Environmental Water Account Expenditures for the Protection of the Delta Smelt in Water Year 2006

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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*) and the activities of the Delta Smelt Working Group. Because this is the sixth in a series of reports written with the same general purpose and audience in mind, 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. Previous years' reports may be found on the California Bay-Delta Authority (CBDA) Science web at http://science.calwater.ca.gov/workshop/past_workshops.shtml.

Over the five years of EWA implementation, the use of EWA assets has undergone a strategic shift, reflecting changes in the understanding of species biology and of the ecological and physical processes operating in the Delta. 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 less by salvage at the export facilities and more by real-time assessment of overall trends in delta smelt abundance and distribution, reproductive potential and other relevant factors, using a decision process described in the 2005 Biological Opinion for the Operations Criteria and Plan (OCAP) (USFWS, 2005). This real-time assessment is intended to generate, if needed, science-based recommendations for modifications to Project operations to avoid delta smelt entrainment events leading to elevated salvage.

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 2005 Fall Mid-Water Trawl survey performed by the California Department of Fish and Game (CDFG) resulted in an index of 24 for delta smelt, the lowest ever recorded (Table 1, Figure 1). Recently, CDFG's 2006 Summer Tow-Net survey generated an index value of 0.4 for delta smelt (Table 1), not substantially different from the 2005 record low of 0.3.

The 2005 Recovery Index was 4, the lowest index ever recorded and well below the 2003 index of 101 (Table 1) and the target abundance criterion of 239[1] specified in the Recovery Plan (USFWS, 1996). Following the criteria specified in the Service's 2005 biological opinion on OCAP (USFWS, 2005), the "concern level" for salvage of adult delta smelt was set at 143. Salvage of delta smelt at the State and Federal export facilities was 336 in WY 2006, very low relative to most of the previous ten years. Salvage for December through June since the implementation of the EWA has ranged from 336 in WY 2006 to 66,526 in WY 2002 (Table 4, Figure 2).

The Interagency Ecological Program (IEP) held a Delta Smelt Program Review in April of 2006 to compile and summarize project-specific information, determine the uses to which project deliverables have been put, and provide guidance for the assignment of long-term research priorities. The information format consisted of oral and poster presentations and group discussion with a Science Advisory Group (SAG). The SAG provided initial impressions and a written report of findings, which is not yet publicly available. The SAG praised the IEP for its science-based approach to collaboration, while recommending reassessment of sampling design to improve efficiency and incorporate recent technological advances, expanded evaluation of existing data, increasing recognition of opportunities for adaptive management, collaborate effectively in synthesis evaluation of multiple interacting threats to delta smelt, and the development of a state-of-the-knowledge conceptual model that incorporates stressors at each life stage.

On July 6, 2006, the Bureau of Reclamation requested reinitiation of formal consultation on OCAP, citing changed circumstances, specifically the apparent recent dramatic decline in abundance of pelagic organisms. The 2005 Biological Opinion remains in effect during consultation.

Delta Smelt Working Group

Because of the high level of concern for delta smelt in WY 2006, the Delta Smelt Working Group conferred frequently throughout the year. Briefing documents and meeting notes are available on the USFWS Sacramento Fish and Wildlife

[1] The median of delta smelt fall mid-water trawl indices in pre-decline years

Office's website at http://www.fws.gov/sacramento/es/delta_smelt.htm. The Working Group's purpose and charge are described in the Service's 2005 Biological Opinion on OCAP (USFWS, 2005). A summary of the Working Group's activities is included as part of the narratives in later sections of this report.

Environmental Conditions

Water year 2006 was expected to be relatively warm and wet, with heightened concern for flooding due to robust end-of-year storage in Central Valley reservoirs. A somewhat-dry fall ended with a two-week series of storms beginning on December 18 which delivered nearly half of the expected yearly precipitation, prompting the SWP and CVP to declare excess conditions in the Delta on December 20. By mid-January the National Weather Service reported that ocean conditions had begun to exhibit a typical La Nina pattern, a periodic cooling of the east-central Pacific which generally brings above-normal precipitation to the Northwest and drought to the continental interior (NOAA, 2006). Many of the January storms were warmer than average, resulting in flooding in several areas of Northern California. The snowpack was above average at higher elevations by the beginning of February, and many reservoirs were at or near flood control level. February was relatively dry, resulting in little gain for the snowpack, which by the first of March was estimated at about 75% of the April 1 average. A series of storms in March brought almost-daily precipitation and very wet conditions, which extended into April. Reservoir storage stood at 115% of average on April 1 as flooding remained a concern for many Central Valley communities. Runoff was forecasted to remain above average through July, and the SWP and CVP predicted that the Delta would remain in excess conditions through the summer (DWR, 2006).

Expenditure of Environmental Water Account Assets/Delta Smelt Situation in WY 2006

Over its six years of implementation, the EWA has used an average of 250 TAF of water assets annually. Asset expenditures varied with Delta hydrology, the level of concern, and the immediate situation as indicated by real-time monitoring evaluated using established decision processes. For planning purposes, fish actions were assumed to be 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. However, in WY 2006, a wet year, the EWA used only 149 TAF of assets, with no fish actions specifically recommended for the protection of delta smelt (Table 2). The center of distribution of delta smelt was such that very little salvage occurred, obviating the use of EWA assets to minimize salvage (Table 2). EWA assets were used only

to implement the VAMP and pre- and post-shoulders for emigrating Chinook salmon. This compares with 290 TAF in 2001, 248 TAF in 2002 and 124 TAF in 2004, all drier years, and with 346 TAF in 2003 and 339 TAF in 2005, which were wetter years (Table 3; Figures 6 and 7). The EWA has tended to expend more assets on average in May than in other months (Figure 6), as assets have been used to support the VAMP export curtailment annually and a post-VAMP shoulder in most years.

In WY 2006, 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 an 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 salvage of delta smelt by the Projects (Table 5).

Actions to Protect Pre-Spawning Delta Smelt

Due to the very low apparent abundance of delta smelt as indicated by the Fall Mid-Water Trawl survey, it was the first priority of the Delta Smelt Working Group to minimize the entrainment of pre-spawning adults. Analyses completed for the OCAP Biological Assessment indicated that by the time a salvage event becomes apparent, it would likely already be too late to provide significant protection. The Working Group believed that it would be prudent to implement a protective action in winter as a precautionary measure, in advance of receiving information from surveys or salvage, and in November began to discuss the most advantageous ways in which to deploy the available environmental water. The Working Group drew from its own analyses and also from those generated by the Pelagic Organism Decline Project Work Team (POD PWT), particularly from observations on winter salvage. Recognizing that environmental water assets would be limited, the Working Group decided early on to try and identify a mid-winter action that would not only be protective of adults, but also minimize or avoid the need for spring actions to protect larvae and juveniles.

