channel gates were closed due to flow levels on the Sacramento River. The Projects declared excess conditions in

the Delta as of December 31. Incidental take of delta smelt began at the CVP on January 4 and at the SWP on January 12. The SWP began making Article 21 deliveries on January 12. Although take was low to moderate compared to other years, concern was high because of the record-low FMWT index. Available data on January 25 indicated that incidental take of adults would exceed the concern level of 892 by the end of the week (Figure 3), prompting a Delta Smelt Working Group conference call on January 28. The DSWG members considered:

- The low FMWT index, an indicator of high concern,
- Incidental take, which by the time of the call had exceeded the concern level,
- Proximity to the onset of spawning; Delta water temperatures were about 9<sup>0</sup> C and the captive smelt at the culture facilities had spawned the previous evening, and
- Preliminary results from the Kodiak Trawl Survey, which had collected only about half as many individuals as in the previous year, about half of which were located in the south Delta (Figure 5.a).

The DSWG members recommended an export reduction to a combined 1,500 cfs, to take effect January 31 (or as soon as possible) and continue for 7 days, unless incidental take of adult smelt appeared to peak prior to February 8. The Water Operations Management Team (WOMT) initially accepted the recommendation of the DSWG, but later, following discussion of environmental water assets available, implemented a reduction of exports beginning February 2 to a combined level of 3,000 cfs. The DSWG members also decided on January 28 to convey to WOMT its desire to pursue particle tracking modeling (PTM) to aid in formulating recommendations for potential configurations of the Head-of-Old-River Barrier.

## February

The Delta Smelt Working Group met again via conference call on February 3, to review the available monitoring data which indicated declining daily incidental take of delta smelt, and recommended to WOMT that exports remain at 3,000 cfs for one more day, and that ramping up exports over the next three days would be acceptable. Following the ramp-up on February 5-7, incidental take of delta smelt continued to decline until combined take fell to zero on February 17 (Figure 4).

On February 1 the export-to-inflow (E/I) standard dropped from 65% to 35%, and opportunities to flex the standard became available. However, early discussions during the February 8 DAT call noted that Delta temperatures were already around 10<sup>0</sup> C and were close to optimal spawning temperatures (12-18<sup>0</sup> C), a potential indication of the onset of early spawning. Many of the delta smelt collected at the CVP in the previous week were at gonadal development Stage 4

(mature), another indicator of spawning readiness. Using a sub-sample of stations from the Kodiak Trawl Survey (February 8-10) (Figure 5.b), 196 adult smelt in the Montezuma and Cache Slough areas were collected; the majority were females, about half of which were mature and a few of which were spent. Female gonadal development was slightly ahead of males, with fewer than 20% of females displaying maturity. During the DAT call on February 22, the SWP announced that its share of San Luis Reservoir had filled and that EWA debt had begun to “spill.” Of the delta smelt collected in survey 2 of the Kodiak Trawl Survey (February 22-25) (Figure 5.c), approximately 63% were female, and approximately half of those were mature. A few females (about 7%) were spent. Most were collected in Montezuma and Cache Sloughs and on the Sacramento River side of the confluence. All debt to the SWP had spilled by March 1.

**EWA Costs.** The Department of Water Resources estimated that SWP exports were reduced by approximately 44.3 TAF as a result of Fish Action #2 (February 2-7).

### March

No incidental take of delta smelt was reported by the Projects during the month of March. On March 10, the Delta Smelt Working Group met to review the March 7 supplemental Kodiak Trawl data (Figure 5.d), which showed that of the 158 adults collected, most (63%) were female and of those, about 60% were mature and 30% were spent. Based upon these results and consideration of Delta temperatures, the DSWG members concluded that most spawning would be completed by April 1. Because relatively short spawning periods result in fewer cohorts spawned, larval entrainment losses may impact year-class success in years of short spawning period duration (Bennett 2005). Thus, a pre-VAMP action could provide a population-level benefit by decreasing larval entrainment losses. To explore the potential benefits of a pre-VAMP action, the DSWG members provided DWR hydrodynamic modeling staff with five paired comparisons for PTM and injection points based upon data from the Kodiak Trawl Survey, and specified a 30% difference in particle fate as their threshold of significance. The DSWG members met again on March 28 to review the PTM runs, but did not make a recommendation at that time, as the 30% difference-in-fate criterion was not met. However, to incorporate the latest information on delta smelt abundance and distribution and projected San Joaquin River flows, the DSWG members requested additional PTM runs with injection points added in the central Delta and using the updated VAMP hydrology.

The 20-mm Survey began March 14, but collected only three fish, not unusual for the first survey period. All EWA debt to the CVP had spilled from San Luis Reservoir by the third week of March. Survey 3 of the Kodiak Trawl Survey

(March 22-25) (Figure 5.e) collected very few fish relative to past years ( $n_{2002}=238$ ,  $n_{2003}=373$ ,  $n_{2004}=196$ ,  $n_{2005}=27$ ), an indicator of an early cessation of spawning. Flows on the San Joaquin River were expected to be in excess of the 5,000 cfs that DWR considered safe for installation of the Head-of-Old River Barrier; however, the VAMP biologists still planned to release and recapture marked fish, and pushed the VAMP start date back to May 1, hoping that flows on the SJR tributaries would have stabilized by that time. A preliminary VAMP target flow of 7,000 cfs at Vernalis was identified, with export-level options of either 1,500 or 3,000 cfs combined, with 1,500 cfs preferred by the VAMP and the delta smelt biologists.

## April

The third supplemental Kodiak Trawl Survey (April 4-5) (Figure 5.f) collected more adults than the previous survey ( $n=197$ ), including 140 females, most of which (115) were either mature or spent. The second and third 20-mm Surveys (3/28-4/2 and 4/11-4/16) collected five and three young of the year (YOY), respectively, fewer than in previous years.

