EXHIBIT P

TO SWANSON DECLARATION

California Resources Agency Action Matrix (draft November 22, 2006)

Timing	Experiment	Triggers	Scientific Uncertainty[1]	Action	Evidence	Response Variable(s)	Detection[2]	Time to Detection[3]	Ongoing Studies
Late Spring	VAMP (larvae)	Existing VAMP protocol determines experimental conditions	Low	VAMP with no South Delta Barriers	Hatch date distributions from FMWT in recent years largely encompassed by VAMP period	Otolith-based hatch dates from FMWT fish	medium	1 year	FMWT & Otoliths
Winter/Early Spring	X_2 and O&M R Flows (larvae)	If on March 1st X_2 14 day running average is east of 65 km, then take action when ripe females found in SKT and/or Delta water temperatures reach ≥12°C	Medium-high	O&M R flow at zero or positive for at least 2 weeks prior to VAMP (the longer provided the more likely to see a response)	• Larger larvae in 20MM survey 4 • Ripe smelt months in advance of most FMWT survivors	1. Otolith hatchdates from FMWT fish 2. Higher FMWT Index 3. Increased number and/or proportion of larger larvae by 20 mm survey 4 4. Larger fish in FMWT	1. Medium 2. Low 3. Medium 4. Low	1. 1 year 2. 5 years 3. 2-5 year 4. 5 year	1. FMWT & Otoliths 2. FMWT 3. 20MM 4. FMWT
	Winter O&M River Flows (adults)	Take action if flows are less than -3500cfs	High	Maintain O&M River flows greater than -3500cfsJanuary and February	Relationship between O&M River flows and adult salvage	Salvage decrease in line with salvage vs. flow regression analysis Effect on population contingent on subsequent conditions affecting survival	High	1 year	O&M River flow monitoring Fish facilities sampling
Summer	Daytime operations of Clifton Court Radial Gates (food web enhancement)	Take action when water temperatures ≥24°C	High	Operate Clifton Court Radial Gates only during the day	• Pseudodiaptomus forbesi epicenter in central Delta • Delta smelt-P. forbesi distribution overlap	1. Higher plankton abundance in Suisun/west Delta; increased P. forbesi co-occurrence with smelt 2. Higher ratio of *P. forbesi* nauplii to adults 3. Better glycogen scores from TNS and/or FMWT smelt	1. Low 2. Low 3. Low	1 and 2. 1 year; if a new *P. forbesi* flux experiment initiated 3. 5 years	FMWT, TNS, Histopathology Neomysis/ Zooplankton survey, 20mmSurvey Zoopl data
Summer-Fall	Summer-fall X_2 positions (Juveniles)	Take action if October-April precipitation has been above-normal If below-normal or drier water year type, no added summer-fall X_2 action	High	$X_2 \leq 80$ km during May-December	• Fall hydro change • Fall X_2 (salinity) change • Fall Environmental Quality Index change	1. Measures of EQ index 2. Broader fish distribution 3. Higher TNS index in following year 4. Improved health of smelt in fall (histopathology) 5. Reduced adult entrainment following year 6. Improved fall-summer stock-recruit relationship	1. High 2. High 3. Low 4. Low 5. Low 6. Low	1. 1 year 2. 2-5 years 3. years 4. 5 years 5. Unknown 6. 5 years	FMWT, Histopathology and other summaries of IEP monitoring datasets
Summer	Summer Yolo Bypass connectivity (Food web enhancement)	No trigger necessary	Very High	Explore ways to add Yolo Bypass flow into Cache Slough during summer	• Yolo bypass generates primary productivity • Net flows move upstream at Cache Slough	Net flow in Cache Slough and *P. forbesi* flux down Cache Slough	Low	Unknown	Requires initiation of a zooplankton flux study in Cache Slough and adjacent areas

[1] Scientific Uncertainty – indicates the confidence that the proposed Action will have a demonstrable population benefit.
[2] Detection – confidence in our ability to detect change in response variable
[3] Time to Detection – Rough estimate of time required to see action affect on response variable. Note: although many of the response variables could show a response in the first year, one year's worth of data (positive or negative) is not sufficient to test the effectiveness of the action.

EXHIBIT Q

TO SWANSON DECLARATION

PELAGIC FISH ACTION PLAN

March, 2007

RESOURCES AGENCY
CALIFORIA DEPARTMENT OF WATER RESOURCES
CALIFORNIA DEPARTMENT OF FISH AND GAME

Pelagic Fish Action Plan

March, 2007

Resources Agency
California Department of Water Resources
California Department of Fish and Game

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Executive Summary

In June 2006, the Legislature directed the Resources Agency to report on proposed actions to address the pelagic organism decline (POD) and stabilize the ecosystem in the Sacramento-San Joaquin Delta. This report responds to that request and builds on the Delta Smelt Action Plan, a 14-point program of scientific research activities and studies which was prepared by the Resources Agency in October 2005.

Pelagic organisms live in the ocean or estuaries like the Delta. Since October 2005, there has been significant scientific study on declining native fish populations in the Delta. The Interagency Ecological Program (IEP), consisting of scientists and managers representing six federal and three state agencies, has 45 studies and monitoring programs underway to determine possible causes for the POD. Over the coming year, IEP's ongoing collaboration with the National Center for Ecological Analysis and Synthesis at the University of California, Santa Barbara is expected to yield important scientific findings. More solution-guiding information has come from other efforts, including work that was presented at the CALFED Science Conference on October 24, 2006.

In July 2006, under the auspices of the Federal Endangered Species Act (ESA), the U.S. Bureau of Reclamation (Reclamation) requested a reconsultation with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service (USFWS) on the State Water Project (SWP) and Central Valley Project Operations, Criteria and Plan (CVP-OCAP). Many of the proposed actions described in this report will be done in coordination with this reconsultation process. Using fresh scientific information from the current POD studies, the reconsultation process will help formulate a more accurate and comprehensive approach to improving Delta ecosystem health for pelagic fish.

The following is a summary of the actions being implemented or under active evaluation to help stabilize the Delta ecosystem and improve conditions for pelagic fish species.

Comprehensive Ecosystem Evaluation Actions

- **Reconsultation under the Federal ESA Related to the Operations of the CVP and SWP** – *Under the ESA, Reclamation requested re-initiation of formal Section 7 consultation with USFWS on the long-term coordinated operation of the CVP and SWP, due to changed conditions for delta smelt.*

  Status: *New. Reconsultation was initiated in June 2006 and will take one to two years.*

  Costs: Consultation costs are unknown. The costs of any additional actions that may be required by a new biological opinion from USFWS are unknown.

- **Initiation of the Process to Develop the Bay-Delta Conservation Plan (BDCP)** – *The BDCP is intended to cover future actions (e.g. water operations and management) by the plan participants who need federal and state ESA take coverage. DFG initiated the process to enter into a planning agreement with the participants under the Natural Community Conservation Planning Act (NCCPA) to define the planning goals, preliminary conservation objectives, and provide a list of the natural communities and endangered, threatened, candidate, or other species that occur, or have the potential to occur in the Delta planning area.*

Status: *New.* The Planning Agreement for the BDCP dated October 6, 2006 has been signed by members of the Steering Committee and can be found at http://resources.ca.gov

Costs: For calendar years 2006 and 2007, Reclamation and DWR are contributing approximately $3 million annually for DFG, USFWS, and NMFS staff and administrative costs related to the development of the BDCP.

Water Project Operations

- **Minimize Net Upstream Flows in Old and Middle Rivers from January to February 15th to 3,500 cfs, or 3,500-5,000 cfs (winter/early spring)** *- Limit the upstream (i.e. reverse or southward) net flow in Old River and Middle River to 3,500 cfs or 3,500-5,000 cfs from January through February 15, depending on water temperature and Sacramento River flow. Increased (more positive) ORMR flows may reduce adult delta smelt entrainment losses at the SWP and CVP intakes, and may also provide a better spawning distribution and reduce subsequent larval entrainment.*

  Status: *New.* The Delta Smelt Working Group (DSWG) reviewed this action and recommended its implementation to the Water Operations Management Team (WOMT). The WOMT approved this action in December 2006.

  Costs: Water costs may be highly variable depending on hydrologic conditions and export demand. Costs were estimated at the level needed to keep flows greater than 3500 cfs in Old and Middle Rivers. If the action were triggered in late December and continued through mid-February, the estimated maximum total water cost would be 580 TAF depending on the amount of export reduction needed to keep flows within the set parameters.

- **Maintain Net Downstream Flow in Old River and Middle River Flows prior to the Vernalis Adaptive Management Program (VAMP) Period (early/late spring)** *- At least two weeks prior to VAMP, maintain net flows in Old and Middle Rivers at zero or positive (downstream or northward) to reduce entrainment losses of larval delta smelt. If March 1 14-day running average X2 position is east (upstream) of 65 kilometers (km), then trigger action when ripe or spent females are found in the Spring Kodiak Trawl (SKT) or within 10 days of Delta water temperatures reaching 12° C.*

  Status: *New.* The DSWG is reviewing this action. Recommendations on implementation will be forwarded to the WOMT for consideration and approval. The decision whether to implement an action would be made on a real-time basis dependent on the specific criteria and conditions for the potential action.

  Costs: Water costs may be highly variable depending on hydrologic conditions and export demand. Estimated water costs for an action during the first two weeks in April range from 35 TAF to 37 TAF. If the action were to extend back to March 1 and continued until mid-April, the estimated maximum total cost would be about 553 TAF

- **No South Delta Barriers during VAMP and until June 1 (late spring)** *- Postpone installation of south Delta barriers until June 1 to reduce the proportion of water drawn towards the pumps from the central and south Delta in order to reduce entrainment losses of larval delta smelt.*

Status: *New.* The DSWG is reviewing this action, and recommended it for implementation to the WOMT. The WOMT is considering this action.

Costs: If this action delays ramping up of exports in late May, there may be costs associated with the action. The maximum estimated cost for two weeks in May would be about 104 TAF, and assumes the VAMP combined export level of 1,500 cfs would continue through May 31.

- **Maintain X2 West of Collinsville during May-December (summer/fall)** - *Increase Delta outflow to maintain an average X2 position west (seaward) of Broad Slough (80 km) near Collinsville from May through December to increase the amount of delta smelt habitat and shift it downstream. Winter entrainment may be reduced and food availability may be improved.*

  Status: *New.* The DSWG is reviewing this action. Recommendations on implementation will be forwarded to the WOMT for consideration and approval.

  Costs: This action is estimated to cost up to 425 TAF with most of the water costs occurring September-November. In below normal water years, the water costs would exceed 1 million acre-feet and such flows cannot be provided by storage releases without dramatic effects on storage levels and temperature conditions for fish upstream in the fall. Therefore, it is impractical to proceed with such flows in below normal and drier years.

Food Web Actions

- **Provide Flows through Yolo Bypass into Cache Slough (summer)** -*Yolo Bypass has high primary productivity in summer, but net flows move upstream from Cache Slough. Increase summer flow connectivity from the bypass to downstream areas to provide for net downstream transport of productivity. Explore ways to add Yolo Bypass flows into Cache Slough during summer.*

  Status: *New.* Implementation in the coming year is unlikely due to the need to develop specific plans, and permit and construct any physical modifications.

  Costs: Costs are unknown at this time and would depend on the structural modifications needed.

- **Manage Flooding in North Delta for Seasonal Floodplain Habitat** – *Modify operations or land management to allow increased area and time of floodplain inundation in the Yolo Bypass and Cosumnes River floodplain. These actions would increase productivity of phytoplankton and zooplankton in order to support adults and egg production in fall, egg production in winter, and young delta smelt in spring and summer.*

  Status: *Evaluating.* This action would likely require additional years to implement actions on the ground.

  Costs: Overall costs are unknown. Planning and environmental review, including conceptual models, are estimated at $500,000.

- **Sherman Island Floodplain Phytoplankton Pilot Project** – *Pilot project to construct mile-long floodways on Sherman Island to emulate floodplains and increase primary production. Water will enter through screened inlets and be pumped out into Sherman Lake by fish-friendly pumps.*

Status: *New.* Under consideration.

Costs: $5.5 - 8.2 million

Habitat Improvement Action

- **Restore Tidal Action to the Suisun Marsh, Blacklock Restoration Project** – *Restore tidal action to the 70-acre Blacklock property, a diked and managed marsh, within the next year using a minimally engineered approach. Restoration to tidal wetland ecosystems is expected to aid in the recovery of several listed and special status species within the marsh and improve food availability for delta smelt and other pelagic organisms.*

  Status: *Ongoing.* DWR constructed one levee breach on October 4, 2006 to return the site to full tidal restoration. A 10-year plan is being implemented to monitor changes in the biota, hydrodynamics, food web productivity, and water quality.

  Costs: DWR, Reclamation, and CALFED are funding the restoration work up to $1.3 million.

- **Restore Tidal Action to the Suisun Marsh, Meins Landing Project** – *Restore tidal action to the 668-acre Meins Landing project, a diked and managed marsh, within the next two years. Restoration to tidal wetland ecosystems is expected to aid in the recovery of several listed and special status species within the marsh.*

  Status: *Ongoing.* DWR acquired the property in December 2005. The planning process is underway, and restoration should be completed within two years.

  Costs: The property was acquired for $900,000, funded equally by the Coastal Conservancy, Reclamation and DWR. Up to $2 million is needed to implement the restoration project.

- **Dutch Slough Tidal Restoration Project** – *Restore tidal action and associated wetlands habitats to the 1,166 acre Dutch Slough Tidal Marsh Restoration Project. The restoration activities and long-term management are designed to contribute to the recovery of several listed and sensitive aquatic species in the western Delta, while providing sustainable ecosystem benefits to improve our understanding of ecological processes and how ecosystems function at different spatial levels.*

  Status: *Ongoing.* Waiting for additional funding. Prepare public draft Environmental Impact Report (EIR) for release in early November 2006 and the final EIR by early 2007. Restoration should be completed within three years.

  Costs: CALFED and the Coastal Conservancy funded the acquisition cost of $28 million. DWR is managing the site for the interim on limited funding. The Coastal Conservancy is funding the planning and environmental documentation. Construction of the preferred alternative is estimated at $30 million. Design, implementation, construction, and monitoring have not yet been funded.

Contaminants Management

- **Encourage Greater Enforcement of the California Water Code and the Clean Water Act for Control of Pyrethroids and Other Contaminants** – *Limit discharge of pesticides, such as pyrethroids and other contaminants, found to contribute to the decline in pelagic organisms or components of the food chain through industry and site specific permitting, TMDLs, implementation of Management Practices (MPs), pesticide shift, pesticide label changes and integrated pest management.*

  Status: *Ongoing.* Under evaluation.

  Costs: Costs are contingent on the types of actions implemented.

Invasive Species Actions

- **Increase Staffing at Agriculture Inspection Stations to Inspect Watercraft for Zebra Mussels and Other Invasive Species** – *Increase staffing and hours of operation at agricultural inspection stations to inspect all boats and watercraft on a 24/7 basis to prevent more aquatic invasive species from entering the state. Higher-cost control and eradication programs will not be needed if species that are potentially invasive are kept out of the state.*

  Status: *New.* Pilot program is being implemented in fiscal year 2006-07. Expansion of the program is being evaluated.

  Costs: About $3.5 million to $4 million annually for an additional 60 Plant Quarantine Inspectors to staff all 16 inspection stations. About half the inspectors are needed to change the part-time stations to full-time, and the other half are needed to resume private vehicle inspections at the current full-time stations.

- **Ballast Water Control** – *Adopt mandatory performance standards for ballast water treatment technologies. The California State Lands Commission (CSLC) January 2006 report to the Legislature recommends specific performance standards for the discharge of ballast water into the waters of the state. New ballast water regulations that pertain to ships traveling between ports within the Pacific Coast region became effective March 22, 2006*

  Status: *Ongoing.* Performance standards for ballast water discharge take effect with the recent signing of Assembly Bill (AB) 497 into law, and would be fully implemented on or before January 1, 2008 under the new law.

  Costs: Costs are contingent on the types of actions implemented.

Other Actions

- **Fund Delta Smelt Culture Lab** – *Provide consistent, long-term funding for the continued operation of the University of California, Davis delta smelt culture and conservation laboratory to provide delta smelt for research.*

Status: *Ongoing.* New long-term funding needed.

Costs: $300,000 to $600,000 per year depending on the level of production.

- **Develop Delta Smelt Refuge Population** – *Develop a delta smelt refuge population at duplicate facilities to protect the species.*

  Status: *New.* Under consideration, funding needed.

  Costs: The estimated one-time cost for labor and facility upgrades at the UC Davis facility is $115,000 (2007-08 year). The cost of rearing fish for a breeding program is estimated to be $110,000 above baseline production costs of $300,000 to $600,000 depending upon production goals. Total costs may be $410,000 to $710,000. Costs at USFWS facilities are not known.

- **Assess and Reduce Power Plant Entrainment** – *Develop better data on current fish losses from Contra Costa and Pittsburg power plants to evaluate potential impacts and develop possible solutions. Implement measures that will reduce direct and indirect impacts to delta smelt and other pelagic species.*

  Status: *Ongoing and Under Evaluation.* The monitoring plan was completed in July 2006 and is being implemented. Reports are expected by January 2008. Measures to reduce take will be implemented according to monitoring results.

  Costs: Mirant's costs for the two-year study to monitor thermal effects, impingement, and entrainment are expected to be $800,000 to $1,500,000 per year for the two power plants, depending on the sample frequency. Costs of measures to reduce impacts are unknown.

Successful implementation of the Pelagic Fish Action Plan depends on several elements, including project management and coordination, scientific peer review of proposed actions, continuing feedback from scientific inquiry, monitoring the results of actions, and adequate funding. The plan was developed in coordination with Reclamation, NOAA Fisheries, and USFWS, and will be managed in close coordination with these agencies and the CALFED Science Program. DWR and DFG will periodically update the plan, pending the results of the ongoing POD studies. All new recommended actions will be scientifically evaluated and peer-reviewed through existing CALFED and IEP processes. Some of the actions have already undergone much of the necessary evaluation process and have an established peer and science review process in place, while other actions still require a more complete evaluation and science review before a decision is made on implementation. To the extent possible, implementation of this Action Plan would use or build upon existing review and evaluation processes in the programs that are currently underway.

Introduction

The San Francisco Bay and Sacramento-San Joaquin Delta (Delta) combine to form the largest estuary on the West Coast (Figure 1). The Delta encompasses roughly 1,600 square miles, provides drinking water for 70 percent of Californians, and irrigation water for millions of acres of farmland. The region supports a variety of natural wetland habitats, as well as a diverse population of wildlife and fish species. Additional background on the Bay-Delta can be found in the Delta Smelt Action Plan released by the Resources Agency in October 2005 at: *http://www.publicaffairs.water.ca.gov/newsreleases/2005/10-19-05DeltaSmeltActionPlan.pdf*.

The Bay/Delta estuary has been impacted for many decades by human activities, such as gold mining, flood protection, and land reclamation. In addition, more than 200 exotic species have been intentionally or accidentally introduced into the Delta. There are urban and agricultural contaminants throughout the system and water project operations have altered the natural amount, duration, direction, and timing of water flows through the Delta. Although these factors may contribute to recent changes in fish populations, more scientific research and analysis are essential to fully evaluate impacts on current conditions.

While several runs of salmon are still listed under the federal and state endangered species acts or experiencing low numbers, salmon populations in general have rebounded to levels not seen in decades. However, other aquatic species have experienced dramatic and unexpected population declines in recent years. Specifically, the population of delta smelt and several other pelagic (open water) fish and aquatic organisms has declined in the Delta.

The Interagency Ecological Program Identifies the Problem

The IEP for the San Francisco Bay-Delta is an estuary monitoring and research program conducted by three state and six federal agencies. The IEP in one form or another has collected data in the Bay/Delta Estuary for over 45 years. The state agencies are Department of Fish and Game (DFG), Department of Water Resources (DWR), and State Water Resources Control Board (SWRCB). The federal agencies are U.S. Army Corps of Engineers (Corps), Environmental Protection Agency (EPA), National Oceanographic and Atmospheric Administration-National Marine Fisheries Service (NOAA Fisheries), U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), and U.S. Geological Survey (USGS). These program partners work to develop a better understanding of the estuary's ecology. Work through IEP is complemented by work done through the CALFED Bay-Delta Science Program. The CALFED Bay-Delta Program is a collaborative effort comprised of 25 state and federal agencies who resolve longstanding issues in the Delta. Additional background on the IEP and CALFED Bay-Delta Program can also be found in the Delta Smelt Action Plan (Resources Agency 2005).