In October 2005 the POD PWT reported its observation that as November-through-March exports have risen since 1999, salvage of delta smelt at the export facilities had also risen, in terms of raw numbers as well as numbers per acre-foot exported (density) and as a ratio of density to FMWT indices (Herbold et al., 2005). The observations appeared particularly compelling as they held across several pelagic species with varying life history strategies. No mechanism had as

yet been proposed, but the management implication was that the observations represented a true relationship, until demonstrated otherwise. A pivotal point, still unresolved, was whether or not incidental take of pre-spawning adults was the key to the decline of delta smelt. The POD PWT analyses suggested that decreases in the Export-to-Inflow (E/I) ratio bringing it below 20% could result in a change in particle fate that could correspond to a decrease in fish salvage. In November, the Service asked the Working Group to consider the potential efficacy of implementing a reduction in the E/I ratio to 20% as a protective measure, to minimize entrainment. At that time, the Working Group was unable to achieve a consensus recommendation. The E/I observation was considered a hydrodynamic effect, with considerable uncertainty as to how migrating adult delta smelt behaved as they encountered the confluence and their subsequent rates of movement into the Sacramento and San Joaquin sides of the Delta. Implementing a 20% E/I could minimize adult entrainment, but would not assure that adults did not move into the South Delta to spawn, and thus may not have prevent juvenile entrainment later in the water year. The Working Group initiated discussion of a proactive winter action intended to minimize the impact of exports on central and southern Delta hydrodynamics and, in turn, the movement of adults into those parts of the Delta. The Working Group remained cognizant of the fact that if an early action did not favorably influence the distribution of adults, few if any EWA assets would remain for subsequent spring actions to minimize entrainment of juveniles.

The Working Group produced preliminary analyses on the co-occurrence of increased winter flows with increased salvage indicating that increases in salvage tend to occur following combined Sacramento and San Joaquin flows of about 30,000 cfs, an indication that adult delta smelt may be cuing on increased flows to begin moving up the estuary to spawn. If it were to be assumed that fish movement began with increasing inflow, and the goal of a winter action would be to get ahead of salvage, then it could be appropriate to begin a winter action coincidentally with the forecast of a substantial storm event. In December, the Working Group produced a draft delta smelt protection strategy which included a winter action aimed at pre-spawning adults and a spring action aimed at larvae. The Working Group prioritized the winter action over the spring action, reasoning that if the winter action were effective, it should reduce or eliminate the need for a spring action. The Working Group believed that to provide protection to pre-spawning adults, a substantial export curtailment would be needed, and based their recommendation for a 15% E/I ratio for the month of January on previous discussions of the observations of the POD PWT. Triggers for implementation were based upon an analysis of historic salvage trends, which estimated that salvage would begin at the export facilities on approximately January 10. To avoid as much adult salvage as possible, the Working Group recommended that the action be implemented one week prior to

the estimated beginning of salvage, on January 3, 2006. After considerable debate, the WOMT tabled the recommendation for implementation but ultimately, the action was not needed due to the timely arrival of abundant precipitation in late December and early January, which resulted in an E/I ratio of less than 15% without modifications to Project operations.

With abundant water in the system, the distribution of pre-spawning delta smelt centered at or near the confluence (Figure 4) for most of the winter. However, due to very low apparent abundance, the concern for adult delta smelt remained high through the winter. For WY 2006 the Concern Level (the cumulative total of pre-spawning adults salvaged by the Projects between December 1 and March 31), which was calculated from the Recovery Index, was 143. In contrast, the Concern Level in WY 2005 was 892 and in WY 2004 would have been 3605, if the current Biological Opinion had been in effect. Although salvage of adult delta smelt was very low compared to other years, the Concern Level was eventually exceeded on March 2 (Figure 3). No fish action was recommended, as the E/I ratio was already below 5% and exports at the SWP were expected to remain relatively low. Under existing conditions, a further curtailment of exports was not deemed likely to significantly shrink the zone of entrainment. Also, referring to historic patterns of salvage as an indicator, the Working Group did not expect that significantly more salvage of adults would occur this year. Salvage at the CVP concluded on March 21; two additional delta smelt were salvaged at the SWP in April.

Actions to Protect Young-of-the-Year Delta Smelt

The Working Group continued to monitor Delta conditions and survey data for indications that spawning had begun. Due to fish condition and Delta water temperatures in mid-March, the Working Group believed that the onset of spawning may have been imminent. The Working Group was asked to consider whether the implementation of a pre-VAMP shoulder to protect early-hatching larvae would be appropriate. The Working Group believed that, in order to have the maximum protective effect, a pre-VAMP action would need to be cued to the onset of spawning. It was assumed that the onset of spawning could be determined either by direct observation (Larval Survey) or by inference, from water temperatures and the appearance of spent adults in salvage or the surveys. A preliminary recommendation was developed to implement a pre-VAMP action two weeks following the inferred onset of spawning. Spawning was not confirmed by the Delta Smelt Larval Survey until mid-April, at which time it was believed unlikely that there were significant numbers of delta smelt near enough to the export pumps to cause additional concern. A pre-VAMP action to protect emigrating Chinook salmon was implemented, but no action specifically for delta smelt was recommended or implemented.

Noting that the Head-of-Old River Barrier (HORB) as well as all South Delta barriers had the potential to affect delta smelt, the Working Group began consideration of modifications to the installation schedule and configuration in January. In conjunction with planning for the VAMP, the Working Group requested several particle tracking modeling (PTM) runs from CDWR staff, both with and without the HORB. As in previous evaluations, the Working Group used a 30% difference in particle fate as the significance criterion. Results of the PTM indicated that the most important factor for entrainment risk was proximity to the export pumps, a conclusion also reached by other investigators (Culberson et al., 2004). Effects of barriers were at no point as great as the effect of overall hydrology. Thus, based on the results of the PTM, the Working Group made the preliminary recommendation that for the VAMP the Projects increase SJR flows to 7000 cfs, curtail exports to a combined 1500 cfs, and not install the HORB, in order of descending importance.