The Delta Smelt Working Group met on April 13 to review the latest PTM results and monitoring and survey data. Review of the PTM results revealed that most of the expected entrainment of particles at the SWP and CVP (incidental take) with baseline river flows and pumping rates would occur during the April 16-April 30 period. Particle entrainment from central Delta injection points dropped from >30% with baseline conditions (1000 cfs exports and 1000 cfs SJR at Vernalis flow) to zero with 5,000 cfs exports and 10,000 cfs SJR at Vernalis flow or with 3,000 cfs exports and 7,000 cfs flow. In each case, entrainment was reduced when the combined level of exports was approximately 50% of SJR flow. Because of the high level of concern for delta smelt, the DSWG members recommended and the WOMT implemented a reduction in combined exports to 50% of the San Joaquin River flow at Vernalis, to begin as soon as possible and continue until the beginning of the VAMP period on May 1. This recommended action was intended to minimize entrainment and otherwise reduce the effect of export pumping on delta smelt larvae prior to the beginning of the VAMP period. No June curtailment was recommended, however, the group recognized that incidental take levels could result in June curtailments.

A special meeting of the CalFed Operations Group was called for April 14 to discuss VAMP operations, but the question of the level of exports was not resolved. VAMP operations were discussed at the regular WOMT meeting on April 19. A proposal was made to go to a combined export rate of 1,500 cfs, depending on Vernalis flows, but a final decision was postponed until after the regular CalFed Operations Group meeting on April 27. On April 27 the CalFed

Ops Group decided to leave the final decision to the WOMT, which met via conference call on April 28. After protracted discussion, the WOMT decided to implement a compromise operations schedule of 1,500 cfs combined exports for the first two weeks of the VAMP, when SJR flows were likely to be most stable and most of the marked fish from the first release groups were expected to be recaptured, and 3,000 cfs for the second half of the VAMP period when another set of marked fish would be released. Incidental take of delta smelt remained at zero during the month of April; however, YOY collected by survey 4 of the 20-mm Survey exhibited a mean length of 13.5 mm by the end of the month, too small to be reported by the export facilities (Figure 6.a).

**EWA Costs.** The Department of Water Resources estimated that SWP exports were reduced by approximately 121.9 TAF as a result of Fish Action #3 (April 17-30).

## May

The VAMP period officially began on May 1, but without resolution of the level-of-exports question. Although the SWP decreased exports to its share of the combined 1,500 cfs (750 cfs), the CVP decreased exports to its share of 3,000 cfs combined (1,500 cfs), for a combined level of exports of 2,250 cfs. After hurried high-level negotiations, the export level was re-set at 2,250 cfs combined, for the entire VAMP period. The May 3 DAT call noted that the E/I ratio was approximately 11%; at 2,250 cfs, exports were well below 50% of the Vernalis flow of approximately 7,800 cfs, satisfying concerns expressed earlier by the Delta Smelt Working Group. The Kodiak Trawl Survey (May 2-3) continued to collect both mature and nearly-mature delta smelt, indicating that spawning had not yet concluded, however, water temperatures had warmed to 17-18<sup>o</sup> C by the end of the first week of May, signaling the end of peak spawning (Figure 11). Survey 5 of the 20-mm Survey (May 9-13) (Figure 6.b) collected 177 YOY with a mean length of 15.6 mm, indicating that smelt could be present at the export facilities without being detected. Most YOY collected by survey 5 were found west of Frank's Tract, with a few in the central Delta. Incidental take remained at zero until May 17 (Figure 9).

The CVP began reporting incidental take on May 17, even though Survey 6 of the 20-mm Survey (May 23-27) (Figure 6.c) collected no smelt in the south Delta. At the WOMT meeting on May 17 the Projects began discussing increasing exports to minimize the accumulation of debt by the EWA, but final decisions were postponed until after holding a special WOMT conference call on May 20. On May 27 the Projects increased exports to approximately 6,200 cfs combined; a small increase in the incidental take of delta smelt occurred with the increased export pumping (Figure 9). Mean length of delta smelt collected by survey 6 was

19.8 mm, indicating that many smelt in the vicinity of the export facilities could be detected and reported in salvage. Incidental take for May was very low compared to recent years (Table 4).

**EWA Costs.** The Department of Water Resources estimated that SWP exports were reduced by approximately 134 TAF as a result of Fish Action #4 (May 1-31).

## June

The Delta remained in excess conditions through June, and was projected by DWR to remain in excess conditions through August and potentially into September. The Delta Cross Channel gates opened the weekend of June 11/12 and were expected to remain open. The WOMT used EWA to ramp up Project exports from June 1-8. Incidental take of delta smelt continued to fluctuate during the first two weeks of June, but dropped to zero by June 18 (Figure 10). Survey 7 of the 20-mm Survey (June 6-11) (Figure 6.d) did not collect any delta smelt in the south Delta, and Survey 8 (June 20-24) (Figure 6.e) did not collect any smelt east of the confluence of the Sacramento and San Joaquin Rivers. Water temperatures in the south Delta trended upward from the low 20's (degrees C) to over 25<sup>o</sup> C, the laboratory-lethal limit for delta smelt (Swanson et al., 2000), as flows on the San Joaquin ebbed from a high of about 16,000 cfs on June 5 to about 6,000 cfs by the end of the month (Figure 11). The Summer Tow-Net Survey, which runs from June through August and collects data on the relative abundance of delta species, began on June 13. The Summer Tow-Net index, which is calculated from a subset of tows, was at 0.3 in 2005 the lowest of record.

**EWA Costs.** The Department of Water Resources estimated that SWP exports were reduced by approximately 34.7 TAF as a result of Fish Action #5 (June 1-8).

## Discussion

Although the effects of EWA fish actions on delta smelt entrainment and incidental take have not been quantified, it is likely that EWA fish actions reduced the loss of both adults and juveniles to the direct and indirect effects of Project operations. Monitoring of real-time data on Delta conditions and incidental take levels and a timely meeting of the Delta Smelt Working Group on January 28 culminated in the implementation of a fish action that, while it could have been both more aggressive and more timely, likely reduced the take of pre-spawning adult delta smelt. Extensive, timely use of particle tracking modeling by the Delta Smelt Working Group indicated that the fish actions implemented in April and May avoided loss of larval and juvenile delta smelt, even though the fish were too small to be detected and counted at the export facilities.