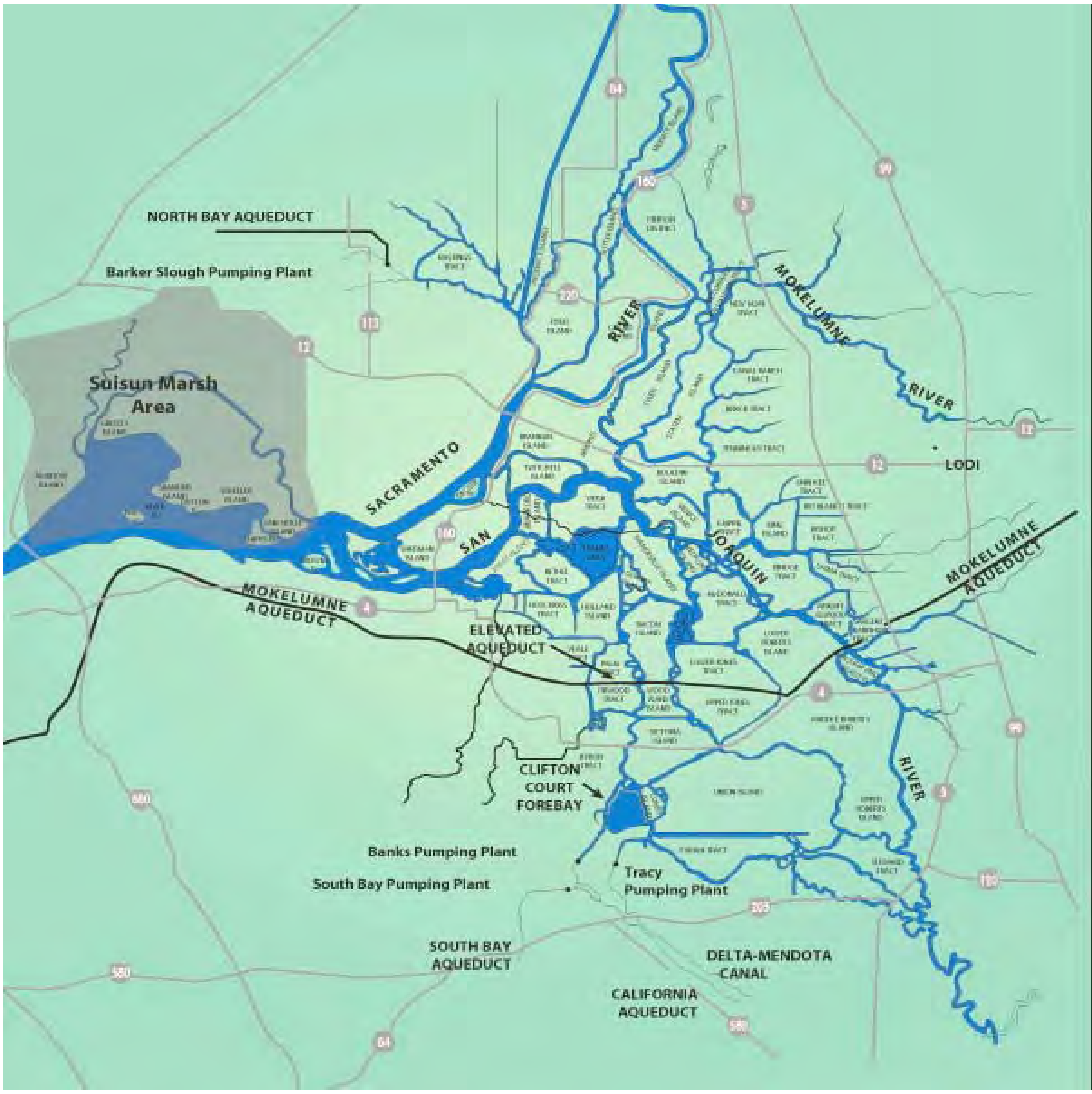

Figure 1. Sacramento-San Joaquin Delta

On February 9, 2005, IEP scientists announced their observation of a decline in pelagic organisms at a public California Bay Delta Authority (CBDA) meeting. At the time, analysis of IEP monitoring data led to the conclusion that declines in several organisms appeared to be a trend, rather than the more usual wide interannual variation in abundance that is somewhat typical for these organisms. The early disclosure of this conclusion to the public and to agency policymakers in this forum illustrates the improved communication that CALFED has fostered. While several of these declining species have shown evidence of a long-term decline, during the three-year period from 2002 to 2004 there appeared to be a more dramatic change. This was unexpected because the hydrological conditions in the San Francisco estuary during this period were believed to be relatively less harmful to fish species. The decline in multiple species also makes the changes during this period of particular concern.

For the three-year period, IEP monitoring identified declines in numerous pelagic fish in the Delta. The abundance indices from 2002 to 2004 include record lows of delta smelt and young striped bass, and near-record lows of longfin smelt and threadfin shad. In contrast, San Francisco Bay monitoring has not shown significant declines in marine and lower estuary species catches, and salmon populations, as mentioned above, have returned to levels not seen in the past 20 to 40 years. In addition to the changes in fish populations, IEP monitoring also found declining levels of zooplankton, such as copepods. These organisms are the primary food for larval pelagic fish and food for older life stages of species such as the delta smelt.

Based on these findings, the most recent decline appears limited to fish species and other organisms that are dependent on the Delta. The IEP developed an initial conceptual model that hypothesized there are at least three general factors that may be acting individually, or in concert, to lower pelagic productivity: 1) toxic effects; 2) exotic species effects; and 3) water project effects (IEP 2005a).

The Response

To address the decline in fish and zooplankton populations, a new IEP working group was formed in January 2005. As part of this effort, state and federal agency scientists are working with leading national environmental scientists to conduct focused and in-depth research activities on the Delta. To help investigate the causes of this unexpected decline, DWR and Reclamation initially authorized an additional $1.7 million in water project funds to augment the $13.5 million annual IEP budget for FY 2005-2006. The total for IEP work, including the POD in FY 2006-07, is $22.5 million. The IEP baseline budget is $12.7 million, with an additional $6.2 million directed towards water project facilities research. DWR and Reclamation are funding the FY 2006-07 POD work for $3.6 million. In addition, there is $2.2 million of CALFED Science Program grant funded work and about $700,000 in CALFED Ecosystem Restoration Program (ERP) funds that provide information and data needed for the POD efforts.

Currently, 45 POD-related studies and monitoring programs are under way. A report synthesizing all the information and data gathered in 2005 was prepared, presented at a public workshop in November 2005, and reviewed by an independent peer review panel in November and December 2005. Based on the peer review comments and recommendations, and information learned in 2005, a workplan for 2006-07 was prepared. The next “synthesis” report is scheduled for December 2007 and will be prepared in collaboration with the National Center for Ecological Analysis and Synthesis at U.C. Santa Barbara. Information and new findings will be made available to agency directors as it becomes available over the next two years.

A review of the new POD information presented at the October 2006 CALFED Science Conference, and subsequent discussions with the fish agencies and water operators, resulted in the development of a number of potential water operations actions. These actions for management of the Bay-Delta system this water year (2006-07), are based on recent hypotheses derived from this new information.

In addition to the IEP effort, the State also responded with the Delta Smelt Action Plan (Resources Agency 2005), to identify and understand the causes for the POD, and other actions to benefit the species. The plan, developed by DWR and DFG, describes current and future work that will provide more answers and guide efforts to restore and protect the Delta ecosystem.

The Need for the Action Plan

In October 2005, the Resources Agency released the Delta Smelt Action Plan. This 14-point plan, developed by DWR and DFG, was a compilation of scientific research activities and studies to identify and understand the causes of the POD, and identify other actions to benefit the species. Although the plan was specific to delta smelt, state and federal agencies recognized that a multi-species approach to species protection through habitat conservation would be a better strategy.

In June 2006 as part of the state budget process, the State Legislature asked for a report describing actions to stabilize changes in the Delta ecosystem and its pelagic organisms. In preparing the plan, DWR and DFG have reevaluated the actions identified in the Delta Smelt Action Plan in light of the latest information available, and have also considered actions suggested by the DSWG, State Water Contractors, environmental organizations and others.

The Budget Act for FY 2006-07 includes specific language related to the POD as follows:

Item 0540-001-0140—Secretary for Resources

1. Pelagic Organism Decline. The Secretary for Resources shall submit a report to the fiscal and policy committees of the Legislature by October 1, 2006 a report on the actions it will take, other than study, in the 2006-07 fiscal year, in an attempt to stabilize the ecosystem in the Delta and to address the Pelagic Organism Decline. The plan should include actions that address the three possible categories of causes of the ecosystem decline being evaluated by the Pelagic Organism Decline Team—water project operations, contaminants, and invasive species. The Secretary shall include actions that exercise all state legal authorities, including authorities for action by departments outside the Resources Agency.

The Resources Agency recognizes and shares the Legislature's concern for the natural resources of California. Although there is statewide concern for the current decline in pelagic species in the Delta, recognizing the limitations of current knowledge is important. Therefore, actions undertaken through this plan should have reasonable scientific support indicating that they will provide potential benefits to pelagic fish, other organisms, and the Delta ecosystem. Actions are also recommended that would be implemented by other California agencies and departments, and federal agencies.

Pelagic Organism Decline Overview

Pelagic Organism Decline (POD)

In the past few years the abundance indices calculated by the IEP Fall Midwater Trawl survey (FMWT) show marked declines in numerous pelagic fish in the upper San Francisco estuary (Figure 2). The abundance indices for 2002-2004 include record lows for delta smelt and age-0 striped bass, and near-record lows for longfin smelt and threadfin shad (Bryant and Souza 2004; Hieb and others 2005). Data from the IEP Summer Townet Survey (TNS) support the FMWT findings: TNS abundance indices for striped bass and delta smelt were among the lowest indices in the 45-year record. In contrast, the San Francisco Bay study did not show significant declines in its catches of marine and lower estuary species during this period (Hieb and others 2004; Hieb and others 2005). Figure 3 shows that the relationship between Delta outflow and the San Francisco Bay shrimp, Crangon franciscorum, has not changed over the past 25 years. Based on these findings, the problem appears to be limited, at this time, to fish dependent on the Delta.

It is important to note that none of the four species showed any large improvement in 2005 over the preceding three years, despite hydrology during 2005 that was presumed to be more favorable. Sacramento Valley water year types for 2002-2004 were dry, above normal, and below normal, respectively, and above normal for 2005. San Joaquin Valley water year types for 2002-2004 were dry, below normal, and dry, respectively, and wet for 2005. Based on historical observations, the abundance and distribution of these species would be expected to improve in years of moderate hydrology as occurred in 2005, but this was not the case. Low abundance for all four species persisted in 2005.

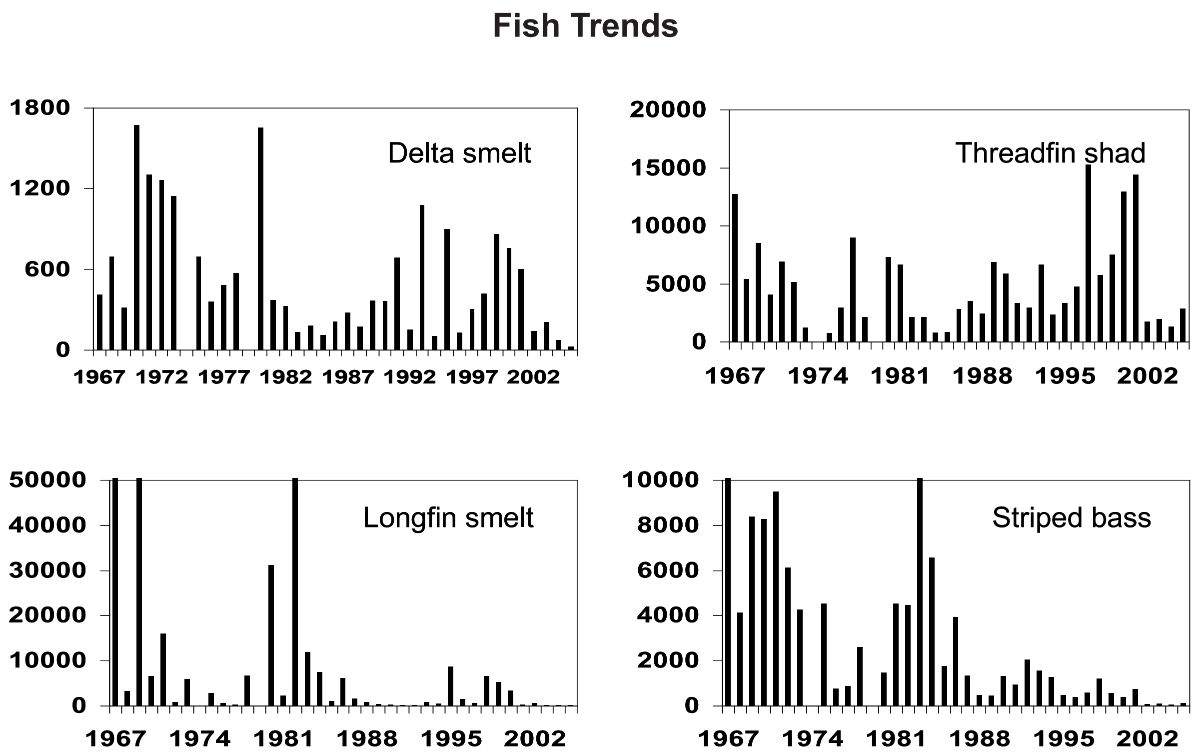

Figure 2. Fish trends depicting Delta pelagic organism decline, 1967-2005. (Source: DFG data)

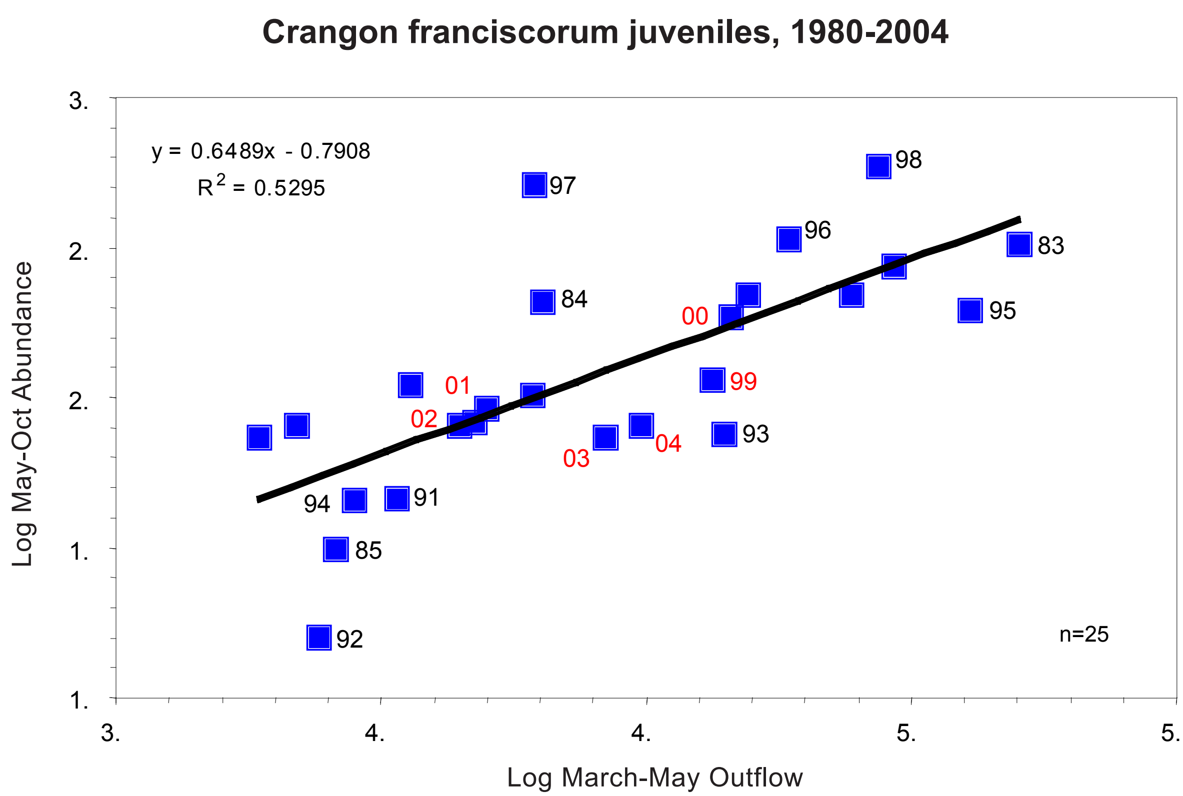

Figure 3. Crangon franciscorum abundance relative to Delta outflow, 1980-2004. (Source: DFG data)

In addition to the declines in fish species, IEP monitoring found declining abundance trends for zooplankton in the Suisun Bay region. Declining abundance was observed for calanoid copepods such as Eurytemora affinis and, more importantly, Pseudodiaptomus forbesi—the primary food for larval pelagic fish in the upper estuary (IEP 1987; Meng and Orsi 1991; Nobriga 2002) and older life stages of planktivorous species such as delta smelt (Lott 1998). Conversely, the invasive cyclopoid copepod, Limnoithona tetraspina, which may be a poor food source for fish and an intraguild predator of calanoid copepods, has increased in abundance and continues to be the most abundant copepod in the estuary (Mecum 2005).

While several of these declining species - including longfin smelt, juvenile striped bass and calanoid copepods - have shown evidence of a long-term decline, there appears to have been a precipitous step-change to very low abundance during 2002-2004. This observation is supported by initial statistical analyses of the FMWT data. Moreover, the record or near-record low abundance levels are unexpected in that the hydrological regime in the San Francisco estuary was moderate during this period. Many estuarine organisms, including longfin smelt and striped bass, typically produce poor year classes in dry years (Jassby and others 1995); delta smelt abundance is generally lowest in very wet or very dry years (Moyle and others 1992). Thus, the moderate hydrology during the past three years was expected to have supported at least modest production.

Multiple pelagic species at more than one trophic level seem to show the 2002-2004 step decline, which is of particular concern. This decline has taken place even as the CALFED program has taken efforts to improve the previously recognized factors that are believed to have affected fish abundance indices. This indicates that more needs to be done to identify what factors limit the production of pelagic fisheries in the upper estuary. Over the past decade, CALFED activities have caused a major shift in the timing of water exports away from the more fish-sensitive spring time to times that were believed to have fewer impacts on fish in the Delta. Also, the development of an innovative Environmental Water Account (EWA) to provide added fish protection and ERP habitat restoration projects were undertaken to recover sensitive fish populations.

Initial Conceptual Model of Decline

IEP's initial conceptual model of the decline hypothesized that there are at least three general factors that may be acting individually or in concert to lower pelagic productivity: 1) toxic effects; 2) exotic species effects; and 3) water project effects (Figure 4). The conceptual model in Figure 4 illustrates the potential pathways by which these factors could be affecting pelagic species in the Delta. For each group of boxes shown in the model, one or more examples are given in italics. The arrows show the potential mechanisms by which changes could occur.

Delta Pelagic Species Conceptual Model

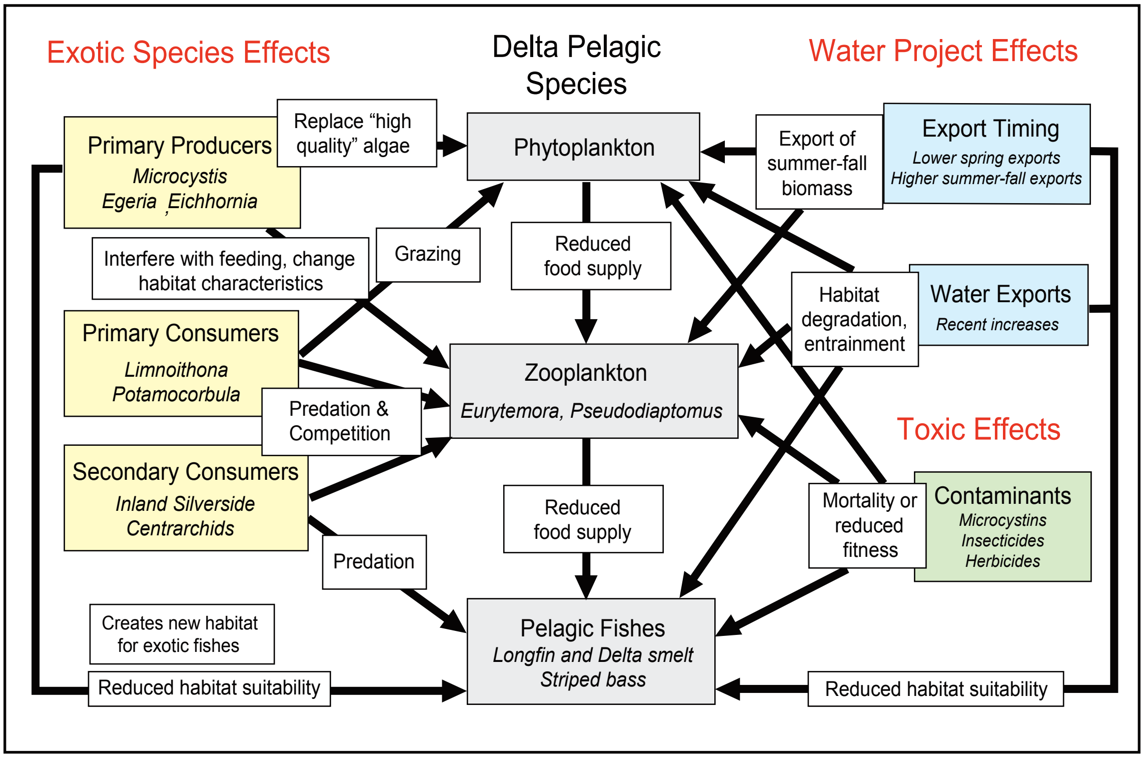

Figure 4. Delta pelagic species conceptual model. (Source: IEP 2005a)

Toxins: Toxins could affect fish directly or indirectly by reducing lower trophic level quantity or quality. Herbicides could directly affect phytoplankton, zooplankton, and fish, while insecticides (pyrethroids, for example) are most likely to affect zooplankton and fish. Toxic effects at lower trophic levels may reduce food supply for fish or their invertebrate prey. Blooms of the blue-green alga (cyanobacteria), Microcystis aeruginosa, have been observed in the Delta since 1999 (Lehman and Waller 2003; Lehman and others 2005). This species often produces toxic metabolites collectively known as microcystins. Microcystins cause cancer in humans and wildlife, including fish (Carmichael 1995), and reduce feeding success in zooplankton (Rohrlack and others 2005). Microcystins have been found in Delta zooplankton and clam tissue and could affect organisms at higher trophic levels through bioaccumulation (Lehman and others 2005).