The VAMP Technical Committee requested a meeting with the Working Group on February 2, to discuss the results of the PTM and the Working Group's preliminary recommendation. Installation of the HORB is an important part of the VAMP protocol, and also significantly affects the number of emigrating juvenile San Joaquin fall-run Chinook that are salvaged at the export facilities. After discussion with the VAMP Technical Committee, additional PTM runs were made, to make the runs consistent with VAMP protocols. The Technical Committee wished to include runs with the HORB in place but with culverts open, hoping to determine whether the protection afforded by the barrier for salmonids could be combined with sufficient flow to provide protection to delta smelt. The latest round of PTM revealed that the effect of the HORB did not change significantly no matter how many culverts were opened, and that flow remained the most significant factor in particle fate. After considering forecast conditions and PTM outcomes, the Working Group made the following prioritized recommendation, in order of highest to lowest preference:

- 7000 cfs SJR/1500 cfs exports/no barrier
- 7000 cfs SJR/1500 cfs exports/barrier
- 5700 cfs SJR/2250 exports/no barrier
- 5700 cfs SJR/2250 exports/barrier (assumed default)

Due to safety concerns, the HORB cannot be installed when SJR flows at Vernalis exceed 5,000 cfs. Flows may subsequently exceed 5,000 cfs, but the HORB would continue to provide protection to emigrating Chinook, even if it were over-topped. San Joaquin flows at Vernalis subsided from peaks near 20,000 cfs in early January to a low of about 5,000 cfs by the end of February, but climbed back to well over 10,000 cfs in March and to over 30,000 cfs by mid-April,

precluding the installation of the HORB. Meanwhile, Project exports decreased in mid-to-late March and for the most part remained relatively low through April. Abundant inflow, lack of a HORB and relatively low exports appeared to obviate a protective pre-VAMP action to protect larval delta smelt. As in WY 2005, the beginning of the VAMP was delayed until May 1, with the hope of more stable flows on the San Joaquin and its tributaries. The Working Group believed that a VAMP running from May 1 until May 31 would provide an incidental benefit to delta smelt by curtailing exports during what they estimated would be the bulk of the spawning period. Based on Delta conditions and the results of survey sampling, the Working Group did not make a recommendation for a post-VAMP shoulder. A post-shoulder was, however, implemented for the protection of emigrating San Joaquin Chinook. No salvage of larval or juvenile delta smelt was observed at the SWP or the CVP in WY 2006.

Discussion

The CVP took delta smelt sporadically and at relatively low numbers from January 2 through March 21, and only a few were salvaged at the SWP in April. This was unexpected, as in most years the SWP has salvaged more delta smelt than the CVP. This suggested to some of the members of the Delta Smelt Working Group that delta smelt experience substantial but unknown pre-screen mortality at the SWP, prompting questions as to the validity of salvage data as an indicator of SWP entrainment. Studies have been proposed to attempt to quantify the apparent disparity; the value of this work is unclear to some, since it is generally agreed among the Working Group that the indirect effects of the export projects, also as yet unquantified, may in many years be more important than the direct effects of entrainment. Others believe that the direct effects of exports may be substantial, but only at specific times, and that more study is warranted; credible estimates of entrainment are needed before it can be said that its effects are understood. Some believe that a quantitative estimate of pre-screen loss will not contribute substantially to the precision of what is likely a very small survival estimate. Use of juvenile salmon as a surrogate for delta smelt in directed studies has been proposed. Historic salvage data across species, however, does not show a consistent pattern to indicate that pre-screen losses are higher at the SWP. Since no reliable data is available to quantify the meaning of salvage statistics, improved analysis of existing salvage data, combined with the ongoing South Delta studies, are at present the best options available. However, the potential value of further studies should not be ruled out.

No salvage of larval or juvenile delta smelt was observed at either the SWP or the CVP. This was also unusual, as juvenile salvage generally far outstrips the salvage of adults (Table 4, Figure 2). It seems likely that there were two reasons for this. First, delta smelt smaller than 20 mm in total length are difficult to

detect and are not generally reported by the Projects. Second, strong, positive outflow occurred throughout the winter and spring, keeping the zone of entrainment small relative to most years and minimizing the likelihood that juveniles would be salvaged. The center of distribution of adults as indicated by the Spring Kodiak Trawl survey (Figure 4) was such that the Working Group believed that most spawning would occur in the lower Sacramento River, Suisun Bay and Napa River areas. This appears to have been borne out by the distribution of larvae as indicated by the 20-mm Survey (Figure 5).

Considerable discussion has also taken place as to whether or not salvage by the Projects has had a significant effect on the delta smelt population as a whole. Rates of salvage may not be reflective of the effects of water project operations on delta smelt. In years when delta smelt appear to be abundant and/or widely distributed, even relatively high salvage may not be of particular concern. However, in years of apparently low abundance and/or limited distribution, particularly when the center of distribution is east of the confluence, even relatively low salvage may be problematic. Noting that losses of delta smelt larvae smaller than 20 mm were a key unknown, Bennett (2005) cited analyses indicating that daily rates of loss may not appear substantial but nevertheless pointed out that cumulative losses of juveniles may be substantial in some years. In a presentation of preliminary analyses of delta smelt entrainment, Kimmerer (personal communication, 2006) estimated that at times, cumulative entrainment of delta smelt larvae may be as high as 30%, making it an important source of mortality. Recent estimates of adult delta smelt entrainment made by Pete Smith (personal communication, 2006) indicate that it is possible that the percentage of the adult population entrained during the POD years could be in the range of 10 to 60 percent. It must here be emphasized that the uncertainty in estimates of both delta smelt entrainment and populations is very high. Reducing the uncertainty in the estimates of entrainment would require new field experiments to measure delta smelt mortality in Clifton Court Forebay and the efficiency of the louvers at the Skinner Fish Facility. Such an effort has recently been proposed by Gonzalo Castillo (personal communication, 2006), but results would not be available for some time.

Many of the conceptual models used in the implementation of the EWA are poorly defined, include untested assumptions and/or rely on unproven relationships (Hymanson and Brown, in press, Poage, 2004). In recent years, the Delta Smelt Working Group has taken great pains to detail for the Service the technical basis for the potential fish actions that they have considered and for the fish actions that they have recommended (Delta Smelt Working Group 2005, 2006). Although the Working Group's meeting notes are publicly available, it seems likely that they are used by only a small core group, and to date little effort has been made to formalize or to broadly disseminate this information to a

larger audience. This oversight should be corrected and the conceptual models used by the Working Group and others should be more widely discussed. This can only result in honing the conceptual models and improving the overall implementation of the EWA.

Further Considerations

Changes in available CALFED Bay-Delta Program funding combined with the need to implement water supply, water quality, levee, and ecosystem restoration projects lead to user contribution negotiations regarding project implementation and regulatory and funding assurances. The result of the negotiations was the development of a Memorandum of Agreement[2], signed in July of 2006, which furthers the development of the Bay-Delta Conservation Plan (BDCP). As a result, the draft Planning Agreement regarding the BDCP[3] (Planning Agreement) was prepared and describes the commitments regarding development of the BDCP and identifies preliminary conservation objectives.