Implicit in the purpose of the EWA is the hypothesis that the protections in the regulatory baseline are insufficient to adequately protect and recover listed and other species of concern. Although it is generally agreed that EWA has succeeded in forging new relationships and improving collaboration between the management agencies, the project agencies and stakeholders, the cumulative effect of EWA actions on fish populations has not been adequately assessed. Making this assessment is not a simple task. The surveys used to estimate delta smelt relative abundance and distribution are not capable of yielding reliable population estimates, “salvage” does not adequately reflect the direct and indirect effects of Project operations, and the effect of EWA on salvage is unknown. These questions are, however, relevant to the research priorities of the IEP and of the POD PWT, whose study plan focuses on the effects of environmental contaminants, invasive species and water project operations. Studies now underway may lead to new strategies to support the adaptive management of Project water operations.

In late 2004, the EWA Team developed performance measures for the EWA that were included in the EWA’s Multi-Year Program Plan<sup>3</sup> prepared by CBDA (CBDA, 2005). At present, these performance measures do not include meaningful biological indicators that have been defined scientifically, such as measures of ecosystem response and species protection and recovery. Also, in their response to re-initiation of ESA Section 7 consultation on the EWA and the Ecosystem Restoration Program (ERP) Milestones<sup>4</sup>, the EWA agencies provided a section on the efficacy of the EWA implementation (CBDA, 2004). Both of these documents include critical discussion of the implementation, accomplishments and limitations of the EWA that will not be repeated here.

### Further Considerations

In water year 2005 the EWA Team negotiated a total of 212 TAF of assets available for purchase, while fish actions required the expenditure of 339.1 TAF of assets, resulting in the accumulation of substantial debt to the Projects. Debt accrued in San Luis Reservoir before the beginning of April (carryover debt from WY 2004 plus Delta Action 8 and the February action) “spilled” when the Projects filled their respective shares of San Luis, leaving 290.6 TAF of debt to be covered by the 212 TAF of purchases. Further, as the Delta remained in excess conditions through the summer, the EWA was not able to transfer assets acquired from north of the Delta, and assets held by the EWA in Oroville Reservoir spilled when Oroville filled. Assets acquired in the export service area

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<sup>3</sup> Available on the CBDA website at need URL

<sup>4</sup> Available on the CDFG website at <http://www.delta.dfg.ca.gov/envcomp/milestones.asp>

totaling 163.5 TAF were available to apply toward EWA debt. EWA debt was reduced further as the SWP used the EWA's 500 cfs of dedicated export capacity to pump excess Delta flows July through September on EWA's behalf. The SWP was able to reduce EWA debt by approximately 1,000 acre-feet per day, over most of the summer. DWR estimated at the end of September that the EWA will carry approximately 56 TAF of debt to the SWP forward into 2006. This carryover debt, combined with budget limitations in FY 2006, may have implications for future EWA fish actions, requiring the EWA Team to prioritize actions and potentially to forgo some fish actions in WY 2006. It seems unlikely that EWA would be able to fully carry out its purpose should insufficient assets be available for species protection and restoration.

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### Literature Cited

Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco estuary, California. *San Francisco Estuary and Watershed Science* 3(2): Art. 1, September 2005

CALFED. 2000. Programmatic Record of Decision. CALFED Bay-Delta Program. August 28, 2000

California Bay-Delta Authority (CBDA). Environmental Water Account Multi-Year Program Plan (Years 6-9), in prep

California Bay-Delta Authority (CBDA). 2004. Reinitiation of consultation: assessing progress towards milestones and the efficacy of the environmental water account. July 9, 2004

California Department of Water Resources (CDWR). 2005. Bulletin 120. <http://cdec.water.ca.gov/snow/bulletin120>

Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. *Transactions of the American Fisheries Society*. 121:67-77.

Moyle, P.B. 2002. Inland fishes of California. Revised and expanded. University of California Press. Berkeley, California.

National Oceanic and Atmospheric Administration (NOAA). 2005. NOAA News Online, <http://www.noaanews.noaa.gov>

Swanson, C., P.S. Young and J.J. Cech Jr. 2000. Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced wakasagi (*H. nipponensis*) in an altered California estuary. *Oecologia* 123:384-390

Sweetnam, D.A. and D.E. Stevens. 1993. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. State of California. The Resources Agency. Department of Fish and Game. Candidate Species status Report 93-DS

U. S. Fish and Wildlife Service (USFWS). 2005. Reinitiation of formal and early section 7 endangered species consultation on the coordinated operations of the Central Valley Project and State Water Project and the operational criteria and plan to address potential critical habitat issues. Sacramento, California. 237 pp

U.S. Fish and Wildlife Service (USFWS). 2004. Five year status review for the delta smelt. Sacramento, California. 50 pp

U.S. Fish and Wildlife Service (USFWS). 1996. Sacramento/San Joaquin Delta native fishes recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon

Williams, J.E., C.A. Macdonald, C. Deacon Williams, H. Weeks, G. Lampman and D.W. Sada. 2005. Prospects for recovering endemic fishes pursuant to the U.S. Endangered Species Act. *Fisheries* 30(6): 24-29

Table 1. Summary of Summer Tow-Net and Fall Mid-Water Trawl survey indices for delta smelt for the post-decline period.

Year	Summer Tow-Net Survey Index	Fall Mid-Water Trawl Index	Recovery Index <sup>5</sup>
1983	2.9	132	17
1984	1.2	182	51
1985	0.9	110	29
1986	7.9	212	70
1987	1.4	280	72
1988	1.2	174	67
1989	2.2	366	76
1990	2.2	364	81
1991	2.0	689	171
1992	2.6	156	26
1993	8.2	1078	400
1994	13.0	102	19
1995	3.2	899	252
1996	11.1	127	28
1997	4.0	303	62
1998	3.3	420	169
1999	11.9	864	322
2000	8.0	756	265
2001	3.5	603	314
2002	4.7	139	33
2003	1.6	210	101
2004	2.9	74	25
2005	0.3		4
Median	8.1	370	104.5
Min.	0.3	74	17
Max.	62.5	1637	589

<sup>5</sup> The Recovery Index is defined in the Delta Native Fishes Recovery Plan (USFWS, 1996) and is derived from a subset of station data from the Fall Mid-Water Trawl

Table 2. Environmental Water Account expenditures in water year 2005.