A shift in pesticide use has also occurred during the same period as the observed decline in pelagic organisms, with a decline in the use of organophosphates and an increase in the use of pyrethroids. The switch from organophosphate to pyrethroid pesticides in agriculture and urban pest management has increased substantially through the 1990s (Kuivila presentation to EET Feb 2005). Figures 5 and 6 show the annual and monthly use of pyrethroid pesticides in the Sacramento-San Joaquin Valley. Pyrethroid pesticide use in the Central Valley has increased steadily over the past decade to levels 300 percent greater than the level of use in 1991 with the largest jump between 2003 and 2004.

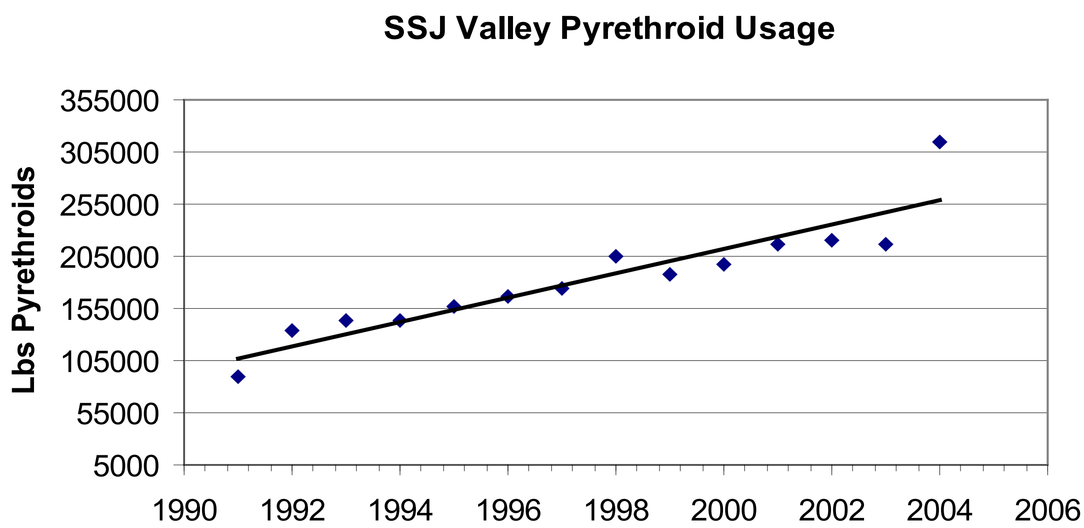

Figure 5. Total reported application of pyrethroid pesticides1 in the Sacramento and San Joaquin Valley2. Yearly data was obtained from the CDPR PUR Database. Data from 2004 is preliminary but not expected to significantly change. (Source: McQuirk 2005)

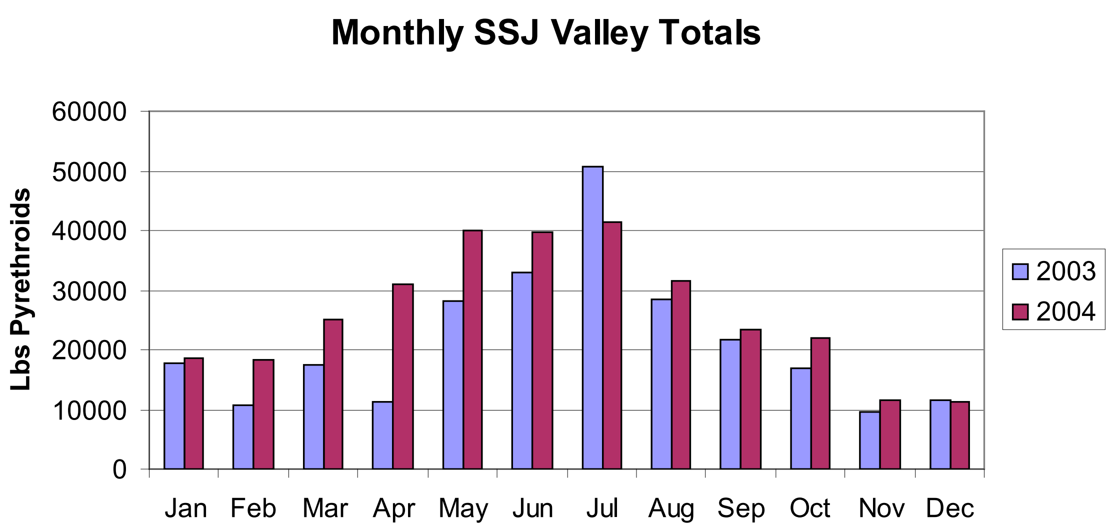

Figure 6. Monthly total3 pyrethroid pesticides applied in the Sacramento and San Joaquin Valley. (Source: McQuirk 2005)

1 Pyrethrin, Permethrin, Cypermethrin, Cyfluthrin, Fenvalerate, Esfenvalerate, Bifenthrin, Flucythrinate, Fenpropathrin, Deltamethrin, Tau-Fluvalinate, and Zeta-cypermethrin pesticide use was queried.

2 Kern County in the San Joaquin Valley was excluded because it drains to the Tulare Lake Bed. Butte, Colusa, Glenn, Sacramento, Solano, Sutter, Tehama, Yolo, Yuba, Fresno, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties were included.

3 Data in both charts includes, agricultural production application and all other reported uses like structural pest control. Household usage is not reported to CDPR

While pyrethroid pesticides have been shown to be less harmful to humans and terrestrial wildlife, and generally have a shorter half-life than organophosphates, they have been shown to be very toxic to aquatic organisms. The rising use of herbicides to control nuisance aquatic weeds in the Delta may also pose a threat to desirable aquatic organisms.

The IEP POD investigations are focusing on recent changes in the use of pyrethroids and aquatic herbicides. IEP conducted acute toxicity studies in the Delta in summer 2005. The invertebrates, Hyalella azteca and Pseudodiaptomus forbesi, were used in standard toxicity tests. Reduced survival and growth were seen at some sites, but no acute toxicity. Due to the brief study period, more extensive testing was conducted in 2006. Additional tests of fish tissue are being conducted to look for indicators of contaminant effects.

There are a number of other potential contaminants of concern such as other pesticides, metals, and natural occurring elements. Increasing discharges from urban sources have resulted in greater contaminant loading, including pharmaceuticals and potential endocrine disrupters. As land use shifts from agriculture to urban, issues of storm water runoff and treated wastewater will continue to grow in the Delta watershed.

Exotic Species: The negative effects of invasive exotic species in the estuary have been well-established. Some notable examples were the substantial declines in lower trophic level production that followed the introduction of the Asian clam, Corbula amurensis, (Nichols and others 1990; Kimmerer and Orsi 1996; Jassby and others 2002) and the reduced abundance of native nearshore fish associated with proliferation of aquatic weeds (Egeria densa) and centrarchid fish (sunfish) along Delta shorelines (Brown and Michniuk in press; Nobriga et al. 2005). The effect of the invasive Asian clam on the productivity of the Bay-Delta estuary and its effects on fish can be seen by the marked drop in longfin smelt abundance over a range of environmental conditions (as indicated by outflow) before and after the invasion of the clam, and during the POD (Figure 7). At this time, limited information exists about quantitative aspects of the estuarine food web needed to estimate Corbula grazing rates or predict whether nearshore and pelagic food webs are coupled in ways relevant to the production of pelagic fish.

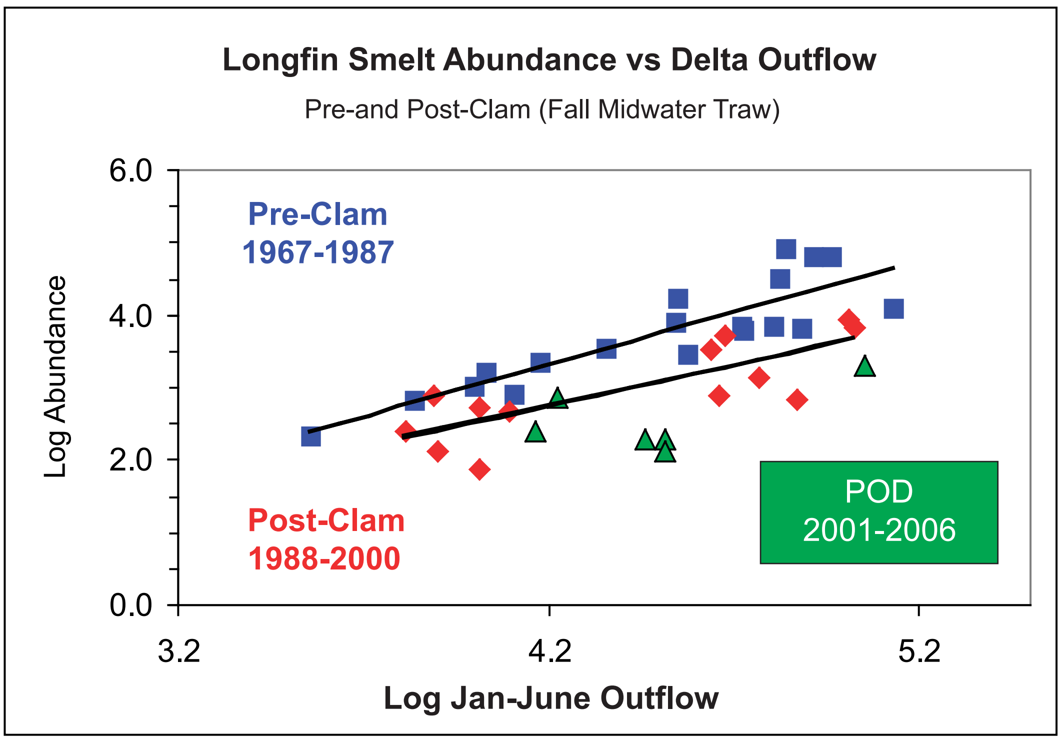

Figure 7. A comparison of longfin smelt abundance relative to Delta outflow (cfs) pre- and post introduction of the Asiatic clam, and during the POD. (Source: DFG and DWR data)

Water Project Operations: Total annual exports are only slightly higher now than they were in the 1980's, as seen in Figure 8. Lower exports in the early 1990's were the result of dry-year conditions and lower Delta inflow (Figures 8 and 9). Figure 8 also shows a reduction in spring exports (April-May) and an increase in summer-fall exports (July-September). These changes are the result of modifications in Delta standards that were intended to indirectly protect fish by improving Delta habitat and actions that were taken by the CALFED WOMT agencies to directly protect fish by minimizing incidental take at the export facilities. Figure 10 shows the drop in the exports from the 1980's to the early 1990's in April and May, and the higher summer exports in the late 1990's to the present. This shift was based on the assumption that lower export rates in the spring would be directly protective of sensitive early life stages of key estuarine fish and invertebrates. However, it is possible that higher exports during summer are causing unanticipated, indirect food-web effects by exporting plankton biomass that would otherwise support the estuarine food web. Other possible mechanisms include increased entrainment of fish during the summer, or a reduction in habitat quality downstream (less area of the appropriate salinity, for example). However, delta smelt are usually not found close to the export pumps during the summer due in part to high water temperatures.

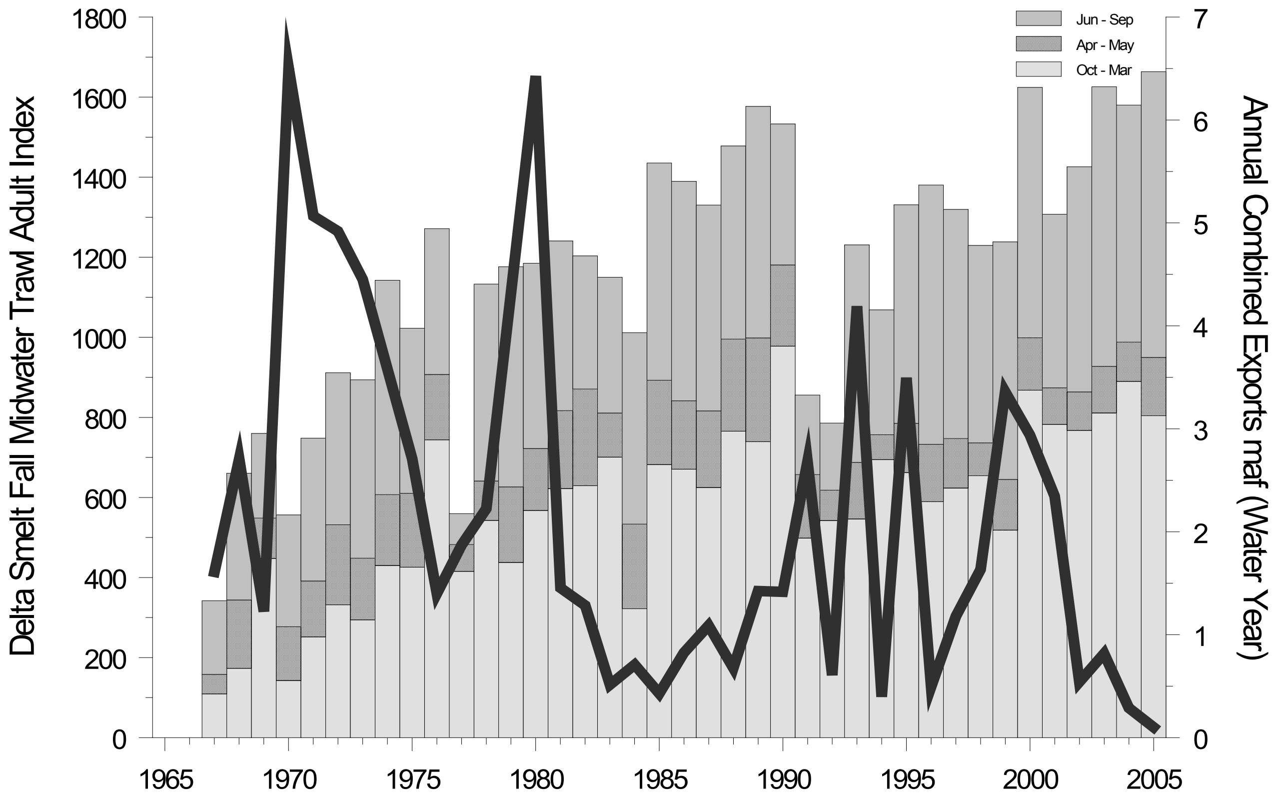

Figure 8. Annual combined exports (SWP and CVP, bar graph) and adult delta smelt midwater trawl index (black line), 1967-2005. (Source: DWR and DFG data)

Changes in Delta Smelt and Distribution of Delta Inflow Over Time

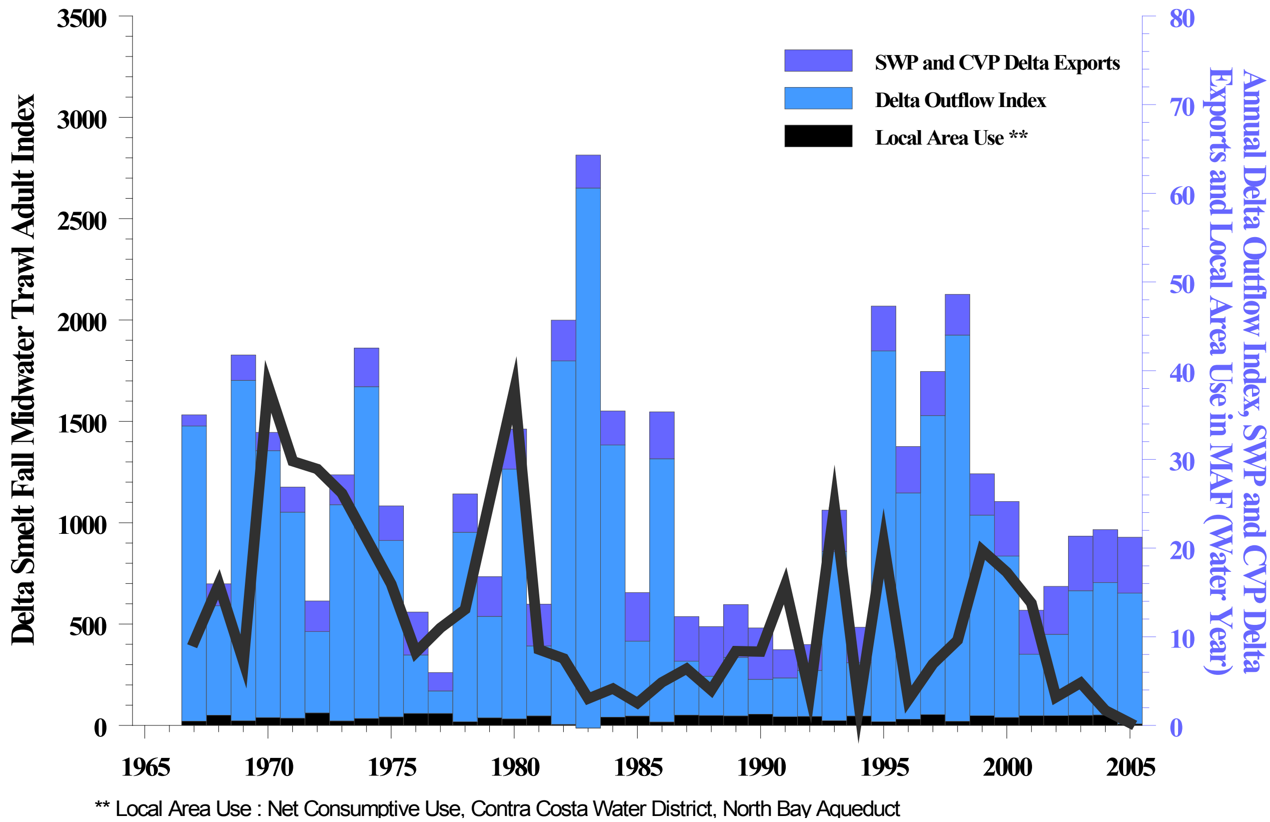

Figure 9. Annual Delta inflow (overall bar height); apportioned among local diversions, combined SWP and CVP exports, and Delta outflow; and adult delta smelt midwater trawl index (black line), 1967-2005. (Source: DWR and DFG data)

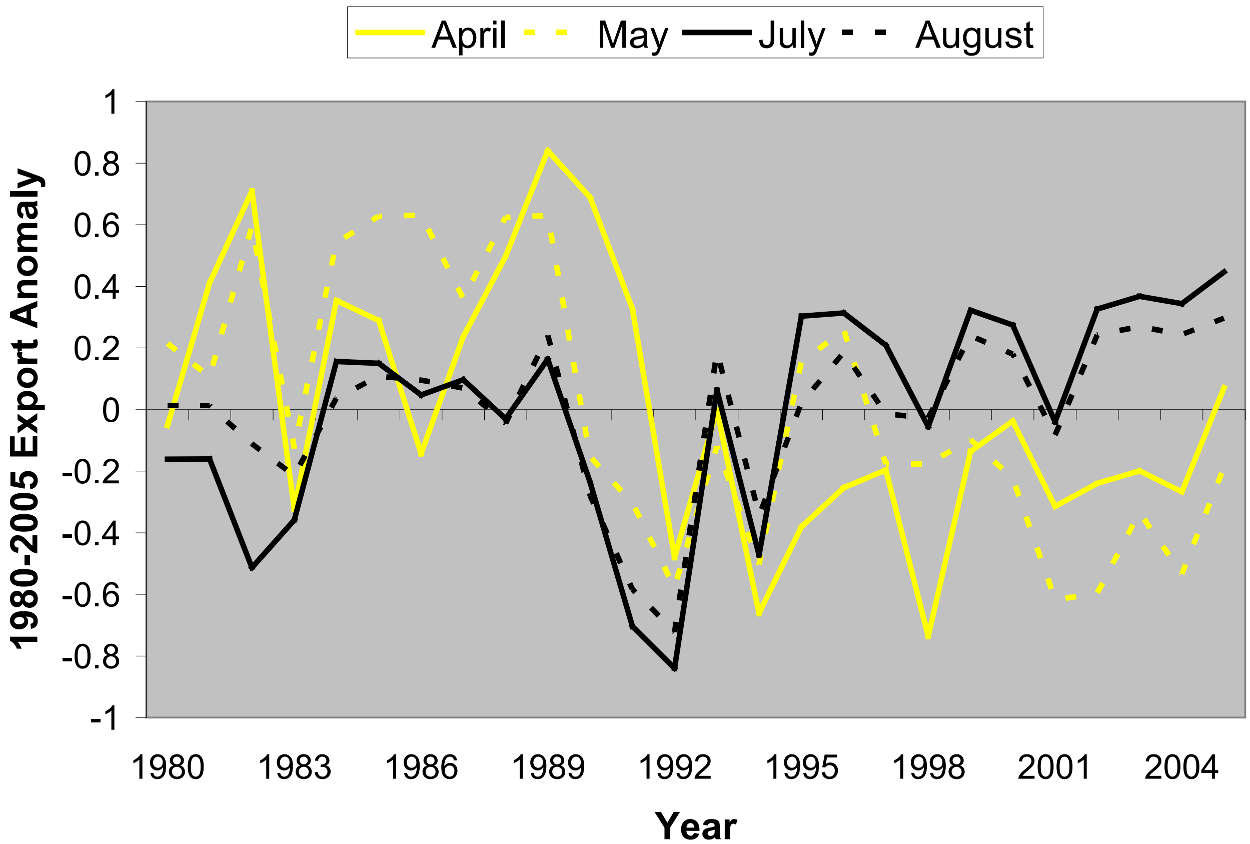

Figure 10. Seasonal shift in combined SWP and CVP diversions, 1980-2005. The units shown (anomalies) represent the amount of deviation from the long-term mean, calculated using the formula (obs – exp)/exp. (obs = mean for year x exports in cubic feet per second (cfs), and exp = 1980-2005 average exports in cfs). (Source: DWR and DFG data)

IEP Synthesis of 2005 Work

In late 2005, the IEP POD Management Team, along with several invited outside experts, reviewed all available data and white papers and summarized this information into the 2005 POD Synthesis Report (IEP 2005b). This report was presented at a public workshop in November 2005 and was subjected to an independent peer review in November andDecember 2005 which was arranged through the CALFED Science Program. Of the recommendations provided by this peer review panel, four have been completed, 20 are underway, and 10 are under consideration for implementation in 2007. The summary of this report follows below. The full text of the report can be found at: *http://science.calwater.ca.gov/pdf/workshops/POD/CDFG_POD_2005_POD_Synthesis_Report_v5b.pdf.*

The initial conceptual model of the POD included three general factors that may be acting individually, or in concert, to lower pelagic productivity: toxins, invasive species, and water project operations. The overall approach for 2005 was based on a “triage” model to identify the most likely causes and then to assign priorities to studies according to where funds and resources could be best used. The 2005 work fell into four general types: an expansion of existing monitoring (four expanded surveys); analyses of existing data (nine studies); new studies (six studies); and ongoing studies (four studies). This summary represents a progress report for the 2005 work completed as of November 2005. Because most of the studies are still in progress, the 2005 findings should be considered preliminary and will be updated as additional information becomes available.