The BDCP will be a conservation plan that will meet the requirements of the state and federal Endangered Species Acts and/or the Natural Community Conservation Planning Act. The BDCP will address covered activities for which applicants may seek take authorizations under California Fish and Game Code (sections 2080.1, 2081, and/or 2835) and serve as a Habitat Conservation Plan under the federal ESA. The planning goals of the BDCP include:

- Provide for the conservation and management of covered species within the planning area;
- Preserve, restore and enhance aquatic, riparian and associated terrestrial natural communities and ecosystems that support covered species within the planning area through conservation partnerships;
- Allow for projects to proceed that restore and protect water supply, water quality and ecosystem health within a stable regulatory framework,
- Provide a means to implement covered activities in a manner that complies with applicable state and federal fish and wildlife protection laws, including CEQA and NEPA;
- Provide a basis for permits necessary to lawfully take covered species,
- Provide a comprehensive means to coordinate and standardize mitigation and compensation requirements for covered activities within the planning area;
- Provide a less costly, more efficient project review process which results in greater conservation values than project-by-project, species-by-species review; and

[2] The MOA may be found online at http://www.dfg.ca.gov/nccp/bdcpexhb.pdf
[3] The draft Planning Agreement may be found online at http://www.dfg.ca.gov/nccp/bdcppa.pdf

- Provide clear expectations and regulatory assurances regarding covered activities occurring within the planning area.

The Planning Agreement identifies the parties' commitment to development the BDCP and describes an interim project process to ensure that new projects approved or initiated in the Planning Area prior to BDCP approval are consistent with the preliminary BDCP conservation objectives and facilitate CEQA, CESA, and FESA compliance. This process will help protect habitat and resources during the planning process, including in addition to the regulatory baseline, the continuation of the Ecosystem Restoration Program, the POD studies and the EWA. The BDCP is on a fast track for development and implementation and is expected to be completed in 2008.

The MOA recognized that the EWA implementing agencies and others agreed to conduct a comprehensive review of the EWA before July 1, 2007, to inform decisions regarding the purpose and need for a long-term environmental water account. The expectation for the comprehensive review of the EWA will be that the review will focus on the biological benefits of the program, in particular, benefits to delta smelt. In this process it will be important to consider the original purpose and intent of the EWA as well as its underpinnings. The EWA was intended to provide water for the protection and recovery of at-risk fish species *beyond what was available through existing regulatory mechanisms*. In other words, the regulatory baseline was assumed to be adequate to prevent further losses to at-risk species, but not sufficient to promote recovery. However, it may be argued that the regulatory baseline has failed to provide the basic safeguard for which it was mandated. EWA cannot be expected to perform a function for which it was not intended; therefore it seems appropriate to examine the regulatory baseline as well. To some extent, this will occur through the reinitiation of formal consultation on OCAP, but should be explicitly discussed in an open forum as well. Conversely, some have argued that the biota of the upper estuary has not been affected by water management, and that species declines have occurred for other anthropogenic reasons, including the introduction of contaminants, invasion of non-native organisms and alterations of the food chain. Whatever their role, these potential decline factors are not readily remediable through the regulatory process, making their abatement problematic. Because water project operations are highly visible and somewhat amenable to manipulation, the expectation for threat abatement via the modification of water project operations may have been unreasonably inflated. Ongoing investigations into the causes of the decline of pelagic organisms may not yield results in a timeframe optimal for management decision-making, further elevating pressure to modify water operations to minimize project impacts. Sorting out the relative contributions of all potential factors in the

decline of delta smelt and other pelagic organisms in the upper estuary is expected to remain a priority for some time.

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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[4]
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	26	4
2006	0.4		21
Median	8.1	366	101
Min.	0.3	26	17
Max.	62.5	1673	589

[4] 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 2006.

Action	Dates	Facility	Amount in TAF	Species Benefited
DCC Gate Closure	Dec	CVP	0[a]	Sacramento River WR Chinook
Pre-VAMP Shoulder	Apr - May	SWP	3	San Joaquin River FR Chinook
VAMP	May - Jun	SWP	55	San Joaquin River FR Chinook
Post-VAMP Shoulder	Jun	SWP	91	San Joaquin River FR Chinook
Total for WY 2006				

[a]no EWA assets were used; this action used only CVPIA (b)(2) assets at the CVP

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	WY 2005	Species Benefited
Oct			5[a]	Salmonids	13[b]	Salmonids				
Nov			15[a]	Salmonids						
Dec					32	Salmonids			4.2	Salmonids
Jan	69	Salmonids	66	Salmonids/Smelt	89	Salmonids/Smelt				
Feb	69	Salmonids/Smelt							44.3	Delta Smelt
Mar	65	Salmonids/Smelt								
Apr	29	Salmonids/Smelt	28	Salmonids/Smelt	19	Salmonids/Smelt	13	Salmonids/Smelt	121.9	Delta Smelt
May	49	Salmonids/Smelt	149	Salmonids/Smelt	208	Salmonids/Smelt	111	Salmonids/Smelt	134	Salmon/Smelt
Jun	9	Salmonids/Smelt	5	Salmonids/Smelt					34.7	Salmon/Smelt
Total	290		248		348		124		339.1	

[a]release of PCWA purchase from Folsom Reservoir, timed for flow and temperature benefits
[b]power generation bypass at Folsom Dam

Table 4. Tabular summary of salvage 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 Salvage[a] (Drier)	WY 2002 Combined Salvage (Drier)	WY 2003 Combined Salvage (Drier/Wetter)	WY 2004 Combined Salvage (Drier)	WY 2005 Combined Salvage (Wetter)	WY 2006 Combined Salvage (Wetter)
December	192	1,129	2,776	126	0	0
January	181	5,231	9,561	4,594	1,647	36
February	3,870	280	1,494	1,161	371	72
March	3,772	225	483	2,177	0	216
April	520	372	492	276	0	12
May	13,170	47,361	16,309	5,749	547	0
June	2,418	11,926	10,096	6,392	1,181	0
Total	26,124	66,526	41,211	20,475	3,746	336

[a] Salvage reported on USBR's Central Valley Operations website, www.mp.usbr.gov/cvo/html/fishrpt.html
[b] based upon the 90% exceedence forecast, which is updated each month throughout the water year

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

1995 / 2005	**December**	**January**	**February**	**March**	**April**	**May**	**June**
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