Action #	Dates	Facility	Amount in TAF	Species Benefited
1 (Delta Action 8)	Dec 6-15	SWP	4.2	WR Chinook
2	Feb 2-7	SWP, CVP	44.3	Delta Smelt
3	Apr 17-30	SWP	121.9	Delta Smelt
4	May 1-31	SWP	134.0	FR Chinook, Delta Smelt
5	Jun 1-8	SWP	34.7	FR Chinook, Delta Smelt
Total for WY 2005			339.1	

Table 3. Summary of EWA expenditures for Water Years 2001-2004, in thousands of acre-feet.

Month	WY 2001	Species Benefited	WY 2002	Species Benefited	WY 2003	Species Benefited	WY 2004	Species Benefited
October			5 <sup>a</sup>	Salmonids	13 <sup>b</sup>	Salmonids		
November			15 <sup>a</sup>	Salmonids				
December					32	Salmonids		
January	69	Salmonids	66	Salmonids/Smelt	89	Salmonids/Smelt		
February	69	Salmonids/Smelt						
March	65	Salmonids/Smelt						
April	29	Salmonids/Smelt	28	Salmonids/Smelt	19	Salmonids/Smelt	13	Salmonids/Smelt
May	49	Salmonids/Smelt	149	Salmonids/Smelt	208	Salmonids/Smelt	111	Salmonids/Smelt
June	9	Salmonids/Smelt	5	Salmonids/Smelt				
Total	290		248		348		124	

<sup>a</sup>release of PCWA purchase from Folsom Reservoir, timed for flow and temperature benefits

<sup>b</sup>power generation bypass at Folsom Dam

Table 4. Tabular summary of incidental take of delta smelt at the State Water Project (SWP) and federal Central Valley Project (CVP) export facilities since the implementation of the Environmental Water Account.

Month	WY 2001 Combined Take <sup>a</sup> (Drier)	WY 2002 Combined Take (Drier)	WY 2003 Combined Take (Drier/Wetter)	WY 2004 Combined Take (Drier)	WY 2005 Combined Take (Wetter)
December	192	1,129	2,776	126	0
January	181	5,231	9,561	4,594	1,647
February	3,870	280	1,494	1,161	371
March	3,772	225	483	2,177	0
April	520	372	492	276	0
May	13,170	47,361	16,309	5,749	547
June	2,418	11,926	10,096	6,392	1,181
Total	26,124	66,526	41,211	20,475	3,746

<sup>a</sup> Incidental take reported on USBR's Central Valley Operations website, [www.mp.usbr.gov/cvo/html/fishrpt.html](http://www.mp.usbr.gov/cvo/html/fishrpt.html)

<sup>b</sup> based upon the 90% exceedence forecast, which is updated each month throughout the water year

Table 5. A comparison of allowable incidental take between the 1995 and 2005 OCAP biological opinions.

<b>1995</b> <b>2005</b>	<b>December</b>	<b>January</b>	<b>February</b>	<b>March</b>	<b>April</b>	<b>May</b>	<b>June</b>
Wetter Years	733 700	5,379 3,000	7,188 2,300	13,354 1,900	2,378 1,000	9,769 37,800	10,709 45,300
Drier Years	8,052 400	13,354 1,900	13,354 1,900	6,979 1,300	12,354 1,100	55,277 30,500	47,245 31,700

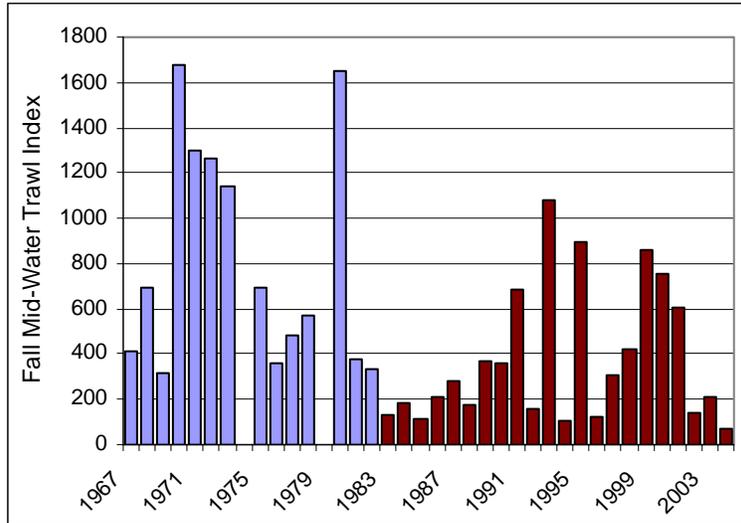


Figure 1. Delta smelt fall mid-water trawl index, 1967-2004. Post-decline years are in red.

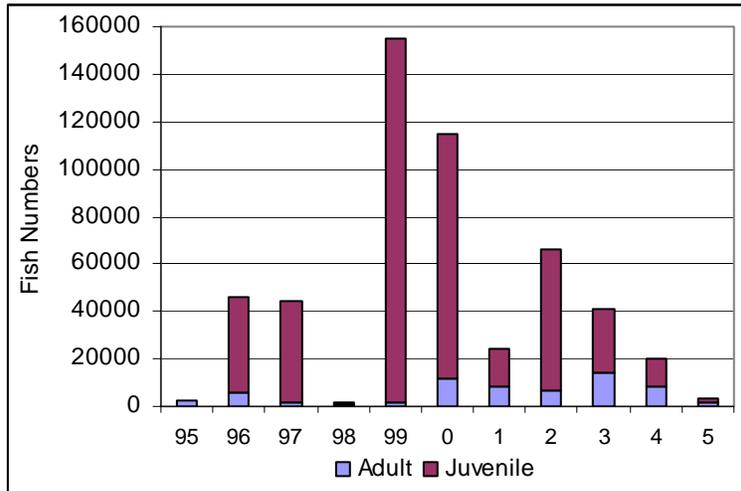


Figure 2. Incidental take of delta smelt at the State and Federal export facilities for December through July, 1995-2005.