Highlights from observations and analytical work in 2005 included the following initial findings:

Abundance of pelagic fishes. 1) Higher outflow conditions in 2005 did not increase the abundance of the POD fish species; 2) there was no evidence of a recent decrease in the amount of "physical habitat" for either delta smelt or juvenile striped bass; 3) there was no evidence of a recent major decline in growth rates for delta smelt, longfin smelt, or striped bass; 4) in 1999 and 2004, delta smelt in Cache Slough had higher growth than other locations; 5) adult striped bass age-fecundity relationships in 2005 did not appear to differ substantially from relationships developed in the 1970's and 1980's; and 6) otolith analyses indicated that in 1999 delta smelt spawned throughout the upper estuary were recruited to the adult population, whereas in 2004, only fish spawned in the Delta were recruited.

Food web/exotic species. 1) Reanalysis of the zooplankton data revealed that there had been no recent step-change in the abundance of calanoid copepods system-wide, however, work continues to determine whether regional declines occurred, e.g. Suisun Bay; 2) there has been no recent major decline in chlorophyll a (an index of phytoplankton biomass); 3) a newly introduced species of zooplankton, Limnoithona, has become the most dominant zooplankton in the estuary, and is apparently not a good food source for many fishes; 4) the toxic blue-green alga Microcystis was present throughout the Delta at substantially higher levels in 2005 than 2004; 5) although there has been a recent expansion in the range of the clam Corbula, recent distribution is comparable to the late 1987-1992 drought; and 6) changes in sediment composition and benthic assemblages occurred estuary-wide in 1999 to 2000.

Toxics. 1) Although studies on contaminants found that there have been changes in the patterns of use for herbicides and pyrethroid pesticides, it is unclear if these changes pose serious risks for aquatic species; 2) significant acute or chronic toxicity to the amphipod, Hyalella azteca, was detected at four out of ten sampling sites, however the cause was not identified; 3) no significant toxicity to the cladoceran, Ceriodaphnia dubia, the delta smelt, or the juvenile striped bass was observed during the study period; 4) delta smelt are more sensitive to copper than previously reported and are 10-12 times more sensitive than juvenile striped bass; and 5) delta smelt from 2003 and 2005 (limited) showed more liver lesions at two locations representing general regions in Suisun Marsh (near and in Nurse Slough) and the Sacramento River (Cache Slough and the Sacramento Deepwater Ship Channel).

Water project operations. 1) There have been changes in the input flows to the Delta in recent years, including a slight increase in average Sacramento River flow since 2001 and a substantial reduction in peak San Joaquin flows since 1999 until 2006; 2) there was no evidence of a recent major change in residence time, consistent with the lack of change in chlorophyll a; 3) increases in the pattern of wintertime salvage are consistent with hydrodynamic changes occurring each winter since 2001. These changes correspond closely in time with reductions in the abundance of several pelagic species (Note that a recent analysis since the 2005 POD Synthesis Report indicates that these salvage levels are similar to those that occurred in the 1980's); 4) historic water diversions by Contra Costa and Pittsburg power plants may have reached 3,200 cfs (both facilities combined at peak loads), but has been reduced with the retirement of generating units in 1995 and 2003. Current maximum diversion flows are 1,460 cfs combined. The fish population impacts of these diversions have not been evaluated since the early 1980's, but given their location and the potentially large cooling water flux through them, the impacts could be substantial.

IEP Study Plan

The major findings through 2005 were synthesized using two conceptual modeling approaches. First, species matrix models were developed and used to examine which stressors (entrainment, toxic effects on fish, toxic effects on fish food items, harmful algal blooms, clam Corbula effects on food availability, and disease and parasites) were most likely to be important. Here, importance refers to either stressors supported by the available data or stressors which could not be ruled out based on the available data. Second, narrative explanations were constructed for the recent step decline in abundance of pelagic species in the context of their long-term trends or previous patterns. To date, two narrative models have been developed: 1) the Winter Entrainment Hypothesis, which focuses on sources of mortality in the central and southern Delta; and 2) the Bad Suisun Bay Hypothesis, which focuses on food web effects in Suisun Bay and the west Delta.

The overall approach for 2006-2007 is intended to evaluate and refine the evidence for the conceptual models. To address the matrix models, the study design is based on temporal, spatial, and species contrasts for selected fish and zooplankton. For each contrast, the variables to be evaluated include: abundance, growth rate and fecundity, and feeding success, condition factor, parasite load and histopathology (fish only). To the extent possible, these data will be collected simultaneously to help evaluate the relative importance of different stressors. The narrative models, on the other hand, posit linkages among different stressors and their possible pathways to produce the observed declines of more than one species. The workplan elements that are based on the two narrative models, therefore, emphasize analyses of the proposed linkages among stressors.

The proposed studies team represents an interdisciplinary, multi-agency effort including staff from DFG, DWR, Reclamation, EPA, USGS, CBDA, San Francisco State University (SFSU) and University of California, Davis (UCD). Project components were selected based on their ability to evaluate the conceptual models, and their feasibility in terms of methods, staffing, costs, timing and data availability. The proposed work falls into three general types: 1) an expansion of existing monitoring (five expanded surveys); 2) ongoing studies (18 studies); and 3) new studies (22 studies). None of the work will effect the mandated monitoring currently being performed by IEP. The initial cost estimate for 2006-2007 is approximately $3.6 million annually.

In addition, the IEP POD Management Team and investigators will enter into a collaborative relationship with the National Center for Ecological Analysis and Synthesis (NCEAS) to carry out the synthesis of all available data and to prepare reports describing the findings. This collaborative effort was a recommendation of IEP's external Science Advisory Group. New information and findings from this synthesis and reporting effort will be made available to the IEP Directors as it becomes available.

The program will be run by the existing IEP Project Work Team (POD PWT) to develop, direct, review, and analyze the results of the effort. Specific IEP work teams will continue to provide an open forum for presentation and review on focused topics, such as food chain, contaminants, and benthic organisms. These forums allow for participation from stakeholders and other interested parties. The program will yield a range of products and deliverables including management briefs, publications and reports, web-based monitoring data, and presentations at conferences, workshops and meetings.

Relationship between 2006-2007 Actions and POD Investigations

Since the start of the POD investigations in 2005, the IEP POD PWT team has developed and refined several conceptual models about the pathways leading to the observed declines in pelagic organisms. These models are based on the results of the POD studies conducted since 2005, earlier research, and assumed mechanisms. While the models continue to evolve, there is a growing consensus that pelagic fish abundance has been adversely affected by at least three general pathways that may have been acting individually or in concert: 1) reduced food availability; 2) reduced habitat quality; 3) increased mortality. The scientific basis for each of these pathways and their linkages to the Pelagic Fish Action Plan are summarized below.

Reduced Food Availability

Evidence: Suisun Bay/Marsh has historically been a major rearing habitat for striped bass, delta smelt, and longfin smelt (Stevens and Miller 1983; Stevens et al. 1985; Moyle et al. 1992; Matern et al. 2002). The marshes and other adjacent shallow habitats are also used by threadfin shad (Matern et al. 2002; Nobriga et al. 2005). The *"Bad Suisun Bay Hypothesis"* posits that the invasive clam, *Corbula amurensis,* depresses zooplankton production in Suisun Bay under low outflow conditions, resulting in decreased availability of food for larval and juvenile striped bass, longfin smelt, and delta smelt (IEP 2005b). Continued introductions of new zooplankton species may be further disrupting the food web. Evidence for the hypothesis includes the following:

Food availability has declined.

- The POD has apparently coincided with a decline in the abundance of some calanoid copepod species (major fish prey items) in the Suisun Bay region.
- The zooplankton community has also shifted. In recent years, a newly-introduced copepod species, Limnoithona, has become the most dominant zooplankton in the estuary. This species is much smaller than the traditional calanoid copepod prey of young pelagic fishes, and therefore may be a less suitable food source.

Food is important for pelagic fishes.

- Unpublished studies have shown that co-occurrence of young delta smelt and their prey during summer is a strong predictor of fall abundance of adult smelt.
- In 1999 and 2004, delta smelt growth was low from the Sacramento-San Joaquin confluence through Suisun Bay, relative to other parts of the system.
- In 2005, delta smelt collected from the Sacramento-San Joaquin confluence and Suisun Bay had a high incidence of liver glycogen depletion.
- In 2003 and 2004, the condition factor of striped bass decreased progressively in fish collected at locations from the Delta downstream to Suisun Bay.
- These series of observations suggest that the lack of food is affecting young pelagic fishes.

Clam grazing may be a key mechanism for food web effects.

- The introduction of the clam Corbula in 1987 coincided with a decline in some zooplankton and at least one pelagic fish species, as well as with a strong decline in phytoplankton biomass.
- Corbula abundance was higher and its distribution was wider in 2001-2004 than during the wetter 1995-1999 period, but similar to the 1987-1992 drought years.

Linkage to Actions: Based on these observations from the POD and other studies, it is reasonable to assume that an increase in high quality prey would benefit pelagic fishes. Hence, much of the emphasis of the Pelagic Fish Action Plan focuses on measures that could increase plankton productivity in the system. Examples include management of north Delta floodplains and tidal marsh restoration in Suisun Marsh. Actions that help to prevent introductions of new invasive species such as the clam Corbula (e.g. agricultural inspection stations; ballast water control) are also important steps in protecting the estuarine food web from additional impacts.

Reduced Habitat Quality

Evidence: Pelagic fish habitat quality is determined by the physical, chemical, and biological conditions in the estuary. Key observations from the POD study related to biological conditions are described in the previous section (Food Availability). Additional results of the POD study have highlighted the importance of water quality, including salinity, water clarity, and toxins.

Analyses by the IEP POD PWT have revealed that there has been a long-term deterioration in habitat quality for pelagic fishes as defined by suitable salinity and water clarity. Both salinities and water clarity have increased in the fall, resulting in lower habitat quality (Feyrer et al. In review). Moreover, there was a recent decline in habitat quality coincident with the POD. In other words, the Delta in fall has become relatively salty and more clear (less turbid) than similar water years in the past. There is evidence that these changes may have population-level effects as fall habitat water quality was found to be a significant predictor of juvenile delta smelt production the following year.

The 2005 POD study did not clearly support or eliminate contaminants as a possible significant cause or additive stressor in the POD. The toxicity work in 2005 was limited due to spatial and temporal restrictions on the sampling and analyses. More extensive bioassay work in 2006, an extreme wet year, showed little indication of toxic effects. However, effects are possible in drier water years; contaminants could affect fishes directly or indirectly by reducing lower trophic level quantity or quality.

The POD study includes investigations of the occurrence and effects of human-made contaminants as well as toxic organisms in the Delta. Among the human-made contaminants, herbicides could directly affect phytoplankton, zooplankton and fishes, while insecticides are most likely to affect zooplankton and fish. Toxic effects at lower trophic levels may reduce food supply for fishes and/or their invertebrate prey. The switch from organophosphate to pyrethroid insecticides increased substantially through the 1990’s, and have been shown to be less harmful to humans and terrestrial wildlife, but more harmful to aquatic organisms (see Oros and Werner report in Attachment A of the 2005 POD Synthesis Report [IEP 2005b]).

Blooms of the blue-green alga (cyanobacteria), Microcystis aeruginosa, have been observed in the Delta since 1999 (Lehman and Waller 2003, Lehman et al. 2005). This species often produces toxic metabolites collectively known as microcystins. Microcystins are cancer-causing to humans and wildlife, including fish

(Carmichael 1995), and reduce feeding success in zooplankton (Rohrlack et al. 2005). Microcystins have been found in Delta zooplankton and clam tissue and could impact organisms at higher trophic levels through bioaccumulation (Lehman et al. 2005).

Linkage to Actions: Based on these observations from the POD study, it is reasonable to assume that improvements in habitat quality would benefit pelagic fishes. As a consequence, the Pelagic Fish Action Plan includes actions to improve habitat for the target species. The plan includes at least three general types of actions to address this issue: 1) increasing the total amount of habitat; 2) improving the quality of the existing habitat; and 3) protecting existing habitat. The Pelagic Fish Action Plan proposes to increase total habitat area by restoring tidal habitat in Suisun Marsh, one of the most important regions for delta smelt and striped bass. In addition, pelagic fish habitat may be improved by: increasing outflow to depress Delta salinities; possibly changing the operations of the CVP and SWP (from the Section 7 OCAP reconsultation for delta smelt); and managing contaminants through the enforcement of the Clean Water Act. Because invasive species affect water quality variables such as water clarity (e.g. the aquatic weed Egeria reduces turbidity), efforts to reduce invasive species are also expected to help protect existing habitat for pelagic fishes.

Increased Mortality

Evidence: The previous sections described evidence from the POD study that food availability and habitat quality could affect pelagic fish conditions leading to increased mortality rates that result in population-level effects. In addition to these factors, the POD study revealed that mortality may have been affected by Delta water diversions. Specifically, water project diversions by the SWP, CVP, and power plants may have increased the direct loss of pelagic fishes. Key observations include the following (additional details are available in IEP [2005b]):

- Winter exports from the CVP and SWP have increased since the late 1990’s.
- Winter Old and Middle River flows have been consistently negative (e.g., net flow is upstream) since 2000.
- In recent years, there appears to have been a step increase in salvage density (fish per acre-foot of water diverted) of adult delta smelt, threadfin shad, and longfin smelt at the SWP and CVP, even as these fish have declined. Although the increased salvage levels are not unprecedented, increased entrainment is consistent with recent-year changes in winter water export operations.
- There is a strong relationship between winter salvage of adult delta smelt and the occurrence of negative flows in Old and Middle Rivers.
- Recent modeling analyses suggest that losses of larval delta smelt at the SWP and CVP can be very high (up to 40 percent) in early spring under certain conditions that can occur in some dry years.
- Preliminary results from Bodega Marine Laboratory suggest that losses of early (winter) spawning delta smelt and their progeny may be especially important to the population. Their evidence indicates that the quality of eggs and young from these winter spawning events may be superior to those produced in spring.
- Diversions by Contra Costa and Pittsburg power plants may reach 1,460 cfs (maximum for both facilities combined at peak loads), potentially resulting in entrainment and impingement of delta smelt and other pelagic species.

Increased winter entrainment of delta smelt, longfin smelt, and threadfin shad represents a loss of the pre-spawning adults and the larval progeny they might have produced. The population effects of these losses are complex and are being evaluated to determine their significance. The proposed association between water project operations and losses of adult and juvenile fishes is summarized in the POD study's Winter Entrainment Hypothesis. With respect to the power plants, the numbers of fish taken at these diversions have not been evaluated since the early 1980's. However, given their location and potentially high diversion rates, the impacts could be substantial.

Linkage to Actions: Based on the results of the POD study, it is reasonable to assume that efforts to reduce fish mortality would benefit pelagic fishes. Relevant actions related to food availability and habitat quality were described in the previous sections. Another key area of emphasis of the Pelagic Fish Action Plan includes actions to assess and reduce mortality caused by water project operations. Examples include: use of water from the Environmental Water Account; Section 7 OCAP reconsultation for delta smelt, a comprehensive review of SWP and CVP impacts; and efforts to assess and reduce power plant entrainment.

Action Plan Overview

DWR and DFG continue to take steps to address the decline of pelagic organisms. In addition to providing the IEP with funding for the POD studies, the departments are developing the Pelagic Fish Action Plan through this document specifically for the protection and recovery of pelagic species. In preparing this plan, the departments have reevaluated the actions identified in the October 2005 Action Plan in light of the latest information available, and have also considered actions suggested by the DSWG, State Water Contractors, environmental groups, and others. The development of the Pelagic Fish Action Plan was closely coordinated with Reclamation, NOAA Fisheries, and USFWS. DWR and DFG will coordinate all actions developed from this plan with these agencies. This action plan will be updated periodically, pending the results of the ongoing POD studies. All new recommended actions will be scientifically evaluated and peer-reviewed through existing CALFED and IEP processes, and will be guided by the results of the POD studies.

Although the Legislature asked for a report describing actions that the Resources Agency would undertake in FY 2006-2007 to stabilize changes in the Delta ecosystem and its pelagic organisms, the preparation of this report may be premature given that the IEP POD studies are ongoing through 2007. This Pelagic Fish Action Plan uses existing knowledge to propose actions to improve the abundance, condition, and distribution conditions of POD fish species. The next IEP POD synthesis report, scheduled for December 2007, will provide additional information on mechanisms to improve conditions for POD fishes, and will be prepared in collaboration with the National Center for Ecological Analysis and Synthesis. Information and new findings will be made available to agency Directors as it becomes available over the next two years.

It is difficult to implement actions to address the POD when the mechanisms that caused the decline are not fully understood and the science to support these actions is not complete. Given the dynamic state of knowledge, new information may lead to the actions proposed in this plan being modified or withdrawn from consideration. A review of the new POD information at the 2006 CALFED Science Conference, and subsequent discussions with the fish agencies and water operators, resulted in a number of hypotheses and potential water operation actions for management of the Bay-Delta system this water year.

The goal of this plan is to identify actions for FY 2006-07 to increase and sustain pelagic fish populations. These include ongoing actions and new actions that can be initiated within the year, have good scientific support that the action will provide the expected benefits, and appear to be technically and politically feasible. Some actions in the plan may not typically be categorized as an action to specifically increase and sustain pelagic species at a measurable level, such as habitat improvement, control of invasive species, and contaminants management. However, these types of actions will help stabilize the system, are generally agreed upon as a good idea, and address the three general factors that may be acting individually or in concert to lower pelagic productivity. Due to the diverse nature of the proposed actions and limits on monitoring abundance and other characteristics of pelagic fishes at a measurable level, any subsequent changes in pelagic fish abundance, condition, and distribution will not be clearly attributable to implementation of any of these actions specifically.

Although this plan proposes many actions specifically related to delta smelt, the agencies recognize that delta smelt cannot, nor should not, be the sole focus of remedial actions and research. The Pelagic Fish Action Plan contains actions that are targeted to improve the ecological health of the Delta and Suisun Bay. As such, there may also be benefits to other pelagic fish species.

Potential Actions

Potential actions considered for the protection and enhancement of pelagic fish species were organized into three categories:

- 2006-2007 Actions – Those actions that can be initiated within the year, have good scientific support that the action will provide the expected benefits, and appear to be technically and politically feasible.

- Completed Actions (Appendix I) – Actions specified in the Delta Smelt Action Plan that have been completed.

- Other Considered Actions (Appendix II) – Other actions that have a longer time horizon for implementation, have more scientific uncertainty that the action will provide the expected benefits, and may have redirected impacts and inadequate funding. These also include studies, assessments, and planning items that are, or could be, funded and implemented to support further actions for pelagic species in the Delta.