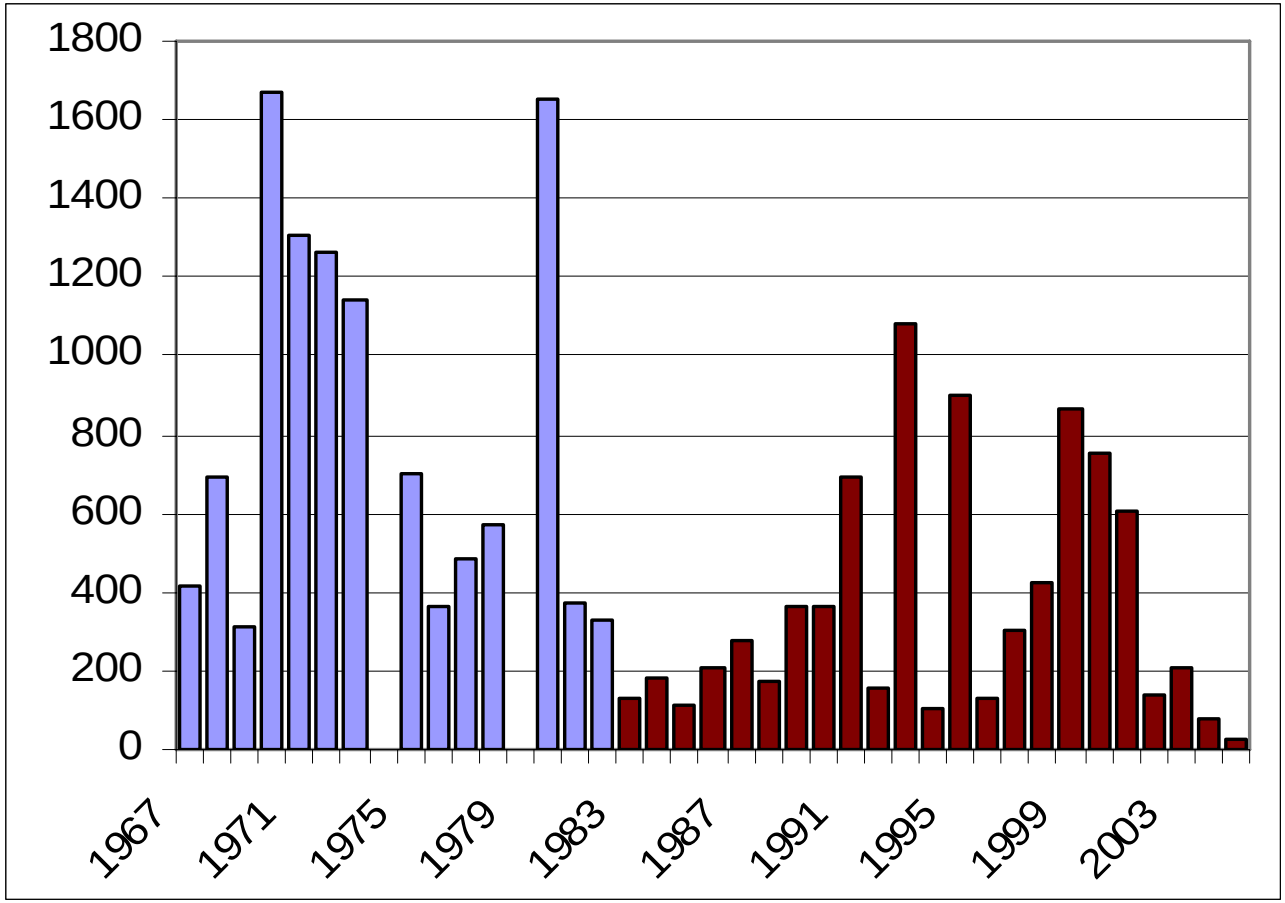


Figure 1. Delta smelt fall mid-water trawl index, 1967-2005.
Post-decline years are in red.

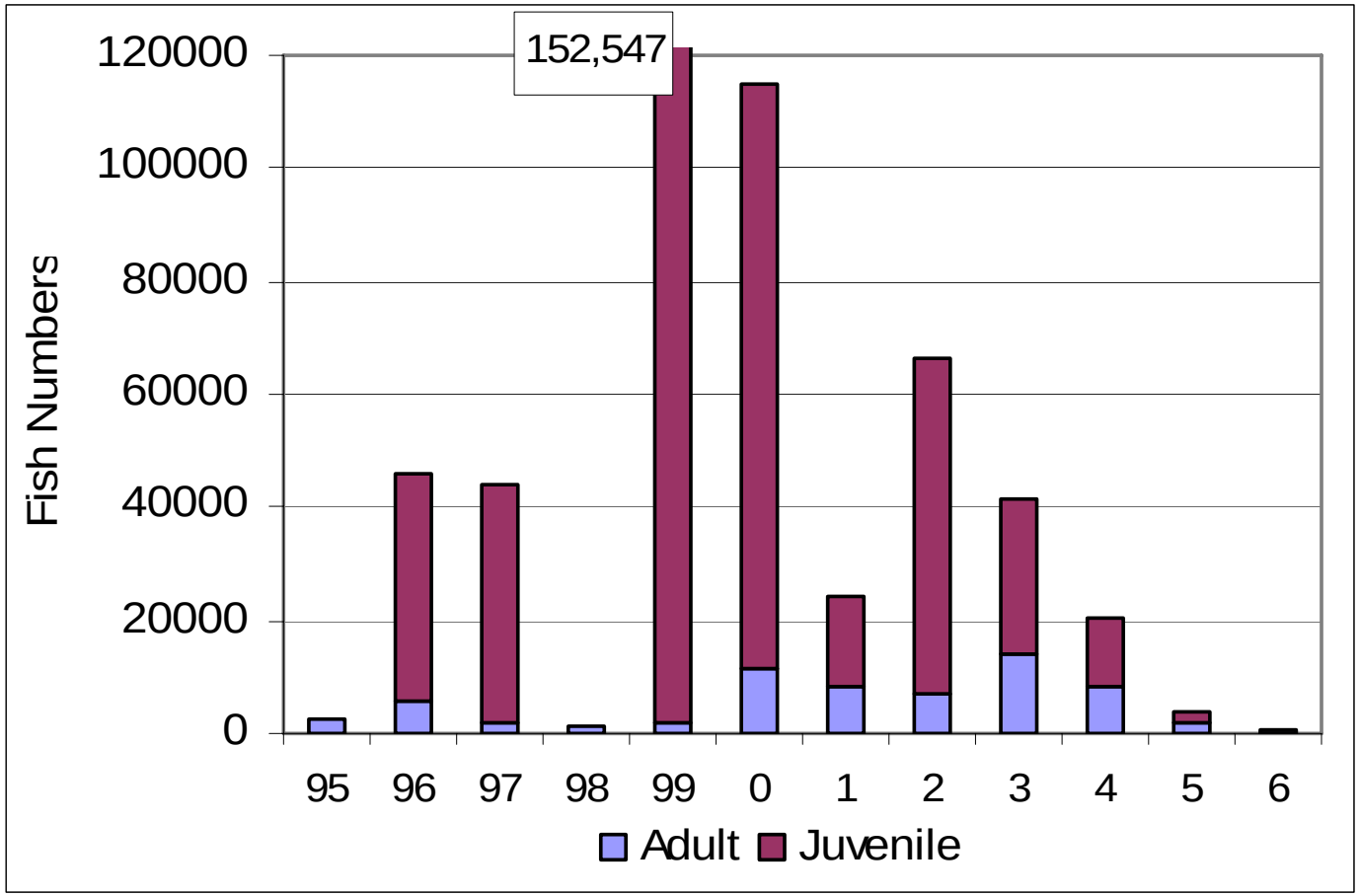


Figure 2. Salvage of delta smelt at the State and Federal export facilities for December through July, 1995-2006. The period of December 1 through March 31 is assumed to comprise mainly adult salvage, while the period of April 1 through July 31 is assumed to comprise mainly juvenile salvage.