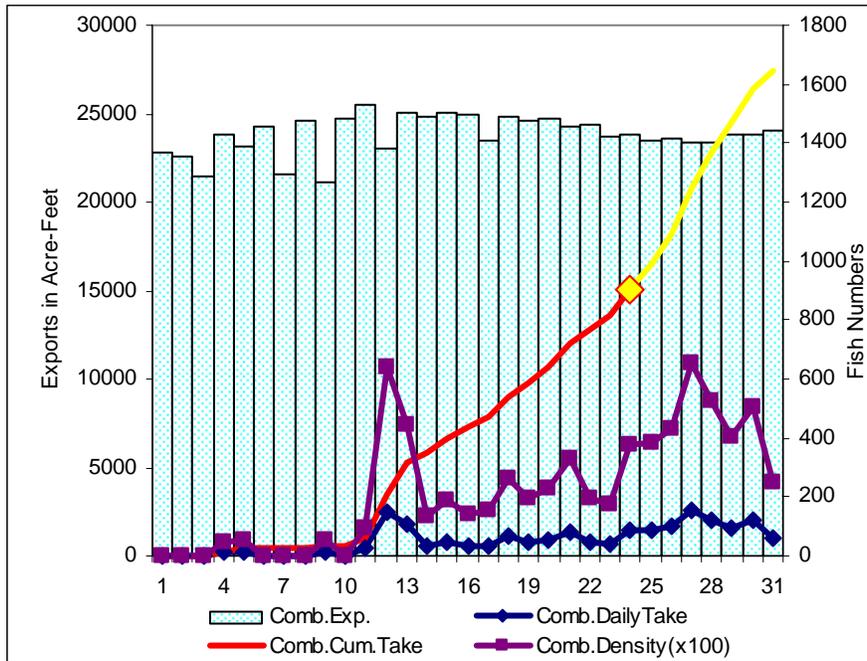


Figure 3. Incidental take of delta smelt at the CVP and SWP (combined) overlaid on combined Project exports for January, 2005. The yellow diamond indicates where the concern level was exceeded.

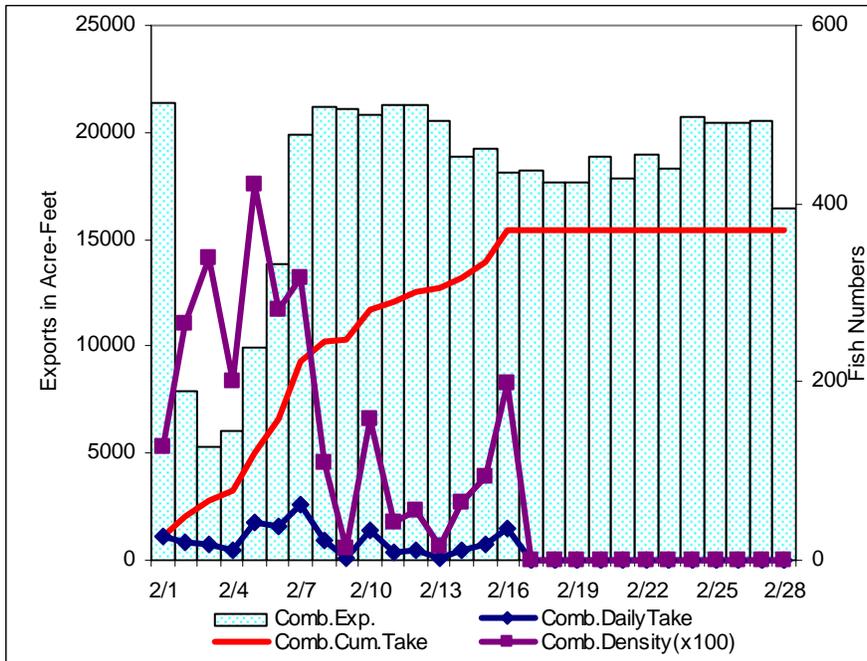


Figure 4. Incidental take of delta smelt at the CVP and SWP (combined) overlaid on combined Project exports for February, 2005.