Road to Implementation

Successful implementation of the plan depends on several elements, including project management and coordination, scientific peer review of proposed actions, continuing feedback from scientific inquiry, monitoring the results of actions, and adequate funding.

Coordination

Good management and coordination will be essential to ensure timely actions. A project manager will be assigned to track and coordinate the actions included in this plan, and make adjustments to these actions based on the latest information from IEP studies. The project manager will work with organizations of the WOMT and the EWA team (known as EWAT), which provide a good mix of agency management and staff to help coordinate the action plan. Oversight of the plan will be managed by DWR and DFG in close coordination with USFWS, NOAA Fisheries, and CALFED Science Program staff. These agencies are also involved in IEP and the IEP POD work plan.

Review and Evaluation

Though the proposed 2006-2007 POD actions have good scientific support, many of the actions will need to undergo some level of further evaluation and scientific peer review before full implementation, which is generally built in as part of the project or program implementation strategy. Some actions may require formal NEPA/CEQA, ESA/CESA, and/or SWRCB review and permitting. Some of the actions have already undergone much of the necessary evaluation process and have an established peer and science review process in place, while other actions still require a more complete evaluation and science review before a decision is made on implementation. This process could be time intensive and potentially delay implementation. To the extent possible, implementation of this Action Plan would utilize and coordinate with existing review and evaluation processes that are inherent in the projects and programs that are currently underway.

Review and evaluation are key components of science-based adaptive management strategies and any accepted scientific process. The goal of this strategic process is to decrease the level of scientific uncertainty associated with POD actions and increase the likelihood of successful outcomes. Ultimately, this strategy seeks to identify the most beneficial, "biggest bang for the buck" actions, and acknowledge the crucial importance of independent review in science-based management decisions. It also recognizes the need to closely monitor and evaluate POD action results during and after implementation. This evaluation and review process will:

- ensure consistent and coordinated assessment of diverse POD actions using local and independent experts,
- minimize unintended consequences,
- help select actions most likely to be effective, and
- provide more credibility and acceptance by fellow scientists, managers, and the public.

Funding

Although some actions in this plan are expected to be funded from existing resources, a ready source of funding is needed so that any additional timely actions can be taken as information about the cause or causes of this decline are identified from the POD studies. This being the case, DWR has established a separate fund to quickly address near-term pelagic fish issues. Initially, this fund has been established with State Water Project funds, but ultimately, other entities will also need to contribute funds. The funds will be reserved for special studies related to possible factors affecting pelagic fish populations, and for enhancement and restoration actions needed to recover these species. Additional funding will be needed for actions to be implemented within the next year.

Water Operations Decision-Making Procedures

Implementation of possible actions related to water project operations will utilize the decision-making process in place for the Environmental Water Account (EWA). EWA actions are taken following discussions involving biologists, project operators, and stakeholders (Data Assessment Team, or DAT) using all available information and the criteria outlined in the decision trees for salmonids and delta smelt. The DAT and the DSWG consider incidental take at the pumps, in-stream and Delta environmental conditions, distribution and abundance of the fish species (as indicated by a variety of sampling programs), and, if appropriate, formulate a recommendation for modification of project operations to reduce adverse effects on fish (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 (DWR, Reclamation, DFG, USFWS, and NOAA Fisheries). Based on an evaluation of this recommendation and the supporting information, the agencies may implement a "fish action," either as recommended or with adjustments. Although the goal of WOMT is to achieve consensus on decisions, the individual agencies retain their authorized roles and responsibilities.

In July 2006, Reclamation requested re-initiation of formal Section 7 consultation under the Endangered Species Act with USFWS on the future combined operations of the CVP and SWP. This process is expected to take about 18 months, during which time there will be a period of interim decision-making concerning water project operations. The DSWG and WOMT will implement these revised decision-making procedures for identifying and implementing protective actions to conserve delta smelt (See section on Water Project Operations Actions).

Action Plan FY 2006-07

This plan identifies actions to stabilize the Delta ecosystem and improve conditions for important pelagic fish species for FY 2006-07. Potential actions considered for the protection and enhancement of pelagic fish species were organized into groups related to the primary potential area of benefit.

Brief summaries are provided in the subsequent sections of this document for the following 2006-07 actions:

Comprehensive Ecosystem Evaluation Actions

- Reconsultation under the Federal Endangered Species Act Related to the Operations of the CVP and SWP – *New*
- Initiation of the Process to Develop the Bay-Delta Conservation Plan – *New*

Water Project Operations Actions

- Minimize Net Upstream Flows in Old River and Middle River from January to February 15th to 3,500 cfs or 3,500-5,000 cfs – *Adopted. Implementing.*
- Maintain Net Downstream Flow in Old and Middle Rivers Prior to the Vernalis Adaptive Management Plan (VAMP) Period – *Evaluating.*
- No South Delta Barriers during VAMP and until June 1st – *Evaluating*.
- Maintain X_2 West of Collinsville during May-December in wetter years – *Evaluating.*

Food Web Actions

- Provide Flows through Yolo Bypass into Cache Slough (summer) - Evaluating
- Manage Flooding in North Delta for Seasonal Floodplain Habitat – Evaluating
- Sherman Island Floodplain Phytoplankton Pilot Project – Evaluating

Habitat Improvement Actions

- Restore Tidal Action to Suisun Marsh, Blacklock Restoration Project – *Ongoing*
- Restore Tidal Action to Suisun Marsh, Meins Landing Project – *Ongoing*
- Dutch Slough Tidal Marsh Restoration Project – *Ongoing*

Contaminants Management Actions

- Encourage Greater Enforcement of the California Water Code and the Clean Water Act for Control of Pyrethroids and Other Contaminants – *Ongoing.* Evaluating

Invasive Species Actions

- Increase Staffing at Agricultural Inspection Stations to Inspect Watercraft for Zebra Mussel and Other Invasive Species – New; Pilot program in 2006-2007
- Ballast Water Control – *Ongoing.* Expand program

Other Actions

- Fund the Delta Smelt Culture Lab – Ongoing. New long-term funding needed
- Develop a Delta Smelt Refuge Population – *New.* Funding needed
- Assess and Reduce Power Plant Entrainment – *Ongoing.* Evaluating

These actions can be categorized into three areas related to the conceptual model of the POD study—toxins, invasive species, and water project operations. Many actions described in this plan are currently being implemented. The larger list of "Other Considered Actions" varies by the amount of time needed to begin, or requires a range of times for study and planning—including the anticipated time necessary for study to determine whether a particular action should be taken, the time for planning the action (including peer review), and the time needed for implementation.

Comprehensive Ecosystem Evaluation Actions

Several new actions are being initiated that would potentially have ecosystem level effects. These comprehensive ecosystem evaluation actions would potentially result in more specific actions or a suite of actions that may benefit pelagic species.

Reconsultation under the Federal Endangered Species Act Related to the Operations of the CVP and SWP

In July 2006, Reclamation requested re-initiation of formal Section 7 consultation under the federal Endangered Species Act with USFWS on the future combined operations of the CVP and SWP. These future operations will be described in the Long-Term Operations Criteria and Plan (OCAP) of the CVP and SWP. This action was taken partially because of the changed circumstances surrounding the delta smelt. This process is expected to take about 18 months, during which time there will be a period of interim decision-making concerning water project operations. The DSWG and WOMT will implement the revised decision-making procedures described above for identifying and implementing protective actions to conserve delta smelt.

The existing Section 7 Biological Opinion will remain in place during the interim. Reclamation and DWR have agreed that certain contemplated actions will not be approved during this interim time period, such as the Long-Term Contract Renewals for the CVP and the increased diversions at the SWP Banks Pumping Plant to 8,500 cfs. EWA and CVPIA (b)(2) resources will be available during this interim time period to be allocated for fish actions to benefit sensitive fish species. The final biological opinion from USFWS is scheduled to be completed by April 2008.

Initiation of the Process to Develop the Bay-Delta Conservation Plan

In December 2005, DFG, DWR, the fishery agencies, several state and federal water contractors, and certain environmental groups initialed a Statement of Principles on Regulatory Commitments and User Contributions designed to do several things including provide a new structure for development of long-term, stable regulatory and funding assurances for the Bay-Delta. The Statement of Principles calls for the development of the Bay-Delta Conservation Plan (BDCP), a conservation plan for the Delta, to obtain the permits necessary to comply with the California Endangered Species Act and the Federal Endangered Species Act. This commitment to the preparation of the BDCP has been further strengthened by the signing of a Memorandum of Agreement for Supplemental Funding for Certain Ecosystem Actions and Support for Implementation of Near-Term Water Supply, Water Quality, Ecosystem, and Levee Actions, which commits the funding necessary to prepare the plan and to complete environmental restoration actions while the BDCP is being prepared.

Under the guidance of the Resources Agency, a Steering Committee consisting of environmental groups, agency representatives, and water contractors has developed a draft planning agreement to guide the development of the BDCP. The geographic scope of the BDCP is to be the statutory Delta. The goals for the BDCP in the draft agreement include providing for the conservation and management of covered species, preserving, restoring and enhancing several natural communities, and allowing for projects to proceed that restore and protect water supply, water quality, and ecosystem health within a stable regulatory framework. The BDCP is intended to be consistent with the CALFED Bay-Delta Program, while taking advantage of the latest scientific information on covered species that will derive from the POD studies and other relevant monitoring and research.

A public review process for the draft planning agreement ended on October 2, 2006. The agreement will be finalized after the public review comments are evaluated.

Water Project Operations Actions

Decision-making for state and federal water operations includes a complex interaction of managing regulated and unregulated flows for diversion, flood control, and power generation purposes, while also meeting a complex set of regulatory and contractual commitments. As part of this action plan, an improved water operations decision-making process will be utilized and additional operational tools and actions will be employed to benefit pelagic fish species. The actions listed in this section are a series of seasonal actions that could be implemented this coming year, if specific environmental and biological conditions occur in the Delta and resources continue to be available to implement each subsequent action. Although DFG would like a specific commitment to action (water) from DWR, DWR believes the process outlined below for identifying these needs as they are encountered is appropriate, given the scientific uncertainty of the benefits of these possible actions and their wide range of possible water costs.

Since Water Year 2000-2001 (WY 2001), the water operators and fishery agencies have used the EWA to provide additional operational flexibility to protect at-risk fish species in the Delta above the regulatory baseline at no increased water costs to the SWP or CVP. The EWA provides a “budget” of water resources that can be used to compensate water users for times when lower water diversions are needed to better protect fish species. EWA acquires alternate sources of water supply, called “EWA assets,” that are used to augment stream flow, Delta outflow, or to modify exports; to provide fish benefits; and to replace regular project water supply interrupted by changes to project operations for EWA purposes. The CALFED Record of Decision (ROD) discusses three tiers of protection for listed fish species:

- Tier I – The regulatory baseline for SWP and CVP operations as determined through the biological opinions for delta smelt and winter-run salmon, Water Right Decision 1641, and the 800 thousand acre-feet (TAF) of CVP Yield pursuant to Central Valley Project Improvement Act (CVPIA) Section 3406(b)(2).
- Tier II – EWA assets combined with the CALFED Ecosystem Restoration Program.
- Tier III - Additional assets separate from EWA can be made available to avoid a jeopardy declaration by the federal fish agencies under the conditions set forth below.

Use of EWA for proposed actions is limited by the amount of water available. Actions to benefit delta smelt and other pelagic species must also be balanced with the potential need for EWA water to protect emigrating salmonids. If water available under the regulatory baseline (Tier I) and EWA (Tier II) is insufficient for actions necessary to avoid jeopardy to the continued existence of threatened or endangered fish species as determined by USFWS or NOAA Fisheries, then additional assets under Tier III can be made available. In considering the need for Tier III assets, the fishery agencies will consider the views of an independent science panel. These assets will be used to prevent jeopardy from occurring or the fishery agencies will take appropriate actions under their statutory authorities.

The implementation strategy for Tier III also identifies tools and funding should Tier III prove needed. Tier III assets for 2007 include $9.45 million in funding from Proposition 13 ($6.25 million) and Proposition 50 ($3.2 million), which could purchase about 55 TAF of water south of the Delta this year. These assets might be augmented during the year with water provided by the SWP and/or CVP, if the operators of these projects wished to avoid a jeopardy determination by the federal fishery agencies.

If USFWS or NOAA Fisheries conclude that jeopardy is still likely after the use of the three tiers of assets, programmatic consultation will be re-initiated. The biological opinion on re-initiation will include reasonable and prudent alternatives that require the minimum level of additional reductions in SWP and CVP exports necessary to avoid jeopardy.

EWA Assets Available in Water Year 2006-2007

Implementation of the EWA will continue in Water Year 2006-2007 (WY 2007) with enough purchased asset capability to provide approximately 210-250 TAF of export reductions at key times to better protect fish, depending on water year type. The amount of water purchased will depend on need as well as hydrology, which in turn determines what sources can be used. “Variable” assets resulting from changes in operation are also available to EWA. In the past 6 years, these assets have ranged in any given year from 0 to 150 TAF with an average of about 82 TAF. All the variable assets anticipated in the CALFED ROD will be available to the EWA. This includes the water storage asset provided by the SWP agreement to carry up to 100 TAF of EWA debt into 2008, in lieu of requiring EWA to purchase storage capacity south of the Delta. (This has been the case for the last several years for the operation of the EWA).

EWA costs in recent years have ranged from approximately $20 million to $30 million annually. For 2006-07, $32.6 million in funding from Proposition 50 is available for water purchases with another $13.2 million available in 2007-2008. The EWA program is ongoing through December 31, 2007, which is the end of the time period analyzed in the EWA EIS/EIR. Decisions on continuing EWA, or a similar program, and associated funding are expected to be made by that time.

In addition to EWA assets, the federal fishery agencies have their normal allotment of b(2) resources of 800 TAF for fishery actions both upstream and within the Delta in 2007. These assets will be used by Reclamation, NOAA Fisheries, and USFWS for meeting anadromous fish goals and new regulatory requirements above those already established when the CVPIA was enacted. Reclamation will also consider providing b(2) carryover storage from WY 2006 (currently at 195 TAF) for the scientific purposes discussed in the Water Operations Actions below, provided they are identified to help evaluate the impacts of CVP operations on pelagic fish in the Delta, used for additional Delta outflow, and not used for export reductions unless other provisions are made with Reclamation. Carryover b(2) assets are subject to spill during the year and will be reduced accordingly if they spill before they are used for this purpose.

Improved EWA Decision-making Process

Revised decision-making procedures for identifying and implementing protective actions to conserve delta smelt with EWA assets are outlined in the USFWS letter of August 21, 2006. Under these revised procedures the DSWG will continue to formulate “fish actions” on a real-time basis for recommendation to the WOMT. The WOMT evaluates the technical basis, as well as water and power costs of each recommendation, and makes decisions determining whether or how the action will be implemented. As requested by the USFWS, the DSWG will document the technical basis of its recommendations to WOMT. In turn, WOMT will document its decision on whether to take the recommended action. For circumstances where WOMT does not follow the DSWG recommendations, WOMT will submit documentation to USFWS with the rationale on why the recommended action was not taken, and the technical justification for how the WOMT decision will ensure adequate protection for delta smelt from the effects of the operation of the SWP and CVP. The USFWS will then evaluate the action proposed by WOMT and take appropriate action.

The DSWG have evaluated several potential delta smelt actions for this year that are discussed in more detail below in POD Actions Using EWA. One potential action for earlier this year—increased fall flows to maintain X2 downstream—was not recommended to WOMT for implementation due to the uncertainties of the timing and quantity of flows needed, and for lack of an appropriate experimental design to test the efficacy of such an operational change. Another action recently evaluated to reduce exports during the seasonal first flush of the Delta tributaries this winter was recommended by the DSWG in early December and approved by WOMT for implementation in late December 2006 or early 2007. In addition, the DSWG evaluated a spring action to postpone installation of south Delta barriers until June 1st. This action was also recommended by the DSWG, and is currently being considered by the WOMT.

Use of EWA in WY 2007

In addition to the improved EWA decision-making process, additional operational tools and actions may be employed to benefit pelagic fish species, including scientifically-designed water operation actions that could be implemented quickly in the coming year. The EWA could be used to implement a number of water operation actions to address recently developed hypotheses based on new information from the IEP POD investigations conducted over the past two years. This new information is helping to inform actions taken under EWA in WY 2007.

The Resources Agency expects that these water operation actions will be joint actions by DWR and Reclamation through the combined use of both EWA and CVPIA 3406(b2) assets. This year would be a favorable time to seek the use of EWA and possible additional Tier III assets to allow for the implementation and evaluation of some of these actions. WY 2007 is a unique year in that it comes after above normal and wet years where reservoirs in the Sacramento and San Joaquin River systems are now at their flood control space requirements, and the state share of San Luis Reservoir is full. Groundwater basins have also greatly benefited from the availability of water for natural recharge and additional surface water banked in these two years. Consequently, water demands from the Delta during the coming winter and spring should be relatively low, and hence, the water supply implications of proposed actions should be more manageable than in a year following dry years.

A review of the new POD information at the October 2006 CALFED Science Conference, and subsequent discussions with the fish agencies and water operators, resulted in the development of a matrix of testable hypotheses leading to potential water operation actions for management of the Bay-Delta system this water year. The POD Management Team and investigators reviewed the science behind the actions and developed specific criteria and conditions for the potential actions. The decision whether to implement an action would be made through the EWA decision-making process on a real-time basis dependent on the specific criteria and conditions for the action, and could be implemented relatively quickly this water year. The IEP will make all reasonable efforts to obtain data that can be used to assess the outcome from any actions taken and begin to evaluate the underlying hypotheses.

Due to the concern for the protection of pelagic fish in 2007 and the developing science, the fish agencies and water operators are also seeking the guidance of the CALFED Science Program in the development of the hypotheses, asset use, and studies related to the use of EWA in 2007. DFG presented a matrix of the possible actions at the annual scientific review of the EWA in November 2006 (see Resources Agency Action Matrix at *http://science.calwater.ca.gov/workshop/ewa.shtml*). The EWA Technical Review Panel is reviewing the actions and is expected to provide feedback on the actions by the end of January 2007. Initial feedback from the Panel indicates that they agree with the general approach of the action matrix.

The IEP Estuarine Ecology Team (EET) also reviewed the matrix of actions. Comments from a few of the EET members indicate they understand the need to take action, are not opposed to taking action, and are ready to help. IEP POD scientists will analyze the results of any 2007 actions as soon as possible after the action is taken and response variables measured, depending on available staff resources. New information will be presented in the IEP POD Synthesis Report due in the last quarter of 2007. The section below describes water operation actions from this matrix, which utilize EWA assets and procedures to implement.

POD Actions using EWA

The EWA provides a means to modify water project operations to reduce impacts to fish, and has been in place and used to help protect fish over the past six years even as the POD has occurred. Several possibilities exist. (1) Export operations may not be having the population impacts many believe they have. (2) The EWA actions taken to date may have been of insufficient magnitude to expect observable large-scale effects on target species. (3) Some other factor, such as invasive species or an unidentified water operation effect, may be effecting pelagic organisms differently now than in the past.

The following actions were developed based on new information from the IEP POD investigations to address the potential direct and indirect effects of water project operations, and focus on reducing pelagic fish entrainment and improving habitat. These potential actions are continuing to be evaluated as additional relevant scientific information becomes available and implementation is assessed. As more information is developed, potential actions may be added or deleted from this list.

Possible actions for FY 2006-07 are summarized chronologically by season in Table 1, and described in the narratives that follow. Information that applies in general to the remaining water operation actions is also discussed below.

Table 1. Potential Resources Agency actions for WY 2007 water project operations.

Timing	Action	Trigger	Scientific Uncertainty*
Winter/Early Spring	Minimize net upstream flows in Old and Middle Rivers from January to February 15th to: a) 3,500 cfs, or	Take action if water temperature <13° Celsius (C), and Sacramento River flow at Freeport > 25,000 cfs for 3 days.	High
	b) 3,500 to 5,000 cfs	Take action if there is no Sacramento River pulse above 25,000 cfs by January 15th.	
Early/Late Spring	Maintain net downstream flow in Old and Middle Rivers prior to VAMP period	If March 1st 14-day running average X_2 position is east of 65 km, then take action when ripe or spent females found in SKT or within 10 days of water temperature of 12° C.	Medium-high
Late Spring	No south Delta barriers during VAMP and until June 1st	WOMT decision to implement action (mid-April-May). San Joaquin River flow and export pumping per VAMP protocol.	Medium-high
Summer/Fall	Maintain X2 west of Collinsville (80 km) during May-December	Take action if water year type is above normal or wet. If water year is below normal or drier, maintain May-June X2 position per D-1641.	High

* Scientific Uncertainty – Indicates the confidence that the proposed action will have a demonstrable population benefit. A low degree of uncertainty reflects confidence in the scientific basis for the action.

The decision whether to implement an action would be made on a real-time basis dependent on the specific criteria and conditions to trigger the potential action. Since these are water operations actions, they could be implemented this year because they would not require lengthy planning, pre-project evaluations, and permitting that habitat restoration or infrastructure changes require. Specific criteria and conditions for the potential actions have been developed and the science behind the actions reviewed by the POD scientists. The potential actions are currently undergoing independent scientific review through the EWA Technical Review Panel, which agrees with the general approach for review of the actions. The IEP-EET team is also providing a scientific review of these potential actions.