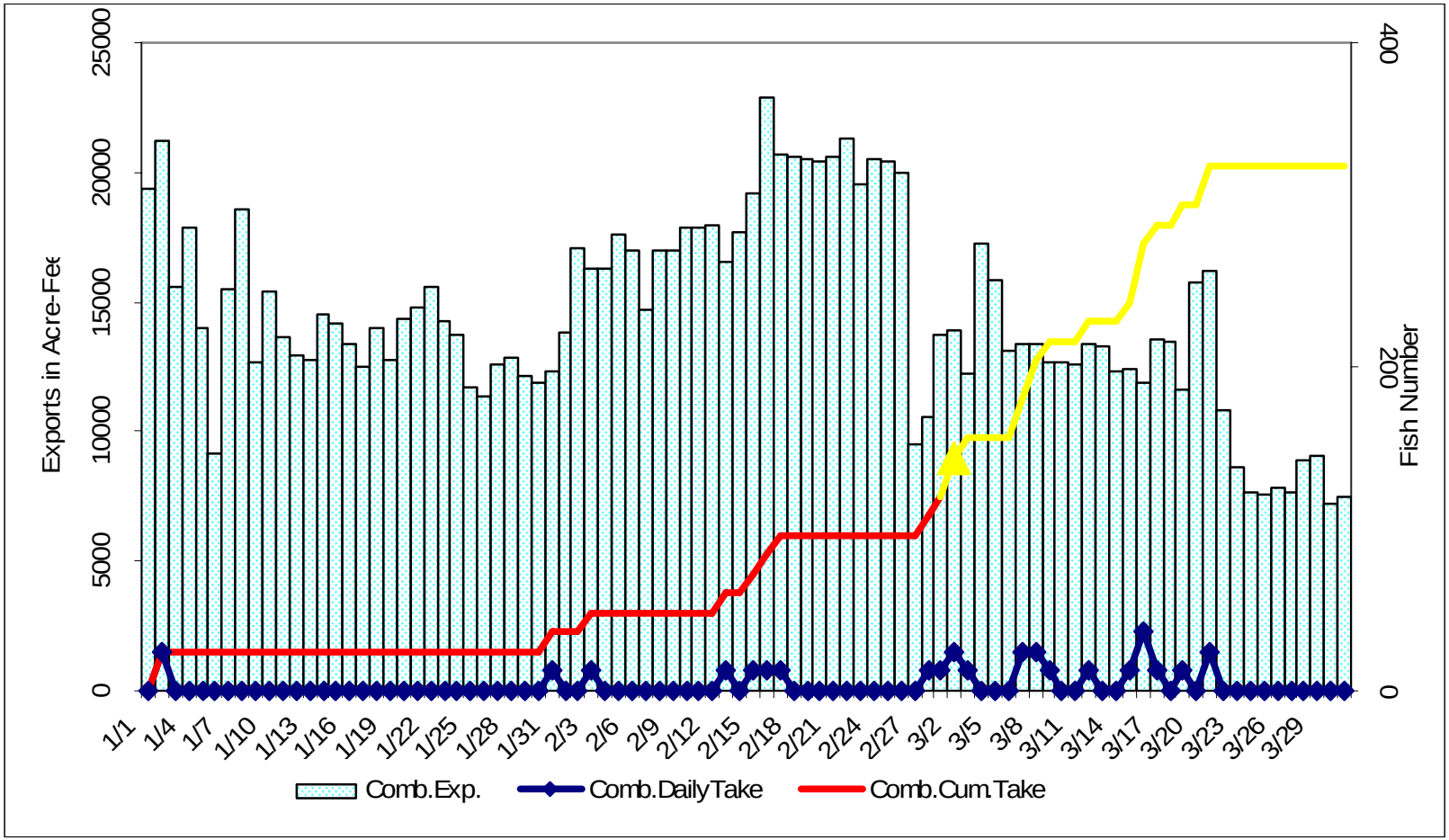
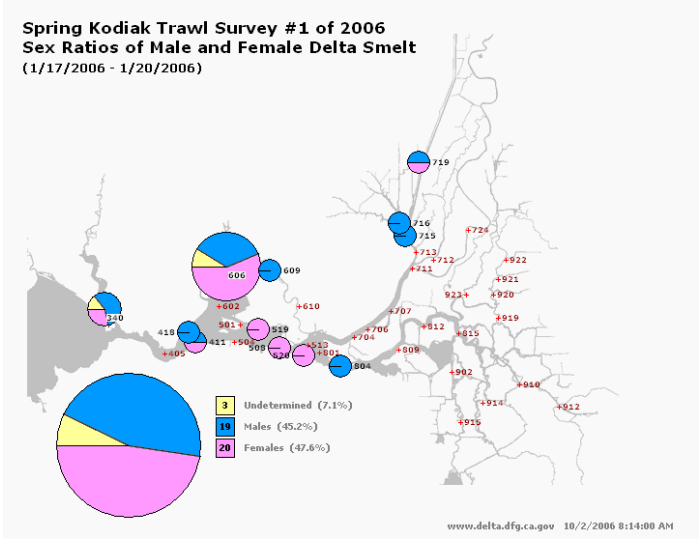
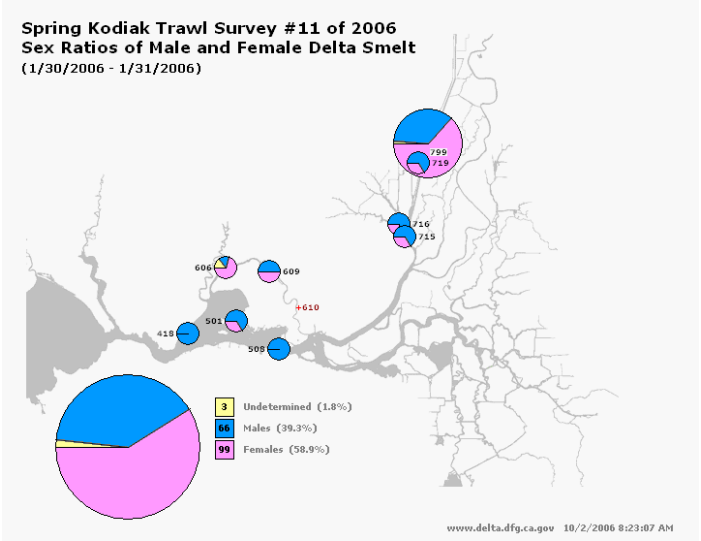