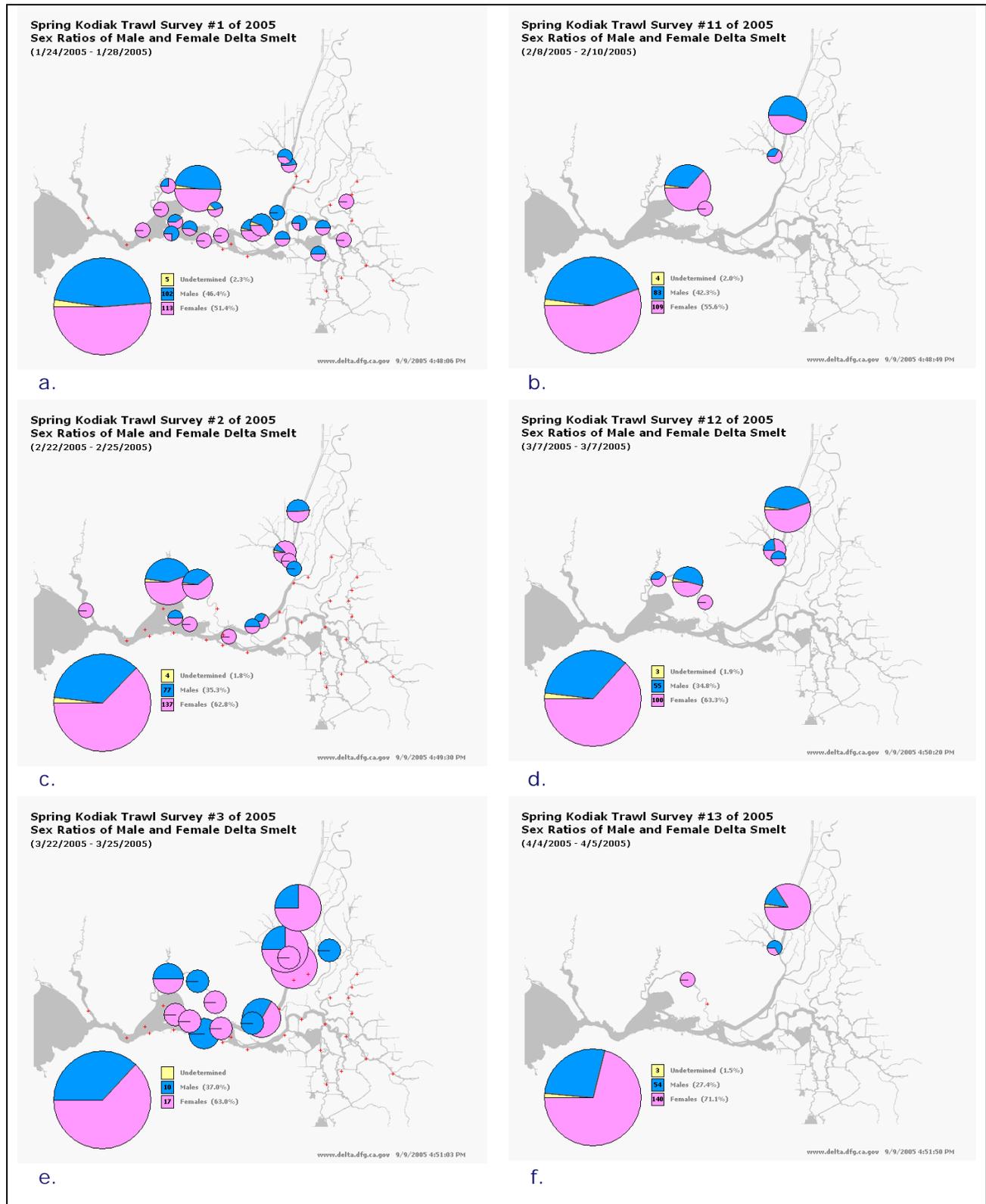


Figure 5. Graphic representation of abundance and distribution of adult delta smelt in water year 2005, as indicated by CDFG Kodiak Trawl Survey sampling.

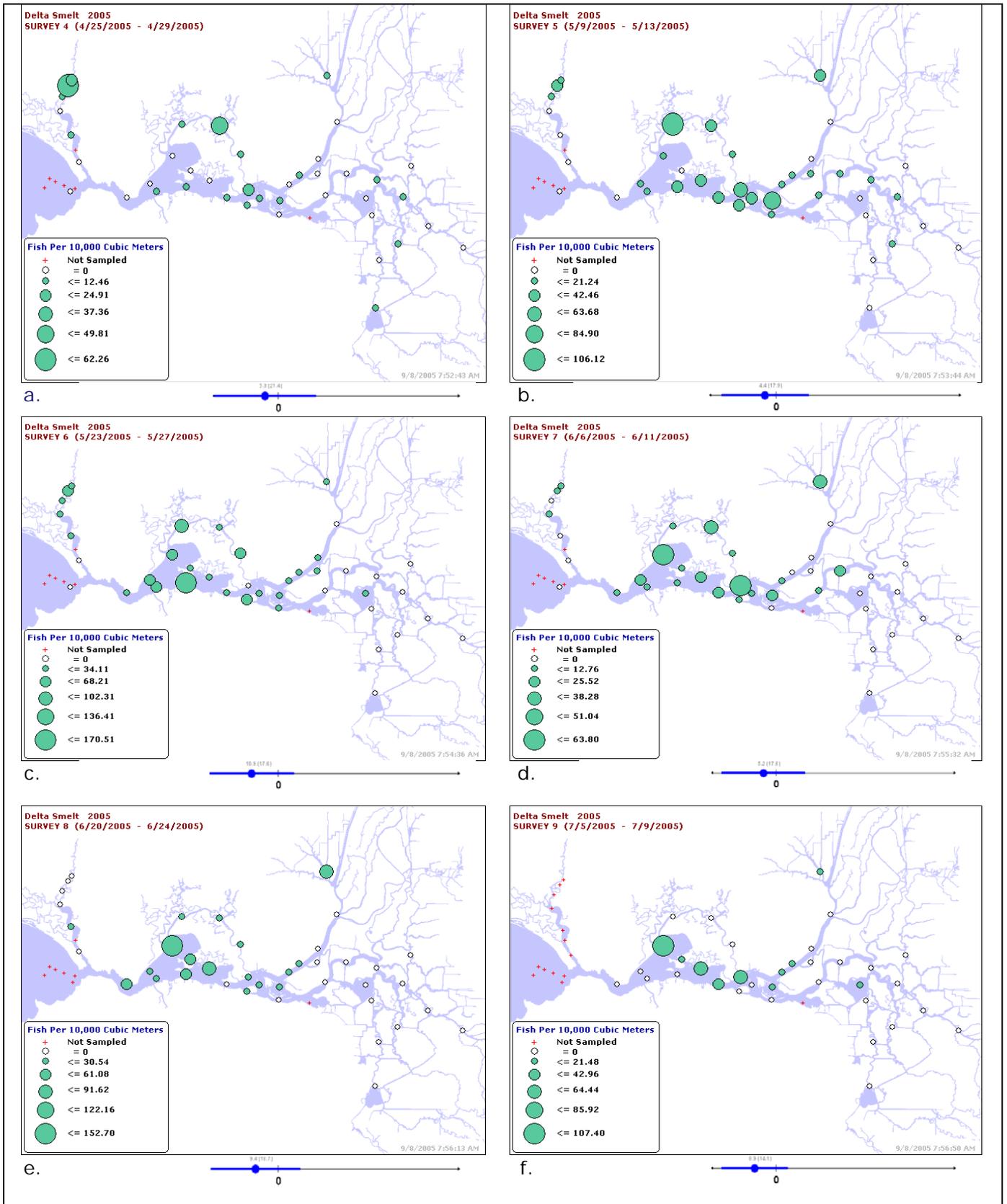


Figure 6. Graphic representation of abundance and distribution of young-of-year delta smelt in water year 2005, as indicated by CDFG 20-mm Survey sampling.