Ongoing IEP monitoring and studies are already in place to collect the data needed to potentially detect a species or system response to the action. The use of multiple measures to detect a change from a given action will help to increase confidence in the ability to detect a response. Some additional monitoring has been proposed and is also being evaluated to increase detection of responses. However, the time needed to detect a species or system response may range from one to five years or longer. Although many of the response variables should show a change in the first year, one year of data is generally not sufficient to test the effectiveness of an action. Confidence in the ability to detect a response varies from high to low depending on the variable being measured, but the use of multiple response variables should help provide a better overall picture of the effectiveness of the action. A response occurring close in time to the action is more likely to be detected, whereas responses to be measured later in time may be confounded by the effects of other factors. The current extremely low level of delta smelt abundance may also make it more difficult to detect a response in that species.

Due to the current workload for the 2006-2007 IEP POD investigations, analysis of the results of these actions may not be completed in time for inclusion in the IEP POD Synthesis Report due in December 2007. Some fish specimens that may be useful to assess effects of actions in 2007 will not be obtained until 2008. However, much of the data will already be collected and available for analysis as soon as staff availability allows. The EWA Technical Review Panel cautioned IEP to be careful with how the data is interpreted, and not to over interpret the results from a single year.

Estimated water costs for these actions range from zero to very high depending on the action. If the actions needed to protect at-risk fish species in WY 2007 exceed those provided by EWA, the WOMT agencies will consider the use of additional assets made available under Tier III of the CALFED ROD.

In order to implement the water project operations actions proposed below, the following steps are presently being taken or, will need to be taken:

- Review of proposed actions by the EWA Technical Review Panel.
- WOMT review and evaluation of each proposed WY 2007 POD action for implementation to benefit delta smelt and other pelagic organisms on a real time basis.
- Evaluate the effectiveness of WY 2007 POD actions in IEP POD Synthesis Report due in December 2007

Minimize Net Upstream Flows in Old and Middle Rivers from January to February 15th to 3,500 cfs, or 3,500-5,000 cfs (winter/early spring)

Limit the upstream (i.e. reverse or southward) net flow in Old River and Middle River (ORMR) to 3,500 cfs or 3,500-5,000 cfs from January through February 15th, depending on water temperature and Sacramento River flow. Increased (more positive) ORMR flows may reduce adult delta smelt entrainment losses at the SWP and CVP intakes, and may also provide a better spawning distribution and reduce subsequent larval entrainment.

During winter and early spring, the ORMR flows are primarily a function of San Joaquin River flow, inflow from the Sacramento River and export pumping rate. By altering operations to limit reverse (upstream) flow between 3,500-5,000 cfs in Old and Middle Rivers, entrainment of adult delta smelt as they begin to migrate to spawning areas would likely be decreased.

This action has been approved by WOMT and could be initiated as early as the last week in December as follows:

- If the average water temperature has declined to less than 13° Celsius (C) at the three Delta stations used by USFWS and flow on the Sacramento River at Freeport exceeds 25,000 cfs for at least three consecutive days, maintain ORMR flows at -3,500 cfs until February 15.
- If by January 15, the Sacramento River flow at Freeport has not yet reached 25,000 cfs, maintain ORMR flows to a range of -3,500 to -5,000 cfs until February 15.
- If the Sacramento River flow is above 25,000 cfs prior to the end of December, and remains above 25,000 cfs through February 15, the DSWG does not anticipate requesting operational changes. However, actions may be considered if Freeport flows increase, but are not sustained above 25,000 cfs, or if high salvage events occur.

The full effect of this action would be achieved if this action were continued until a subsequent action is triggered.

Rationale: Recent analysis has shown that salvage of adult delta smelt is very low or zero during years when ORMR flows are positive (i.e., away from the export facilities). Conversely, salvage increases in years when ORMR flows are negative (towards the export facilities). The relationship appears linear; however, more data will help better define the relationship. The underlying mechanism behind the relationship is that delta smelt are less vulnerable to entrainment and subsequent salvage when less water is being drawn from the central Delta to the south and when suitable habitat for spawning is found farther away from the export diversions.

Pros and Cons:

Pros: The project operators have the ability to moderate export flows to maintain the designated flow range through Old and Middle Rivers to reduce adult delta smelt entrainment at the SWP and CVP Delta pumping plants, which may lower population level impacts of the export facilities. Secondary benefits of this action could be reduced subsequent delta smelt larval entrainment losses (mortality) at the facilities, an increased percentage of early-spawned fish, increased size of delta smelt in the fall, and increased abundance of juveniles in the following year.

Cons: Implementation of this action would place heavy demands on EWA water, and may exceed available assets if San Joaquin River inflows are in the typical range and export pumping rates are high.

This action has a high degree of scientific uncertainty because the relationship between net flow in Old and Middle Rivers and adult delta smelt salvage may not be linear. Average flow for the two months may not be the best predictor of salvage; antecedent conditions and events over shorter time periods in January and February may determine the outcome. The range of salvage is fairly wide at two-month average flows close to the selected target and at more negative flows. The migration behavior of delta smelt is not currently known (timing, destination).

If entraining fewer adult delta smelt results in more spawning in the southern Delta, entrainment of newly hatched delta smelt larvae may increase. No data are presently available to assess this potential outcome because these larval smelt are too small to be detected in current fish facility sampling. Avoiding upstream flow on Old and Middle Rivers once spawning has begun should increase the survival of larvae produced in the southern Delta. (See early/late spring action below)

Time to Implementation: This action has been approved for implementation by the WOMT. In general, this action would be initiated from January through mid-February unless the target flow conditions in Old and Middle Rivers are already satisfied. However, the action could be triggered and initiated as early as late-December 2006, and could end in mid-February 2007, depending upon river flows and exports. The decision whether to implement an action would be made on a real-time basis dependent on the specific criteria and conditions for the potential action.

Costs: Water costs may be highly variable depending on hydrologic conditions and export demand, and were estimated at the level needed to keep flows greater than -3500 cfs in Old and Middle Rivers. If the action were triggered in late December and continued through mid-February, the estimated maximum total water cost would be 580 TAF (ranging from 9 to 112 TAF per week) depending on the amount of export reduction needed to keep flows within the set parameters.

Maintain Net Downstream Flow in Old and Middle Rivers prior to the Vernalis Adaptive Management Plan (VAMP) Period (early/late spring)

At least two weeks prior to VAMP, maintain net flows in Old and Middle Rivers at zero or positive (downstream or northward) to reduce entrainment losses of larval delta smelt. If the March 1 14-day running average X2 position is east (upstream) of 65 kilometers (km), then trigger action when ripe or spent females are found in the Spring Kodiak Trawl (SKT) or within 10 days of Delta water temperatures reaching 12° C.

ORMR flows in March through May are primarily a function of San Joaquin River flow into the Delta and export pumping rate. Because San Joaquin River inflow is usually less than the export flow, ORMR flows are often in the reverse or upstream direction. With increasing upstream flows, there is increasing entrainment of delta smelt at the SWP and CVP pumps. The action is to maintain downstream (positive or northward) flow in Old and Middle Rivers once delta smelt spawning begins unless the March-April X_2 position in the Bay-Delta is seaward of 65 km. The action is focused on the first two weeks of April (just prior to the VAMP period), but could be started as early as March 1. Based on the start time, the action could extend over a two to six week period.

Implementation of this action would be triggered when ripe or spent female delta smelt are found in the SKT or within ten days of water temperature in the southern or central Delta increasing to12° C, the temperature at which delta smelt spawning is expected to begin. Ten days is about the time required for the attached eggs to hatch at this temperature, producing free-floating larvae which initially have very limited swimming ability. The action would likely not be necessary if on March 1 the 14-day running average X_2 position in the Bay-Delta is west (seaward) of 65 km because with this condition delta smelt would likely be distributed to the west and spawning would occur away from the influence of SWP and CVP pumping. The action would continue for at least two weeks, or if possible, until the start of the VAMP period (mid-April to mid-May). If these criteria are met, measures will be taken to maintain a downstream flow in Old and Middle Rivers utilizing increased San Joaquin flows or decreased exports at the SWP or CVP facilities.

Rationale: Favorable X_2 location during the spawning period reduces the exposure of delta smelt to effects of reverse flow in the southern Delta channels. With a less favorable X_2 location, avoiding upstream flow in Old and Middle Rivers once smelt have begun spawning in the central or southern Delta will reduce entrainment losses of larval smelt.

Combined particle tracking and 20 millimeter (mm) survey distributions suggest population losses are directly correlated with X_2 position and could reach an estimated 20-40% when X_2 moves landward of 60 km. Maintaining X_2 in a favorable location during the spawning period of delta smelt reduces their exposure to the effects of reverse flow in the southern Delta channels. If X_2 is in a less favorable location and delta smelt spawn within the Central and southern Delta, then avoiding upstream flow in Old and Middle Rivers once they have begun spawning will reduce entrainment losses of the smelt larvae. A favorable location for X_2 during this period is defined as seaward of 65 km based on a 14-day running average.

Delta smelt hatch dates back-calculated from otoliths (ear bones) indicate most fish surviving to summer-fall were hatched during the VAMP period when San Joaquin River flow is typically augmented, export pumping is relatively low and ORMR flows are from south to north (downstream). Ripe and spent adult smelt are commonly observed in the weeks and months prior to the VAMP period, so the scarcity of early-spawned smelt in fish sampling later in the summer or fall suggests either early spawning fish and/or their offspring experience high mortality, including loss from entrainment. If, as hypothesized by Bennett (unpublished data), early-spawned fish have high natural survival rates and potentially high reproductive value to the population, then their increased vulnerability to entrainment episodes may have important negative effects on the population.

Based on otolith strontium chemistry, in the POD years a relatively higher proportion of delta smelt surviving to summer/fall originated in the north and central Delta in recent years (Hobbs/Bennett, unpublished data) while contributions from other areas (e.g. Suisun Marsh) have declined for reasons yet to be determined. If persistence of the population depends increasingly on recruitment from the central Delta, then actions to minimize impacts of water management on survival of fish spawned in this area is warranted.

Pros and Cons:

Pros: Benefits include reduced entrainment of delta smelt, increased abundance and distribution of young delta smelt, and an increased percentage of larger, early-spawned fish. Avoiding upstream flow on Old and Middle Rivers once spawning has begun should increase the survival of larvae produced in the southern/central Delta. The immediate positive effects on survival of delta smelt larvae seem likely. Whether there is a positive effect on age and size composition or abundance at later life stages, will depend on whether summer food conditions limit smelt population levels. Recent data suggest that summer food levels are limiting delta smelt abundance in the fall. Increasing the survival of delta smelt in the spring and early summer may not translate directly into increased fall population levels of delta smelt unless early hatching fish can survive through the summer.

Cons: Depending on water year and other actions taken, there may not be enough assets to maintain a positive flow in Old and Middle Rivers during this period.

Although the immediate effect on increasing the survival of delta smelt larvae seems likely, the scientific uncertainty of this action is medium-high. No data are presently available to assess this outcome directly because these larval smelt (less than 20 mm) are not detected in current fish facility sampling. The subsequent effect of this action on abundance depends on intervening factors later in the season, such as summer food limitation, which may diminish or override the benefits of this action.

In the post-VAMP period, inflow from the San Joaquin River usually decreases and diversions from the Delta increase. Salvage may increase at this time because the area of the Delta affected by pumping (zone of entrainment) expands as the pumping rate increases. Increased numbers of smelt in the salvage after the VAMP period may also be an indication of a larger post-larval and juvenile population in the affected portion of the Delta due to the benefits from prior action.

Time to Implement: This action can be implemented immediately upon a decision by WOMT. The decision whether to implement an action would be made on a real-time basis dependent on the specific criteria and conditions for the potential action. The action could be triggered on March 1, but would more likely be the first two weeks of April as a pre-VAMP action. The action could extend over a two to six week period depending on the start date.

Costs: Water costs may be highly variable depending on hydrologic conditions and export demand. Estimated water costs for an action during the first two weeks in April range from 35 TAF to 37 TAF. If the action were to extend back to March 1 and continued until mid-April, the estimated maximum total cost would be about 553 TAF (ranging from 35 to 108 TAF per week).

No South Delta Barriers during VAMP and until June 1 (late spring)

Postpone installation of south Delta barriers until June 1 to reduce the proportion of water drawn towards the pumps from the central and south Delta in order to reduce entrainment losses of larval delta smelt.

ORMR flows in March through May are primarily a function of San Joaquin River flow into the Delta and export pumping rate. Because San Joaquin River inflow is usually less than the export flow, ORMR flows are often in the reverse or upstream direction. With increasing upstream flows, there is an increasing entrainment of delta smelt at the project pumps. Under this action, no barriers in the southern Delta would be operated during the VAMP period (typically April 15 to May 15), and thereafter until June 1. San Joaquin River flow and export pumping would be maintained according to VAMP protocol.

As part of the VAMP experimental design, a barrier is constructed at the head of Old River, where it begins at the San Joaquin River, to keep migrating young salmon in the San Joaquin River where survival is higher than if they move into Old River and the interior Delta. Three other temporary barriers are also constructed at other locations in nearby southern Delta channels. Together, these barriers dramatically alter flow patterns in the southern Delta, blocking the flow of water from the San Joaquin River through upper Old River to the CVP and SWP diversion facilities, so that more exported water flows from north to south in Old and Middle Rivers from the central Delta. During the 31-day VAMP period, combined SWP/CVP export pumping is relatively low, typically 1,500, 2,250 or 3,000 cfs per the VAMP design. Local agricultural diversions also operate at high rates in this season. Positive ORMR flows cannot be achieved unless the export flow is provided from the San Joaquin River via the upper reaches of Old and Middle Rivers.

Rationale: Recent particle tracking models (DSM-2) suggest the south Delta barriers substantially increase central and south Delta particle entrainment risk under VAMP conditions.

Combined particle tracking models and 20 mm survey distributions suggest population losses are directly correlated with X2 position and might reach an estimated 20-40% when X2 moves landward of 60 km. Maintaining X2 in a favorable location during the spawning period of delta smelt reduces their exposure to the effects of reverse flow in the southern Delta channels. A favorable location for X2 during this period is defined as seaward of 65 km during a 14-day running average.

Delta smelt hatch dates back-calculated from otoliths indicate most fish surviving to summer-fall were hatched during the VAMP period when San Joaquin River flow is typically augmented, export pumping is relatively low, and ORMR flows are from south to north (downstream). Ripe and spent adult smelt are commonly observed in the weeks and months prior to the VAMP period, so the scarcity of early-spawned smelt in fish sampling later in the summer or fall suggests either early-spawning fish and/or their offspring experience high mortality, including loss to entrainment. If, as hypothesized by Bennett (unpublished data), early-spawned fish have high natural survival rates and potentially high reproductive value to the population, then their increased vulnerability to entrainment episodes may have important negative effects on the population.

Based on otolith strontium chemistry, in the POD years a relatively higher proportion of fish surviving to summer/fall originated in the north and central Delta in recent years (Hobbs and Bennett, unpublished data) while contributions from other areas (e.g. Suisun Marsh) have declined for reasons yet to be determined. If persistence of the population depends increasingly on recruitment from the central Delta, then actions to minimize impacts of water management on survival of fish spawned in this area is warranted.

Pros and Cons:

Pros: Benefits include reduced entrainment of larval delta smelt, increased abundance and distribution of young delta smelt, and an increased percentage of larger, early-spawned fish.

Avoiding upstream flow on Old and Middle Rivers once spawning has begun should increase the survival of larvae produced in the southern and central Delta.

The immediate positive effects on survival of delta smelt larvae, until the early summer survey, seems likely. However, a positive effect on age and size composition, or abundance at later life stages, will depend on whether summer food conditions for delta smelt limit smelt population levels. Recent data suggest that summer food levels are limiting delta smelt abundance into the fall, and the increase in delta smelt in the spring and early summer may not translate directly into increased fall population levels of delta smelt.

Cons: This action has a medium-high degree of scientific uncertainty. The barrier at the head of Old River is presently utilized to increase survival of Chinook salmon smolts migrating out of the San Joaquin Basin. The other barriers are used to help maintain water levels in the southern Delta to prevent cavitation of agricultural diversion pumps. Postponement of barrier installation would conflict with these purposes.

Time to Implement: Agreement to implement this action may take some time in order to resolve issues regarding the use of these barriers. This action would be implemented during the 31-day VAMP period starting on or about April 15. The barriers addressing local agricultural diversion would not be fully installed until June 1.

Costs: If this action delays ramping up of exports in late May, there may be some costs associated with the action. The maximum estimated cost for two weeks in May would be about 104 TAF (ranging from 26 to 52 TAF per week), and assumes the VAMP combined export level of 1,500 cfs would continue through May 31.

Maintain X_2 West of Collinsville during May-December (summer/fall)

Increase Delta outflow to maintain an average X_2 position west (seaward) of Broad Slough (80 km) near Collinsville from May through December to increase the amount of delta smelt habitat and shift it downstream. Winter entrainment may be reduced and food availability may be improved.

Through a combination of increased upstream releases and decreased project exports, the X_2 position is maintained seaward of Broad Slough during May-December. This action might be implemented if the current water year type is “above normal” or wetter, which is largely determined by precipitation and runoff in the previous winter and spring. This action would not be considered for implementation if the water year is a “below normal” or drier year because water costs would exceed 1 million acre-feet, and such flows cannot be provided by storage releases without dramatic effects on storage levels and temperature conditions for fish upstream in the fall.

Rationale: Higher Delta outflow in the summer and fall can increase the amount of habitat for delta smelt. If smelt use this habitat and their distribution is wider and shifted downstream, subsequent entrainment in the winter will be reduced.

Pros and Cons:

Pros: Benefits may include an improved Environmental Quality Index, wider geographic distribution of delta smelt, decreased larval and adult delta smelt entrainment at project pumps, and an increased percentage of early-spawned fish. Food availability may also be improved resulting in improved survival and health of the fish.

Cons: Water assets could be difficult to provide. The scientific uncertainty of this action is high. The effectiveness of this action depends on fish behavior in reaction to changed habitat conditions, and most responses pertaining to increased population numbers are expected well after the period of action implementation. Post-VAMP delta smelt salvage may increase if Delta inflow from the San Joaquin River decreases and diversions increase because the zone of entrainment expands and the post-larval and juvenile population may be larger due to the positive effects of prior actions.

Time to Implement: Once the management decision is made, and if assets are available, implementation can occur almost immediately.

Costs: This action is estimated to cost up to 425 TAF with most of the water costs occurring September-November. In below normal water years, the water costs would exceed 1 million acre-feet and such flows cannot be provided by storage releases without dramatic effects on storage levels and temperature conditions for fish upstream in the fall. Therefore, it is impractical to provide such flows in below normal and drier years.

Food Web Actions

Over the past several decades, phytoplankton levels in the Delta have decreased by close to 50 percent (Jassby and others 2002). Many zooplankton species have also undergone severe declines. Food scarcity due to reduced phytoplankton and zooplankton production is considered one of the possible causes for the decline in pelagic fishes, including the delta smelt. A CALFED study found that two of the most effective approaches to improve food availability for aquatic organisms in the Delta are floodplain restoration and the creation of more inundated habitat (Jassby and Cloern 2000). For this reason, the CALFED ERP encourages restoration of marshes and floodplains as a tool to rebuilding food webs to support Delta ecology, and lists several tidal marsh and floodplain restoration projects as priorities in its most recent multiyear program plan.

A key goal of these actions is to create habitat that will generate high quality phytoplankton for increased food web and pelagic fish production. However, many parts of the Delta are presently plagued by blooms of the toxic alga Microcystis aeruginosa. While Microcystis contributes to phytoplankton primary productivity, its toxic blooms are likely a detriment to the Delta food web. Hence, this action targets habitat restoration projects that favor high quality species of phytoplankton such as diatoms and certain flagellated algae.

Provide Flows through Yolo Bypass into Cache Slough (summer)

Yolo Bypass has high primary productivity in summer, but net flows move upstream from Cache Slough. Increase summer flow connectivity from the bypass to downstream areas to provide for net downstream transport of productivity. Explore ways to add Yolo Bypass flows into Cache Slough during summer.

Increasing summer flow connectivity from Yolo Bypass to downstream areas may provide a net downstream transport of food production to support juvenile delta smelt. Primary productivity in the Yolo Bypass is high, but net flow in Cache Slough is upstream once floodwaters drain. Additional research and planning is needed to explore ways to add Yolo Bypass flows into Cache Slough during summer before a specific action could be recommended. It is currently unclear if or how this action could be implemented and the objectives met. The action will likely involve structural modifications and not water operation changes.

Rationale: Yolo Bypass generates primary productivity. Increased flow from the Yolo Bypass (inflow or managed wetlands) during the summer is expected to deliver more phytoplankton and zooplankton to the Delta to support young delta smelt. Providing an overlap in distribution between delta smelt and food would potentially enhance feeding conditions and help reduce summer food limitation resulting in increased survival and size to fall.

Pros and Cons:

Pros: Potential benefits are based on enhancing the food web for pelagic fishes. Increased flow from the Yolo Bypass is expected to deliver more phytoplankton and zooplankton to the Delta to support young delta smelt and other pelagic fish. Food supply benefits may include enhanced Calanoid copepod and chlorophyll a transport, and improved delta smelt-food co-occurrence. Fish benefits may include increased abundance, condition, size, and energy density of delta smelt and possibly other pelagic fishes.