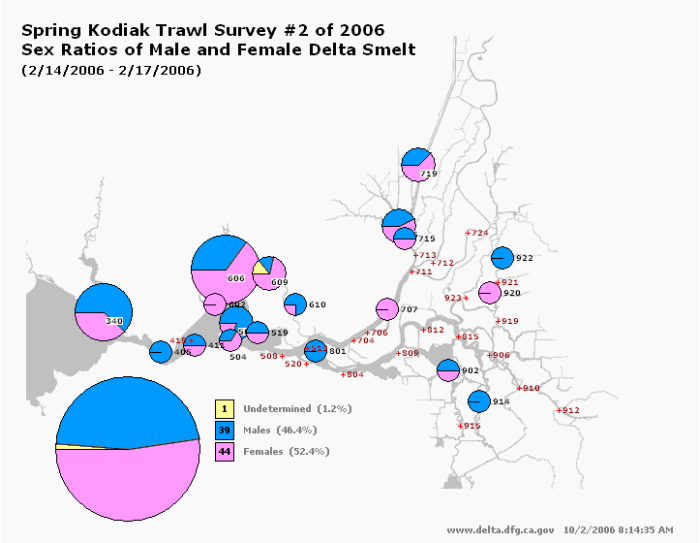
Figure 3. Salvage of adult delta smelt at the CVP and SWP (combined) overlaid on combined Project exports for January 1, 2006 through March 31, 2006. Salvage did not occur in December. The yellow diamond indicates where the Concern Level of 143 was exceeded.



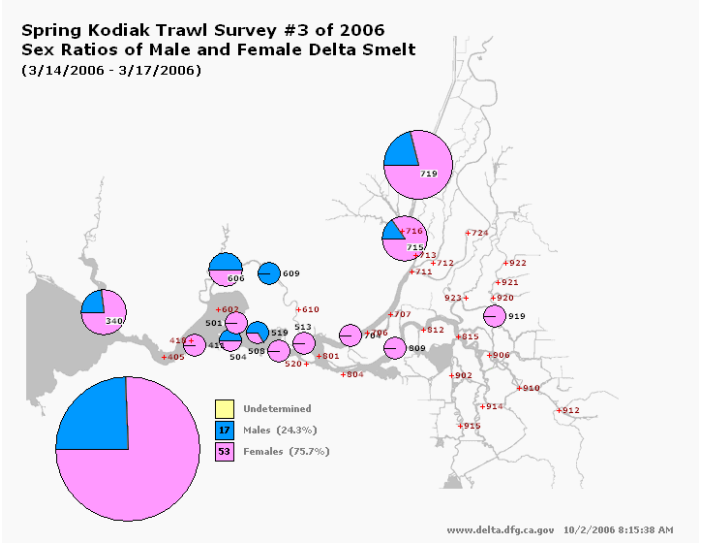
a.



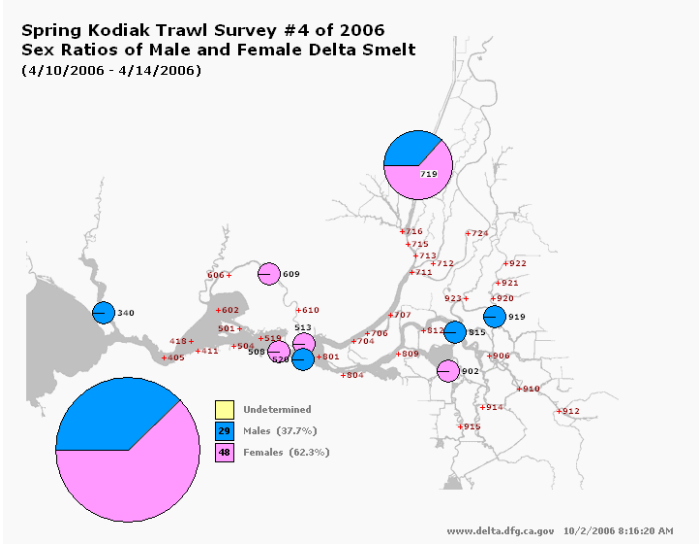
b.



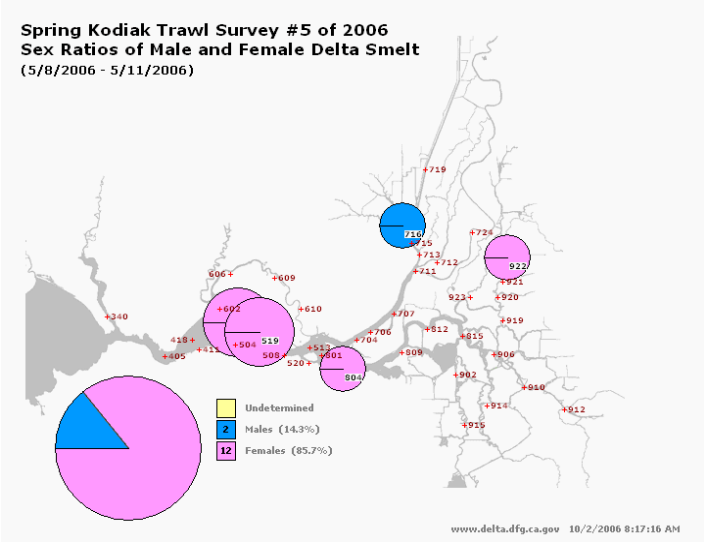
c.



d.



e.



f.

Figure 4. Graphic representation of abundance and distribution of adult delta smelt in water year 2006, as indicated by CDFG Kodiak Trawl Survey sampling.