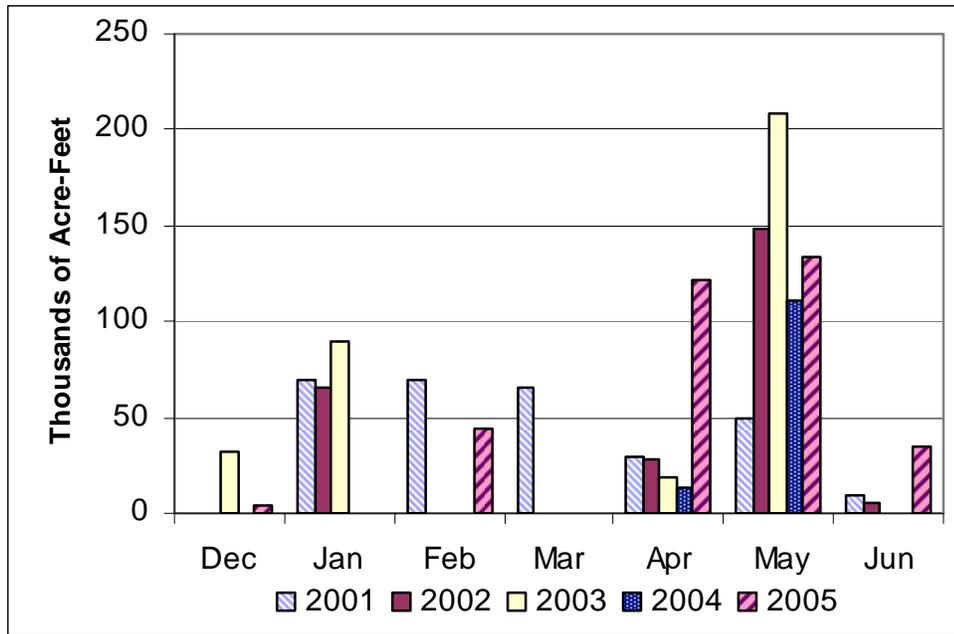


Figure 7. EWA assets expended annually, by month.

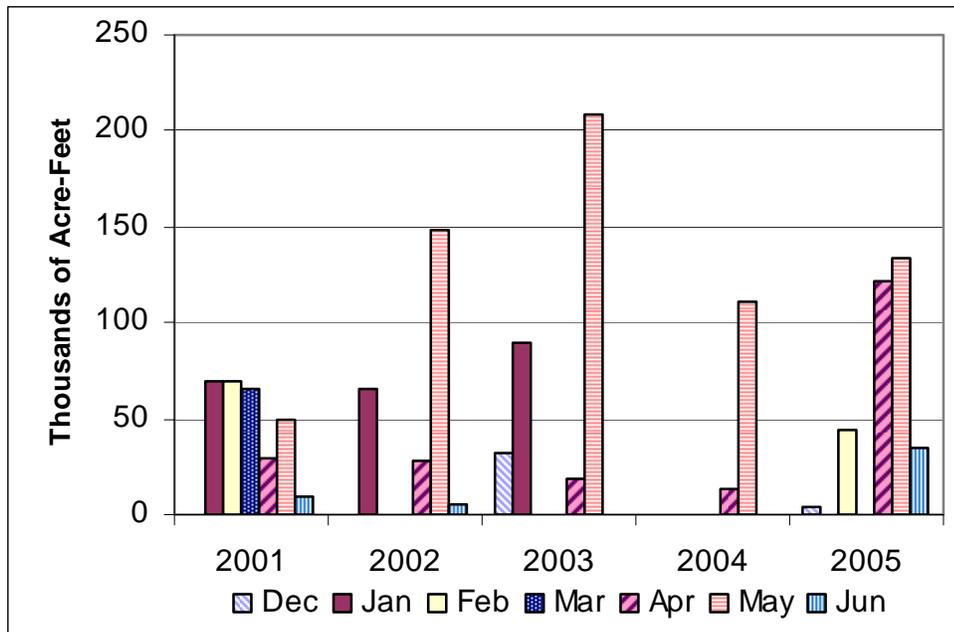


Figure 8. EWA assets expended monthly, by year.

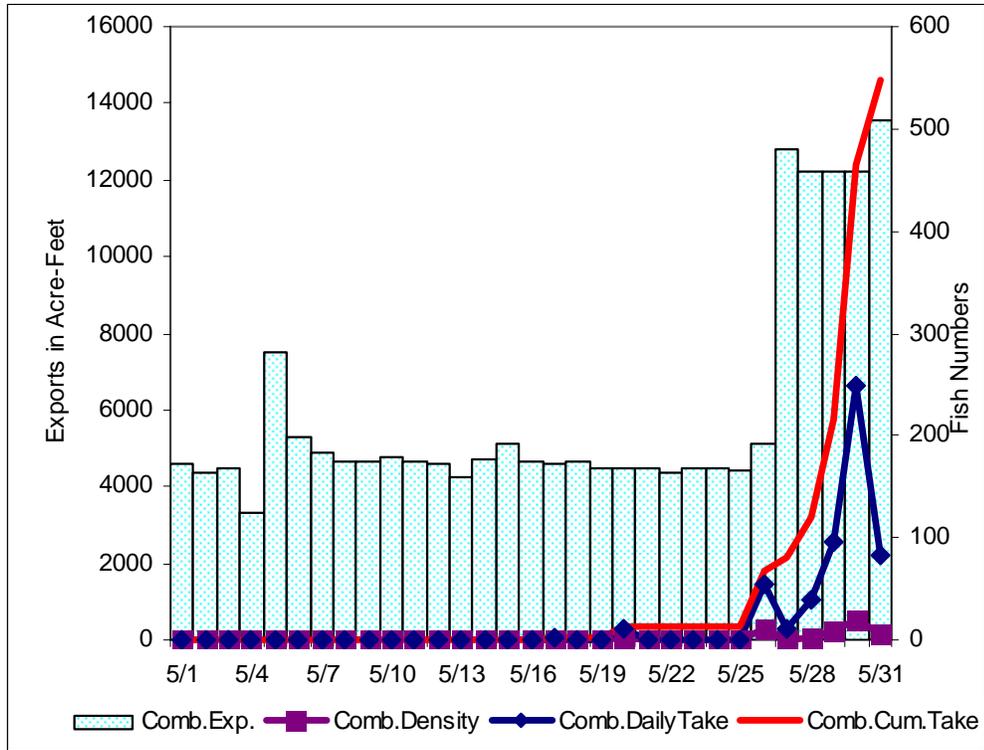


Figure 9. Incidental take of delta smelt at the CVP and SWP (combined) overlaid on combined Project exports for May, 2005.