Cons: The scientific uncertainty of this action is very high. The hydrodynamics of the Cache Slough complex are very uncertain. The confidence in detecting a change is low and would require initiation of a zooplankton flux study in Cache Slough and adjacent areas.

Additional research and planning is needed before a specific action could be recommended because it is unclear if or how this action could be implemented and objectives met. The action will likely involve structural modifications and not operations changes, which makes it unlikely to be implemented in the coming year.

Time to Implement: The action would be implemented during summer months. Implementation in the coming year is unlikely due to the need to develop specific plans to implement the action, and permit and construct any physical modifications.

Costs: Costs are unknown at this time and would depend on the structural modifications needed to implement the action.

Manage Flooding in North Delta for Seasonal Floodplain Habitat

Modify operations or land management to allow increased area and time of floodplain inundation in the Yolo Bypass and Cosumnes River floodplain to increase productivity of phytoplankton and zooplankton in order to support adults and egg production in fall, egg production in winter, and young delta smelt in spring and summer.

The north Delta includes substantial areas of seasonal floodplains including Yolo Bypass and Cosumnes River. The suite of actions to enhance the development of productive seasonal floodplains includes:

a. Manage flooding to increase the area and time of inundation during winter and early spring. The Yolo Bypass presently floods via Fremont Weir in about 60 percent of water years, and more via western tributaries (though not at the level as when Fremont Weir overtops). However, inundation generally occurs in January or February, and may not occur at all during very dry years. Managed seasonal flooding in selected areas should be considered to supplement natural flood events, especially if inundation can be designed in a way that is consistent with flood control and local land use—agricultural and wildlife area operations, for example. Note that managed seasonal flooding is already conducted in autumn and early winter by private and public landowners to support waterfowl. Extended inundation could be considered through conservation easements and other inducements.

b. Changes in topography to increase the area and duration of inundation during winter and early spring. Topographical changes to floodplain habitat in areas such as Yolo Bypass and Cosumnes River could enhance the frequency and duration of inundation. This action would allow more efficient use of both natural and managed flow events. As one possible example, selected lands immediately adjacent to the Yolo Bypass Toe Drain could be reconfigured with setback levees to promote seasonal flooding immediately adjacent to the channel, while providing additional protection for local landowners from nuisance flooding. Restoring the mouths of tributaries within the Bypass could create seasonally inundated “delta like” channels that may enhance food web productivity.

Projects can be phased so as to provide opportunities to monitor the outcomes and assess whether later actions are likely to fulfill expectations. The first phase could flood smaller areas utilizing existing water in the Bypass by manipulation of present infrastructure or small changes in topography. Larger areas could have enhanced inundation by increasing water in the Bypass through manipulation of the Sacramento Weir or modifications of the Fremont Weir.

The Fremont Weir on Yolo Bypass could be slightly modified to increase the duration and timing of inundation. Modifications to west side tributaries could also provide increased inundation and residence time when the Fremont Weir does not overtop. Operation of the Sacramento Weir could also be modified to allow greater manipulation of water that enters into the bypass, or possibly, to leave the weir out longer once removed.

Cosumnes River has an intact hydrograph making direct manipulation of the river flow impossible. Strategic breaching of the levees could increase the acreage of floodplain inundation, and minor changes in floodplain topography could also be undertaken to increase area, timing, and duration of floodplain inundation.

Rationale:

Food scarcity due to reduced phytoplankton and zooplankton production may be considered one of the causes for the decline in pelagic fishes, including the delta smelt. Increased production of zooplankton for delta smelt in all life stages is critical to their survival. Increasing the area and time of floodplain inundation may boost productivity of phytoplankton and zooplankton to improve larval survival, increase juvenile recruitment, improve adult condition and egg quality, and ultimately lead to increased reproductive success. Inundated floodplains are highly productive ecosystems; however, most of these areas have been reclaimed in the Delta during the past 100 years due to levee construction and agriculture. Restoring, enhancing, or re-creating these habitats could greatly increase phytoplankton primary productivity and help create a more robust food web to support pelagic species.

There is evidence that substantial numbers of delta smelt utilize freshwater sloughs in areas adjacent to wetlands and seasonal floodplains in the northern Delta for part of their life cycle; especially spawning and early larval stages. Moreover, recent evidence suggests that seasonally inundated floodplains in these areas generate high levels of high quality plankton biomass that is exported to adjacent channels and downstream areas that are occupied by delta smelt (Schemel et al. 2003; Sommer et al. 2004). This leads to the conclusion that an increase of productive seasonal floodplains would likely increase appropriate prey organisms for delta smelt larvae survival, as well as for other pelagic species.

Together, Yolo Bypass and Cosumnes River floodplains comprise tens of thousands of acres. The Cosumnes River has a historically intact hydrograph with extensive tracts of seasonally inundated floodplain. Most of the available floodplain is already under management for habitat preservation or wetlands protection by either private organizations or federal and state agencies. Both these areas are directly upstream from delta smelt spawning and rearing habitat.

Pros and Cons:

Pros: Delta smelt and splittail already inhabit channels adjacent to these areas, though historically in much greater numbers. By increasing the period of inundation, production of planktonic organisms and other carbon sources could be increased, possibly reducing the food scarcity that presently exists.

Both these areas are directly upstream from delta smelt spawning and rearing habitat. On Cosumnes River, most of the available floodplain is currently already under management for habitat preservation or wetlands protection by either private organizations or federal and state agencies. Modifications to the levees should not be difficult. On Yolo Bypass, the area already undergoes inundation during 60 percent of water years, and land use is conducive to periodic flooding. Much of the area is under agency management or coordinated by stakeholders groups.

As an indirect benefit, increasing the amount of floodplain and the time of inundation will take pressure off downstream levees and decrease the risk of flooding downstream sites and urban areas.

Cons: The immediate and direct impact upon delta smelt populations may not be as dramatic as the long-term impacts. Residence time of new nutrients in the delta must be long enough to allow for uptake into the food chain. Restoration of local habitats may provide increased nutrients, but these nutrients may not be immediately available to local delta smelt. Increased inundation of these areas in the last few years was expected to result in greater primary and secondary production. However, IEP monitoring has not seen an increase in either delta smelt or striped bass abundances.

For some areas, such as the southern Yolo Bypass, there is no managing agency at present, so management and long-term maintenance would need to be established. There are also landowner issues in some areas. Depending on locations, the proposed action will need careful planning to assure their compatibility with agriculture, mosquito abatement, and managed wetlands. Habitat restoration cannot proceed without resolving these issues through structural or non-structural (e.g. conservation easements) methods. In areas such as the Yolo Bypass, these measures will need careful planning to assure their compatibility with flood control conveyance through the area. Hence, project designs need to be flood neutral or improve conveyance. Coordination with the US Army Corp of Engineers will be necessary.

Aquatic weeds are a recurring problem in many shallow water areas of the Delta. Toxic algal blooms represent an additional related issue. Design criteria (not yet developed) are needed to minimize these problems.

Water quality to downstream areas could be compromised due to methylation of on site mercury or increased dissolved organic carbon from peat soils, and could be detrimental to some long-lived fish species and public health.

Time to Implementation: This action could be initiated this year, but would likely require additional years to implement actions on the ground. Negotiating with landowners and other groups on the Yolo Bypass for increased inundation periods could take one to three years. Actual implementation of modifications of the Fremont Weir, operations of the Sacramento Weir, or breeches in levees could take very little time, but would be subject to environmental review and permitting including NEPA/CEQA, ESA/CESA, SWRCB and others.

Costs: Overall costs are unknown. Planning and environmental review, including conceptual models, are estimated to cost about $500,000.

Next Steps:

- Develop plan in coordination with the Yolo Working Group to formulate actions focused on the lower bypass area.
- Seek legislative and local leadership support.
- Implement planning and environmental review for above actions as funding becomes available.

Sherman Island Floodplain Phytoplankton Pilot Project

Pilot project to construct mile-long floodways on Sherman Island to emulate floodplains and increase primary production. Water would enter through screened inlets and be pumped out into Sherman Lake by fish friendly pumps.

Low summer primary productivity in the lower Sacramento-San Joaquin Delta is thought to be contributing to the POD. Floodways will be constructed and maintained on the southwest corner of Sherman Island, an area owned by DWR, to attempt to increase phytoplankton and zooplankton levels near the confluence of the San Joaquin and Sacramento Rivers. These floodways will be below mean sea level, but will be designed to emulate floodplains and the consequent high primary production observed on floodplains such as those in the Yolo Bypass and Cosumnes River. This action is a concept that is worthy of testing on a pilot scale to address the scientific uncertainty related to the benefits and possible impacts of a larger scale program.

The initial pilot project will consist of six separate floodways built to test three different design complexities; a “floodplain” floodway, a floodway with several small ponds, and a floodway with a tidal channel network. This will allow manipulation of flows and management practices to determine optimal conditions for production of desirable plankton species. The floodways will be operated during the late spring and summer months (April through September) when food supply is limiting delta smelt survival in the lower Delta. Gates can be closed and the floodways pumped dry in late fall through early spring to inhibit the growth of undesirable aquatic vegetation.

The floodways will be located on Mayberry Point in the southwest corner of Sherman Island, and will be approximately 3000 feet long by 300 feet wide. Water will be pumped in via screened gates along Mayberry Slough, and the enriched water will be pumped out directly into Sherman Lake. These floodways will act as slow moving plug flow incubators for phytoplankton and zooplankton. Water depths will be two to six feet depending on the floodway experimental design, and the hydraulic residence time will vary between seven and 14 days.

Six 3,000-foot long floodways separated by berms will be graded into three different designs with two floodway “replicates” per design. These three designs will include a flood plain “pond” design with a few small ponds, a tidal marsh “channel” design with a network of shallow, dendritic channels, and a “simple” design gently sloped toward the center and outflow without any channels or ponds. Flow through these floodways will be controlled by screened gates at the head of each floodway and by pumps at the outflow into Sherman Lake. Archimedes style or Wemco-Hidrostal screw pumps will be used to gently move water and organisms back into the Delta. Phytoplankton, zooplankton, and fish as well as water quality variables will be monitored at both the inlet and outfall. Additional water quality monitoring will occur at horizontal transects and selected sites within the floodways and in several reference sites outside of the floodways. The floodways will be operated as an adaptive management experiment with three design “treatments” and adjustable flow rate and depth. The aim is to find the floodway configuration with the highest quality production efficiency and the least amount of undesirable byproducts.

The proposed floodways would emulate the hydrology and geomorphology of floodplains and tidal wetlands. However, in contrast to previous ecosystem restoration projects, these floodways are not intended to provide habitat for fish. Rather, they are intended to provide good growth conditions for target phytoplankton and zooplankton species and act as a “fish food pump” for the surrounding lower Delta. The floodways would be designed to maximize “fish food” production and minimize production of unwanted species (such as Corbula, Egeria, and toxic and non-nutritional plankton species). Conceptually, the floodway design is embedded in an adaptive management framework as advocated by the CALFED ERP. Physical floodway design elements include geomorphic and hydrologic features characteristic of flood plains and tidal wetlands such as flood and marsh plains with and without small channels and ponds, fluctuating hydrological connectivity with the Delta, pulsed flooding, and fluctuating water depths and residence times. If successful, this technology can be transferred to other islands to augment production of beneficial species throughout the delta.

Rationale:

One of the major hypotheses for the causes of recent and long-term higher trophic level POD in the Delta is the simultaneous decline in pelagic primary and secondary producers (food web hypothesis). These declines at the base of the food web have been linked to the destruction of shallow water habitat, diversion of productive waters, and the invasion and expansion of exotic species.

A CALFED study found that two of the most effective approaches to improve food availability for aquatic organisms in the Delta are floodplain restoration and the creation of shallow water habitat in subsided Delta islands. Consequently, the CALFED ERP encourages floodplain and shallow water restoration as a tool to rebuild food webs to support delta smelt, and lists several floodplain and wetland restoration projects as priorities in its most recent multiyear program plan.

Over the past 100 years, most of the floodplains and shallow water wetlands in the Delta have been reclaimed for agricultural purposes by levee construction. The majority of reclaimed lands in the lower and central Delta have subsided 15 to 30 feet below sea level. Tidal marsh restoration in this area would require significant quantities of fill material to rebuild elevations, which would be both difficult and costly. Suitable potential shallow water restoration sites are generally far upstream of the lower Delta, and increased primary production in these areas may not benefit lower or central Delta species. It is also questionable whether production in existing floodplain and tidal marsh areas along the edge of the estuary such as the Yolo Bypass, Cosumnes River, Liberty Island, and Suisun

Marsh can be transported to the lower Delta to provide the necessary food for delta smelt during the summer months.

By creating floodplains in this area, we accrue the benefit of floodplain production where it would otherwise be impossible to do, while being able to manage time of inundation, residence time, depth and other environmental factors that could increase production of desirable organisms.

Pros and Cons:

Pros: Direct benefits would be increased primary and secondary production. Higher production on floodplains has been well documented. The ability to replicate this production on an engineered and actively managed floodway has not yet been demonstrated. The ability to manage inflow, outflow, and residence time allows for the manipulation and control of primary production, aquatic weeds and undesirable terrestrial and aquatic species. Potential contribution to the food sources in the confluence area is unknown.

Indirect benefits include improved habitat, and increase soil accretion on Sherman Island from sediment deposition and vegetation growth.

DWR owns much of Sherman Island and short term leases can be modified to utilize land for this purpose. Construction and operation are highly feasible, though permits for possible take of fish species and discharge from the floodways would be needed.

Discharge from the floodways can be timed to coincide with flood tides to prevent downstream import of phytoplankton and zooplankton to clam inhabited areas.

Cons: This action is a concept that needs testing on a pilot scale to address the scientific uncertainty related to the benefits and impacts of a larger scale program. Possible impacts include production of undesirable phytoplankton (e.g. *Microcystis*) and zooplankton (e.g. *Limnoithona tetraspina*), carbon loading of effluent, hypoxia, taste and odor problems, and methyl-mercury production.

Temperature differences between the floodways and the Delta could cause plankton and fish mortality.

Even with screening, larval delta smelt could be entrained within the floodway or damaged in the pumps.

Time to Implementation: Scientific review and identification of funding for design development could begin immediately. Design and environmental documentation would follow. Implementation of a pilot project would require about two to five years.

Costs: $5.5 - 8.2 million

Next Steps:

- Provide conceptual plan for scientific review.
- Seek funding to develop engineering design incorporating changes made during review process.
- Decide whether to move forward with a pilot program and obtain funding.
- Begin engineering designs while preparing environmental documents (NEPA/CEQA).
- Complete environmental documents and consultation with agencies involved in permitting process.

Habitat Improvement Actions

Habitat improvement actions are a multispecies approach to protecting and restoring areas to benefit multiple species, including delta smelt and other pelagic fishes. The current CALFED ERP planning process for the Delta and Suisun Marsh proposes to enhance managed wetlands and restore tidal wetlands to benefit multiple species. Under the ERP, the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) and the Suisun Marsh Plan (SMP) are the first of several regional plans intended to refine the existing planning foundation, guiding long-term implementation of the CALFED ERP element. The multispecies approach of these plans may result in a healthier ecosystem and provide benefits to other species of concern through the proposed actions.

Two of the 2006-2007 actions for habitat improvement are located in Suisun Marsh. The Suisun Marsh provides foraging and rearing habitat for several species, including delta smelt, and serves as a critical link between the Delta and San Francisco Bay. Only about 10 percent of the marsh's tidal wetlands remain and the completion of the proposed restoration projects would significantly increase that acreage to provide additional foraging and rearing habitat.

Restore Tidal Action to the Suisun Marsh, Blacklock Restoration Project

Restore tidal action to the 70-acre Blacklock property, a diked and managed marsh, within the next year using a minimally engineered approach. Restoration to tidal wetland ecosystems is expected to aid in the recovery of several listed and special status species within the marsh and improve food availability for delta smelt and other pelagic organisms.

The Blacklock site will be restored to a fully functioning tidal wetland by constructing levee breaches in one or two locations (DWR and Reclamation 2006). Once the levee is breached, a passive approach will be used in which natural sedimentation and plant detritus accumulation contributes to restore intertidal elevations, and natural colonization establishes the desired plant and wildlife communities. The underlying restoration requirement for this site is subsidence reversal, as the site ranges from three feet, to more than five feet, below local mean high water. Tidal flow is expected to utilize the existing remnant channels to some extent, with some new channels forming as sedimentation progresses. This design is a minimal-engineering approach that relies on natural processes to meet project goals and objectives of improving habitat conditions for tidal marsh species. Implementation of this project includes a monitoring plan, an Adaptive Management Program, a maintenance program, and an invasive species control plan.

Rationale:

Restoration of tidal wetland ecosystems is expected to aid in the recovery of several listed and special status species within the marsh, and will benefit multiple species, including delta smelt and other aquatic species. This restoration project would provide additional foraging and rearing habitat for delta smelt and other pelagic species. It is also expected to increase phytoplankton primary productivity thereby increasing food availability for pelagic species.

Pros and Cons:

Pros: This restoration represents an opportunity to realize many of the ecosystem benefits that are commonly associated with healthy tidal marsh habitat, and will benefit multiple species. Targeted wildlife species include the Suisun song sparrow, black rail, common yellowthroat, and other avian species. Fisheries benefits include providing habitat and increased food availability for delta smelt, longfin smelt, Sacramento splittail, Chinook salmon, and other aquatic species. Many uncertainties remain regarding delta smelt biology and ecology, as well as how to design restoration and management actions to maximize benefits for sustaining delta smelt. Resolving these uncertainties and incorporating this new knowledge into adaptive restoration and management actions is critical for saving this species. This project will be monitored to document the expected beneficial effects and detect potential impediments to successful marsh restoration, as well as potential adverse outcomes. Implementation of this project includes a monitoring program, an Adaptive Management Program, a maintenance program, and an invasive species control plan.

A new tidal channel network is expected to form, partially re-occupying remnant channels and otherwise forming within the newly forming tidal marsh surface. Restoration of tidal flows would produce substantial changes to the habitats and biological, physical, and chemical functions of the site. Vegetation would transition to a mix of species suited to the intertidal brackish environment with the site eventually becoming fully vegetated, except for channels. Some open water areas may persist in the long term.

Knowledge expected to be gained from this restoration includes rates of sedimentation and marsh development, the role of existing emergent vegetation in influencing sedimentation, channel network formation and overall geomorphology, hydrology, water quality impacts, and species use. The results would provide valuable information to scientists and decision makers in long-term land use and restoration planning throughout Suisun Marsh.

Cons: As possible impacts, this action could provide habitat for non-native aquatic and terrestrial species, and could increase production of methylated mercury. However, project implementation includes a monitoring program and an invasive species control plan. The goals for the monitoring program include: 1) avoidance of adverse impacts from construction and restoration activities, and 2) restoration outcome monitoring. Monitoring includes components for native marsh vegetation development, invasive plant species establishment, aquatic species utilization, food web productivity, and water quality.

Short-term adverse water quality effects could occur when pond water is initially mixed with tidal water after the levees are breached. The potential water quality effects would not be significant because they would be limited to one tidal cycle, and the volume of water in the pond is much less than the volume of water in Little Honker Bay and Nurse Slough, which would quickly dilute water flowing from the pond.

Time to Implementation: DWR constructed one levee breach on October 4, 2006, to return the site to full tidal restoration. The site will be monitored for a 10-year period to determine post-breach changes in the biota, hydrodynamics, food web productivity, and water quality.

DWR acquired the Blacklock property in December 2003 using CALFED Ecosystem Restoration Program grant funds and Suisun Marsh Mitigation Agreement Phase C Mitigation funds. DWR released the Draft Restoration Plan in April 2006, which was reviewed by the USFWS, DFG, Reclamation, and Suisun Resource Conservation District (SRCD), and also underwent CALFED Science Program independent review. Comments received were incorporated in the revised June 2006 Draft Plan available on-line at: *http://www.iep.ca.gov/suisun/restoration/blacklock/doc/BlacklockDraftRestorationPlan_061506.pdf*.

DWR is the California Environmental Quality Act (CEQA) lead and Reclamation is the National Environmental Policy Act (NEPA) lead for this action. Cooperating agencies include the DFG and SRCD, plus the USFWS and U.S. Army Corps of Engineers in an advisory role.

Costs: CALFED ERP funded the property acquisition for $536,750. DWR, Reclamation, and CALFED sources are funding the restoration work at up to $1.3 million for the currently approved restoration project.

Next Steps:

- Construction occurred on October 4, 2006.
- Monitoring for: 1) avoidance of adverse impacts from construction and restoration activities, and 2) restoration outcome monitoring including food web productivity.

Restore Tidal Action to the Suisun Marsh, Meins Landing Project

Restore tidal action to the 668-acre Meins Landing project, a diked and managed marsh, within the next two years. Restoration to tidal wetland ecosystems is expected to aid in the recovery of several listed and special status species within the marsh.