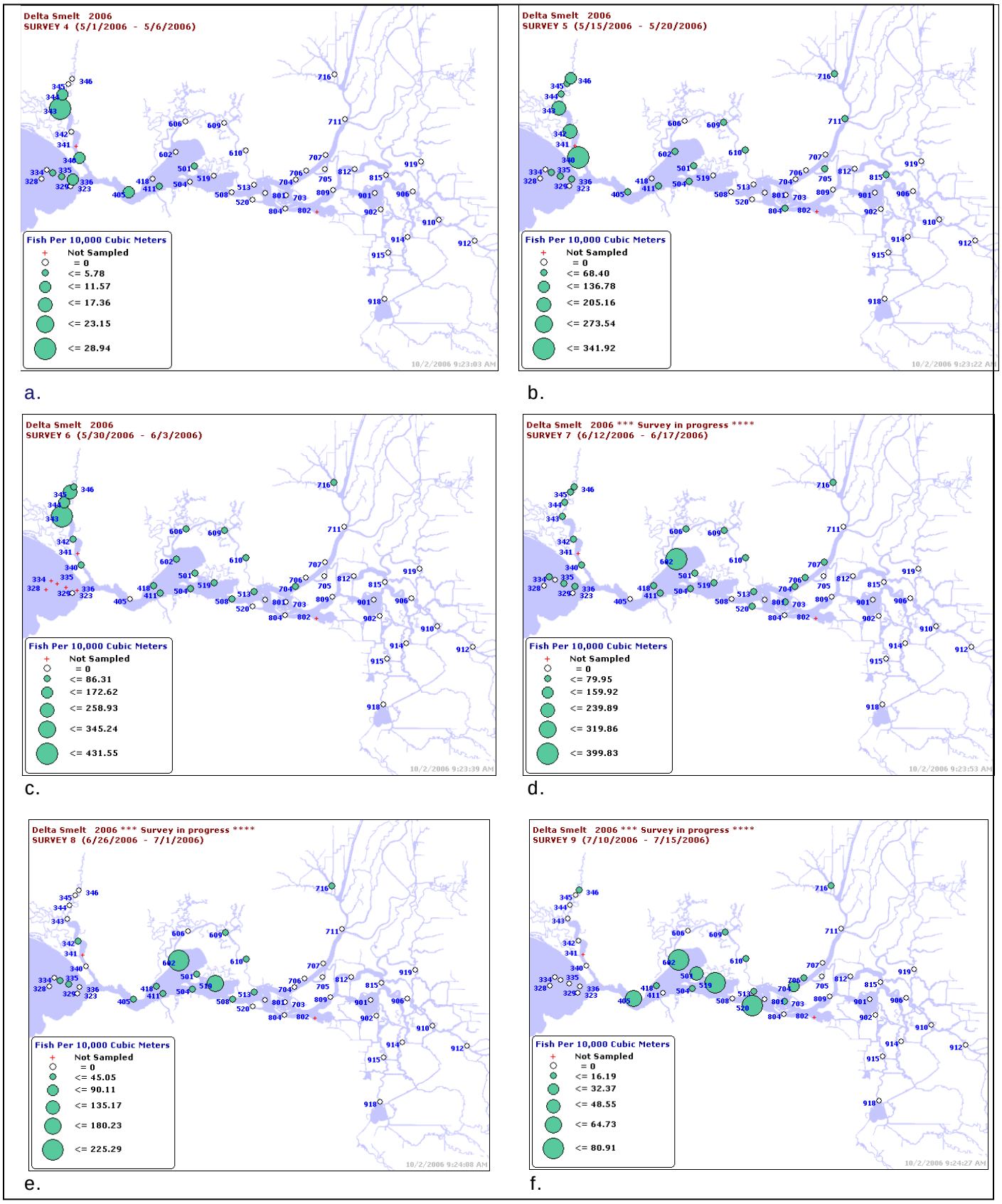


Figure 5. Graphic representation of abundance and distribution of young-of-year delta smelt in water year 2005, as indicated by CDFG 20-mm Survey sampling.

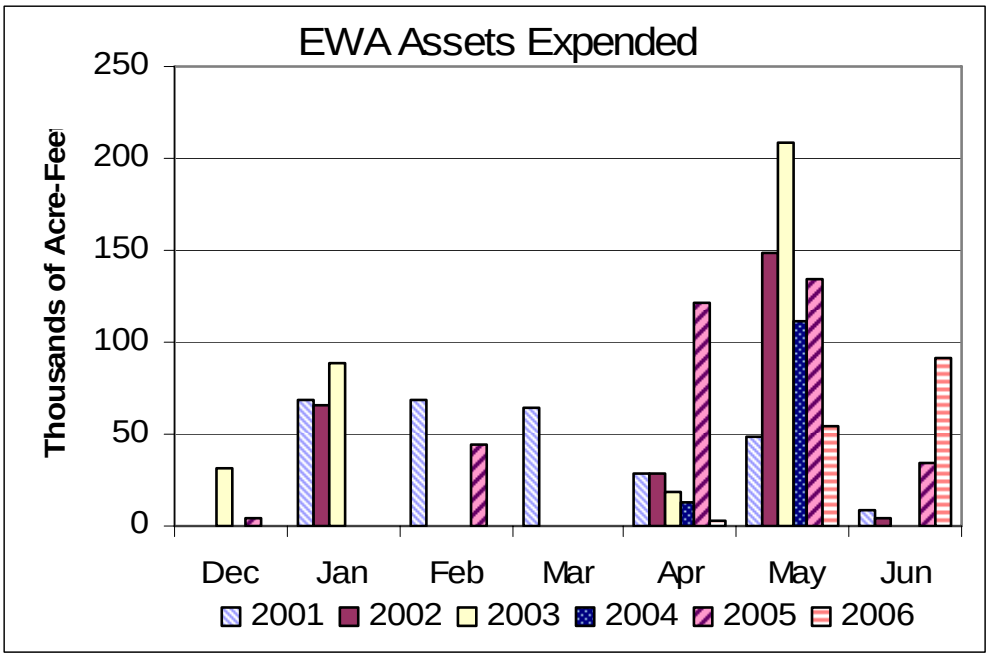


Figure 6. EWA assets expended annually, by month.

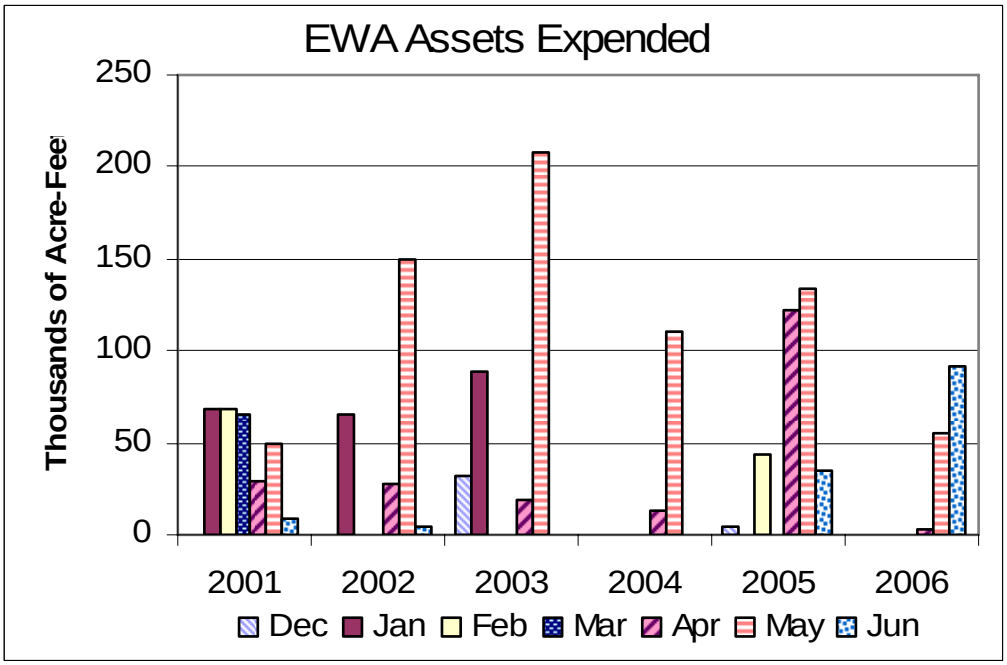


Figure 7. EWA assets expended monthly, by year.