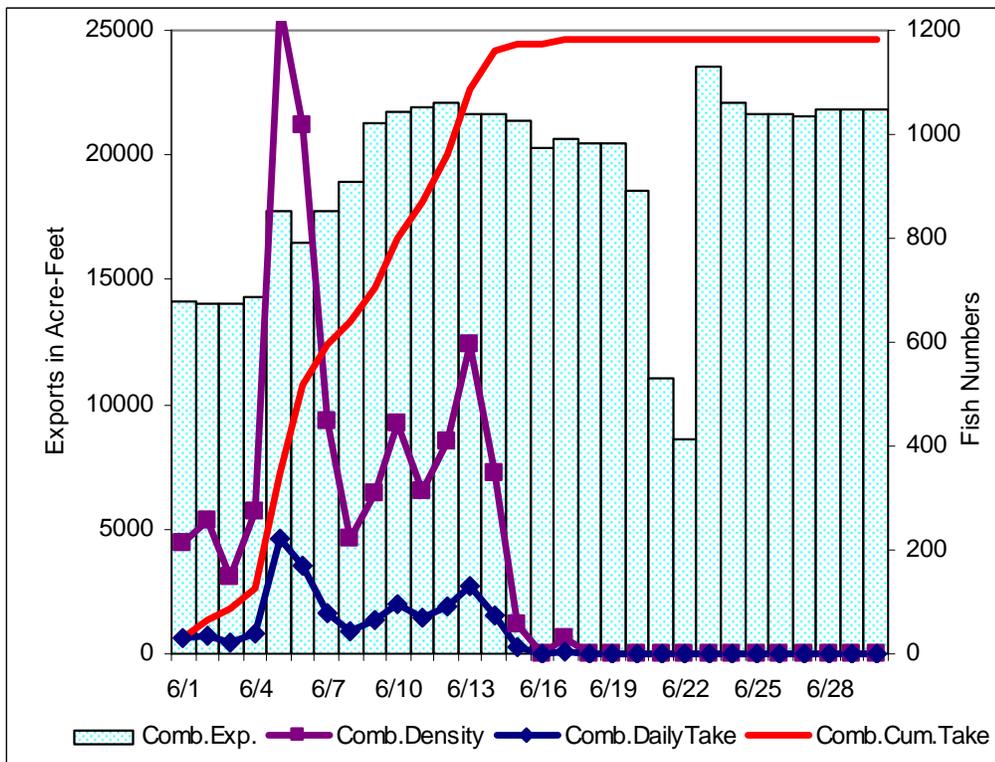


Figure 10. Incidental take of delta smelt at the CVP and SWP (combined) overlaid on combined Project exports for June, 2005.

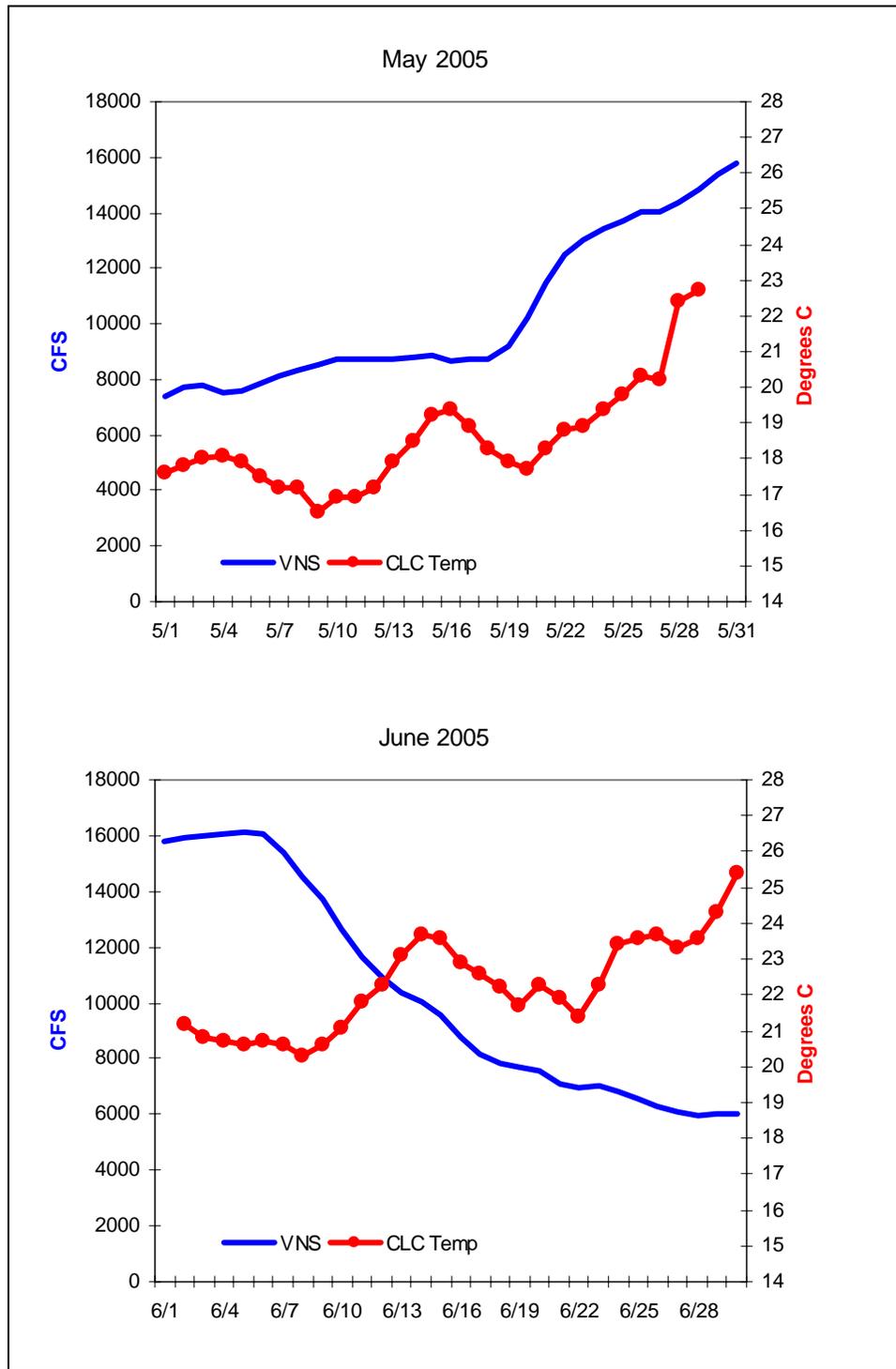


Figure 11. San Joaquin River flows at Vernalis (VNS) in cubic feet per second, plotted with water temperatures at Clifton Court Forebay (CLC) in Celsius.