DWR acquired the Meins Landing Duck Club in December 2005 and is proposing to restore the area to tidal wetlands. Meins Landing is a 668 acre seasonally managed (nontidal) marsh in Suisun Marsh, Solano County. DWR proposes to convert it to tidal wetlands and designate some of the restoration as mitigation for impacts to the state and federally-listed endangered Salt Marsh Harvest Mouse (SMHM) from DWR's proposed project to raise the levees on Van Sickle Island. Meins Landing is a mosaic of wetlands and uplands that could provide a diversity of habitats when restored. The site is currently leveed and managed as seasonally flooded wetlands used for waterfowl hunting. The project could enhance the existing pickleweed acreage and convert some of the weedy areas into brackish and salt marsh dominated by pickleweed or other emergent species. Conversion of less desirable non-native dominated sites to tidal marsh and transitional uplands would likely increase the overall value of Meins Landing for native species such as the SMHM and burrowing owl.

Rationale:

Restoration of tidal wetland ecosystems is expected to aid in the recovery of several listed and special status species within the marsh, and will benefit multiple species, including delta smelt and other aquatic species. The Suisun Marsh provides foraging and rearing habitat for several species including delta smelt, and serves as a critical link between the Delta and San Francisco Bay. Only about 10 percent of the marsh's tidal wetlands remain, and the completion of the proposed restoration projects would significantly increase that acreage to provide additional foraging and rearing habitat.

Pros and Cons:

Pros: Restoration of tidal wetlands will benefit multiple species including delta smelt and other aquatic species. Many uncertainties remain regarding delta smelt biology and ecology, as well as how to design restoration and management actions to maximize benefits for sustaining delta smelt. Resolving these uncertainties and incorporating this new knowledge into adaptive restoration and management actions is critical for saving this species. This project will be monitored to document the expected beneficial effects of this project and detect potential impediments to successful marsh restoration, as well as potential adverse outcomes. Implementation of this project would likely include an Adaptive Management Program, a maintenance program, and an invasive species control plan.

Cons: The effects of restoring tidal action to managed wetlands are unknown. Water quality could be compromised due to methyl mercury or improved as enhancements to managed wetlands are implemented under the Suisun Marsh Habitat Management, Preservation, and Restoration Plan. This action could provide habitat for non-native aquatic and terrestrial species. Project implementation will include a monitoring program and an invasive species control plan.

Time to Implementation: DWR acquired the property in December 2005. Restoration can now progress and should be completed within two years.

Costs: The property was acquired for $900,000 funded equally by the Coastal Conservancy, Reclamation, and DWR. Up to $2 million is needed to implement the restoration project.

Next Steps:

- Develop restoration and monitoring plans.
- Ensure environmental compliance, including all necessary state and federal permits and approvals for endangered species.
- Identify funding sources for implementation and long-term management.

Dutch Slough Tidal Marsh Restoration Project

Restore tidal action and associated wetlands habitats to the 1,166 acre Dutch Slough Tidal Marsh Restoration Project. The restoration activities and long-term management are designed to contribute to the recovery of several listed and sensitive aquatic species in the western Delta, while providing sustainable ecosystem benefits to improve our understanding of ecological processes and how ecosystems function at different spatial levels.

With funding provided by CALFED and the California Coastal Conservancy, DWR took title to the Dutch Slough property on October 31, 2003, to convert 1,166 acres of irrigated pastureland and levees to tidal wetlands and associated habitats. The design features will create a complex of emergent freshwater tidal marsh, riparian, and upland habitats.

The Dutch Slough property was a high-priority acquisition due to the rare availability and desirable elevations for large-scale restoration in the western Delta. The project alternatives have been designed to significantly aid in the recovery of several listed and special status species (delta smelt, Chinook salmon, and splittail). The design alternatives incorporate trophic conditions likely to support food web connections and habitats in the western Delta that some native fishes can use year-around, including attractive spawning habitat located away from the export pumps during most wet years.

The project goals and objectives are to:

1) Benefit native species by re-establishing natural ecological process and habitats
2) Contribute to scientific understanding of ecological restoration by implementing the project under an adaptive management framework
3) Provide shoreline access and educational and recreational opportunities

Rational:

The project is seen as a significant step in recovery of the ecological health of the Sacramento-San Joaquin Delta for two reasons. First, it would be the largest tidal wetland restoration designed to recreate the dominant type of habitat present historically in the western Delta (a mosaic of marsh plain drained by a sinuous branching tidal channel network with adjacent riparian habitats). Second, the project and restoration actions are designed with the assistance of a blue-ribbon panel of scientists using an adaptive management framework intended to benefit native fishes and other aquatic and wetland species. This scientific method will maximize the information value of restoration and management actions to learn how to best achieve the project objectives. Results from other tidal marsh restoration projects, such as Decker Island, will be used in the design process to avoid undesirable outcomes. Lessons learned from monitoring the restoration actions, and experimental designs that test hypotheses about ecosystem functions, will help inform key planning and design decisions for future restoration projects in the Delta.

Pros and Cons:

Pros: This large-scale restoration site (1,166 acres) is strategically located in the western Delta. The proximity to diverse species in Suisun Marsh, Big Break, and Marsh Creek provides greater connectivity and enhancement for the recovery of sensitive aquatic species. The size makes it possible to restore large, contiguous blocks of tidal marsh with branching channels, including subtidal channel habitat that supports native fish species and their critical life cycles. The project will restore a natural transition from marsh to uplands, but will also include open water for greater production of prey sources for beneficial species. To reduce short term costs, the project will be phased to focus restoration on high priority habitats as funding becomes available.

The application of an adaptive management plan will be used to test hypotheses and adjust actions to benefit future restoration and aquatic resources in the Delta. There is also a great opportunity to connect the adjacent Marsh Creek, which can expand the fish migration corridor while providing episodic delivery of sediment to raise subsided site elevations. A vast consortium of scientific knowledge about tidal marsh elevation and marsh scale is anticipated to be collected as key uncertainties, hypotheses, and experimental designs are tested and the results applied to other projects to improve the recovery of at-risk species and native biotic communities.

Experiences from the Decker Island restoration project will be incorporated into the design of Dutch Slough so that undesirable outcomes can be avoided. Results of the Dutch Slough restoration project could lead to other projects to benefit food production such as phytoplankton production floodways.

Cons: There would be significant unavoidable and cumulative impacts on extant terrestrial and wetland biological resources through the conversion of habitat associated with irrigated farmland. Terrestrial avian species would likely be the most adversely impacted. There could be the establishment of some habitat that could benefit nuisance species such as mosquitoes and invasive nonnative plants and animals.

Increased mercury methylation associated with created wetlands could cause bioaccumulation and toxicity to fish. Breaching levees to restore full tidal action has elevated concern about the potential to raise groundwater levels in adjacent low-lying areas (i.e., residential, agricultural land, and drinking water sources) by increasing groundwater recharge. Water quality issues include an increase in salinity and dissolved organic carbon.

A significant volume of fill material will be needed for the preferred alternative design, and material availability is limited and expensive to import.

Time to Implementation: DWR acquired the property in December 2003. Restoration can now progress and should be completed within three years.

Costs: CALFED ERP and the California Coastal Conservancy provided funding for the acquisition for a total of $28 million. DWR is managing the site for the interim on limited funding. The Coastal Conservancy is also funding the planning and environmental documentation. Construction of the preferred alternative is estimated to be approximately $30 million. Funding for the planning design, implementation, construction, and monitoring has not been determined at this time.

Next Steps:

- Prepare public Draft Environmental Impact Report (EIR) for release in early November 2006 and the final EIR by early 2007 for certification by DWR (the state lead CEQA agency).
- Apply for funding from available sources.

Contaminants Management Actions

Actions for the management of potential contaminants that may impact pelagic organisms are primarily more regulatory in nature. One of the areas that the IEP POD investigations are focusing on is the recent changes in pesticide use, mainly pyrethroids and aquatic herbicides. In addition to these chemicals, there are a number of other potential contaminants of concern including other pesticides, metals, and natural occurring elements. Increasing discharges from urban sources have resulted in greater contaminant loading, including pharmaceuticals and potential endocrine disrupters. As land use shifts from agricultural to urban, issues of storm water runoff and treated and reclaimed wastewater will continue to grow in the Delta watershed. While regulation of contaminants is not within the purview of the Resources Agency, support to other regulatory agencies responsible for contaminants management is important to prioritize actions and to secure funding.

Encourage Greater Enforcement of the California Water Code and the Clean Water Act for Control of Pyrethroids and Other Contaminants

Evaluate options to limit discharge of pesticides, such as pyrethroids and other contaminants, found to contribute to the decline in pelagic organisms or components of the food chain through industry and site specific permitting, TMDLs, implementation of Management Practices (MPs), pesticide shift, pesticide label changes and Integrated Pest Management.

The SWRCB and Department of Pesticide Regulation (DPR) have a primary role in the enforcement of limiting pollution discharge through the Clean Water Act, and enforcing the Porter-Cologne Act – California Water Code. Pyrethroids and other contaminants are thought to contribute to the decline in pelagic organisms or components of the food chain. If ongoing research confirms pyrethroids' effects, these agencies should be encouraged to take immediate and appropriate regulatory actions to reverse these effects. Other mechanisms available to the regulatory agencies include:

1) Fully Implement the Irrigated Lands Conditional Waiver Program in the Central Valley – The Central Valley Regional Water Quality Control Board (CVRWQB) has primary responsibility to implement the Irrigated Lands Conditional Waiver Program to address discharges of waste from agricultural lands to surface waters. This program allows farmers, in lieu of monitoring each point discharge on their property, to form groups where common points of aggregated discharge enter the streams and rivers. This program also requires farmers to implement management practices to improve and protect water quality. By fully implementing this program, regulatory agencies and researchers could determine the temporal and spatial discharges of agricultural contaminants, and their potential effects on aquatic organisms. This could lead to actions as described in 2) and 3) below.

2) Total Maximum Daily Loads (TMDLs) – Limit the cumulative total load of any one contaminant. Requires dischargers to monitor their discharge and control amounts entering the river.

3) Implement additional Management Practices (MPs) for tail water and storm water runoff from irrigation agricultural lands –

    a) Develop and require on-site cultural practices (the methods and techniques of farming a particular crop) to reduce transport of pesticides and other contaminants into the water system. These can include field level practices, such as tail water management and integrated pest management to reduce total pesticide use. Currently, EPA, DPR, DFG, and CVRWQCB are funding work to develop MPs for pesticides, as well as other protection measures for aquatic organisms. It could also include looking at application methods to minimize transport.

b) Examine existing NPDES permits (wastewater, reclaimed wastewater, and storm water) and require monitoring for new and emerging contaminants of concern. If present, MPs should be required to reduce loading of urban runoff contaminants to the waterways. Current urban use of pyrethroids has increased dramatically. Runoff of urban applied pyrethroids should be studied, and MPs implemented to reduce loading into waterways.

4) Pesticide shift, label changes and MPs – Identify alternative pesticides that might substitute for pyrethroids that would have less effect on aquatic organisms. Improve or apply additional pesticide use label restrictions to reduce offsite migration to waterways. Also, apply integrated pest management to reduce pesticide use.

Rationale:

One of the areas that the IEP POD investigations are focusing on is the recent changes in pesticide use. The use of pyrethroids in agriculture and urban pest management has expanded as organophosphate use is reduced. Pyrethroids are the synthetic version of pyrethrins, which are the natural insecticide extracted from chrysanthemums. Pyrethroids are more commonly used, and have a greater toxicity and half-life than the natural form. Increased spraying for mosquitoes because of West Nile Virus might also be leading to more routes of exposure. However, recent spraying in some areas has used the natural form rather than the synthetic form. Pyrethroids generally have a shorter half-life than organophosphates, but can be very toxic to aquatic life.

There are a number of other potential contaminants of concern including other pesticides, metals, and natural occurring elements. Increasing discharges from urban sources have resulted in greater contaminant loading, including pharmaceuticals and potential endocrine disrupters. As land use shifts from agricultural to urban, issues of storm water runoff and treated wastewater will continue to grow in the Delta watershed.

Pros and Cons:

Pros: If the decline is linked to the contaminants, these actions would have a direct benefit by reducing effects on pelagic organisms. If contaminants are affecting the food chain, reduction would result in more abundant food organisms. This action could also stimulate research and adoption of alternative pest control methods.

Cons: It may be hard to implement some of these actions because of a lack of alternatives. There will probably be resistance from the agricultural community and the pesticide manufacturers due to loss of productivity or potential loss in net income. Municipalities may also be resistant to increased costs of implementing management practices and reducing discharge and loading. Funding of management practices through grants or other sources may provide financial relief.

Although this action has the potential to benefit many species and generally improve Delta habitat and therefore should be fully supported, it would not affect POD species in 2007.

Time to Implementation: Ongoing. Timing will vary depending on the specific action.

Costs: Unknown

Next Steps:

- Coordinate with DPR, CalEPA, and EPA for completion of studies, and their regulatory oversight, and enforcement actions.

Invasive Species Actions

Invasive species are organisms that have been transported by human activities into regions where they did not occur historically and successfully reproduce in their new location (Carlton 2001). Once established, such species can create negative economic, ecological, and human health impacts. There are hundreds of invasive species that have been introduced to the Bay-Delta that can affect delta smelt and other native organisms in a variety of ways. Responsibilities related to invasive species are distributed among departments in the Resources Agency and other agencies including CalEPA. Many departments play active roles, and coordination is improving to ensure adequate efforts are made as relates to prevention, detection, control, and education.

Increase Staffing at Agriculture Inspection Stations to Inspect Watercraft for Zebra Mussel and Other Invasive Species

Increase staffing and hours of operation at agricultural inspection stations to inspect all boats and watercraft on a 24/7 basis to prevent more aquatic invasive species from entering the state. A pilot project is underway by the Department of Food and Agriculture for FY 2006-07 and could be fully implemented in FY 2007-08. If appropriate funding is provided, extremely expensive and often unsuccessful eradication programs for future invasive species will not be needed if invasive species are kept out of the state.

A significant potential pathway for introduction of aquatic invasive species is recreational boats. One potentially devastating invasive species that has been detected attached to trailered boats is the zebra mussel, Dreissena polymorpha. This Eurasian native has already invaded the Mississippi River drainage and the Great Lakes, where it competes with native organisms for food (filter feeds on plankton) and space, and increases water clarity through filter-feeding which results in increased growth of aquatic plants. The zebra mussel also has a major economic impact because it attaches itself in huge numbers to submerged surfaces including water intake and conveyance structures, fish screens, and boats. Social and water quality impacts from this invasive species include: taste and odor issues in drinking water resulting from dead and rotting mussels, increased organic carbon loads that need to be treated and removed from drinking water, and the potential for algal blooms resulting from the rejection of blue-green algae when feeding.

The California Department of Food and Agriculture (CDFA) operates 16 agricultural inspection stations on the major highways entering California. Presently, nine of these stations are open 24 hours per day, 7 days per week, while the other seven are open on a part-time basis (approximately eight hours per day). Additionally, current staffing is only adequate to inspect commercial vehicles (trucks); no private vehicles are being inspected.

Until July 2003, CDFA inspectors checked all watercraft entering California through these stations for invasive aquatic species, including zebra mussel. In 2003, the program was subjected to severe budget cuts and the ability to inspect small, privately transported watercraft was lost (large watercraft, transported by commercial carriers, are still being inspected). In July 2006, CDFA began a one-year pilot project at the Needles border station on Interstate 40 that resumes private vehicle inspection. For the duration of the project, CDFA is inspecting private vehicles for the purpose of generating data to support future budget change proposals to resume private vehicle inspections at all 16 stations on a full-time basis.

All agricultural inspection stations need to be opened 24 hours per day, 7 days per week and be adequately staffed. Staff must be trained to identify zebra mussels and other aquatic invasive species (including aquatic weeds) that are transported on vessels and pose a major risk to waterways and aquatic ecosystems. All boats need to be inspected. CHP staff should also be trained to identify invasive species, and contaminated vessels should be reported to DFG.

When zebra mussels are found at an inspection station, CDFA staff clean as many of them from infested boats as possible at the station, and then place the boat under quarantine to destination with instructions not to place the boat in water until it is released from quarantine. At destination, DFG personnel supervise the final cleaning or treatment to mitigate the infestation risk. Zebra mussels have been detected 63 times at agricultural inspection stations since 1993. Adequate staffing to inspect all incoming watercraft at agricultural inspection stations is essential to keeping this invasive species out of California, where it could cause ecological and economic disaster.

Rationale:

Prevention, as opposed to control efforts once a population is established, is known to be the most cost effective and environmentally sensitive method of managing aquatic invasive species. Ballast water and recreational boats are probably the most significant pathways for introduction of invasive aquatic species, so strong support and education regarding this program will be important to maintain its effectiveness. Introduction of the zebra mussel would have disastrous ecological effects and would cost billions of dollars annually for water agencies, irrigation districts, recreational and commercial boating interests, and the state (increased maintenance cost for water projects, navigational aides, pilings/docks/boat ramps, bridge supports and abutments, fish ladders/raceways/weirs).

Even with the current limited operating hours and vessel inspections, several boats harboring zebra mussels are detected each year. Zebra mussels have been detected 18 times since private vehicle inspection was discontinued in July 2003. On August 11, 2006, a recreational boat was intercepted at the inspection station in Needles under the CDFA pilot project. This boat was rejected for carrying zebra mussels. Normally, this boat would have passed the inspection station without being inspected. Again on October 25, 2006, a second recreational boat was intercepted that carried over 50 zebra mussels primarily on the stern and outdrive, but a few small shells were found in the cooling system after it was treated with a bleach solution. CDFA anticipates that the pilot project data will indicate that the need exists for inspection of all private watercraft at the border stations, and will pursue funding accordingly.

Before the severe budget cuts, CDFA routinely conducted inspection of privately-hauled vessels on a full-time basis. Therefore, CDFA has the ability to reinstate this program with additional budgetary and staffing resources.

Pros and Cons:

Pros: Interception is straightforward and achievable. Inaction will be disastrous. Direct benefits in preventing, or at least delaying, the introduction of the zebra mussel and other harmful non-native species will save the state, private and public agencies, companies, and citizens billions of dollars each year in anti-fouling management and maintenance costs; protect native species and ecosystem from the zebra mussel; and maintain high drinking water quality. This action will indirectly prevent the importation of other harmful species (e.g., green mussels, aquatic weeds, and quagga mussels), educate boaters about transporting invasive species, and prevent (or at least delay), eradication efforts that would most likely include the application of chemicals to a waterbody.

CDFA anticipates that the pilot project data will indicate that the need exists for inspection of all private watercraft at the border stations, and will pursue funding accordingly. CDFA would welcome the opportunity to share information and build a strong coalition of agencies and interest groups in support of preventing the introduction of invasive species.

Cons: Potential negative impacts may be the inconvenience to vessel owners and commercial haulers delayed during inspection and during vessel cleaning and quarantine. Another impact would be the redirection of DFG staff time for cleaning and quarantine activities.

Although this action has the potential to protect many species, as well as Delta habitat, and therefore should be fully supported, it would not affect POD species this year

Time to Implementation: This action could be implemented as soon as increased funds and additional staff are in place. Training can occur within the first month of hire (on an individual basis) or annually at annual training events/conferences.

Costs: It is estimated that implementing this action would require the hiring of an additional 60 Plant Quarantine Inspectors to staff all 16 inspection stations and cost $3.5 million to $4 million annually. Approximately half the inspectors would be required to change the part-time stations to full time, and the other half would be needed to resume private vehicle inspections at the current full-time stations.

Next Steps:

- Resources Agency support of CDFA's efforts to fund more inspector positions.

Ballast Water Control

Adopt mandatory performance standards for ballast water treatment technologies. CSLC's January 2006 report to the California Legislature recommends specific performance standards for the discharge of ballast water into the waters of the state. New Ballast Water Regulations that pertain to ships traveling between ports within the Pacific Coast region only became effective March 22, 2006.

The 1999 Ballast Water Management for Control of Non-indigenous Species (NIS) Act (AB 703) charged the CSLC with oversight of the state's first program to prevent species introductions through the ballast water of commercial vessels (Falkner and others 2005). Upon the sunset of the law, the Marine Invasive Species Act (AB 433) was passed in 2003, revising and widening the scope of the CSLC program to more effectively address the NIS threat. Under the new law, the expanded Marine Invasive Species Program (MISP) continues to monitor compliance with the requirement to manage ballast water of foreign origin. Compliance with all aspects of current laws and associated regulations exceeds 95 percent. This includes reporting requirements, fee submission, and ballast water management requirements.

The Governor recently signed into law the Coastal Ecosystems Protection Act (AB 497) to control invasive species in the ballast water discharged by ships. Performance standards for ballast water discharge proposed by CSLC take effect with the passage of this bill. These standards are to be fully implemented on or before January 1, 2008.

In addition, the San Francisco Regional Water Quality Control Board determined that ballast discharge is a form of pollution (biological pollution) under the CWA. A 2005 federal court ruling defined non-indigenous species as “pollutants” present in discharges from vessels and found that such discharges are not exempt from permitting requirements (NPDES). Some regional boards placed specific water bodies within their regions on the CWA 303(d) list as impaired by exotics. San Francisco Bay was listed in 1998. In 2006, the SWRCB will consider listing proposals for the Delta, the upper San Joaquin River, and the Cosumnes River. Once on the 303(d) list, the regional boards must develop programs for managing pollutant loads, but has been difficult to establish TMDLs for exotic species.

Rationale: For marine and estuarine environments, the ballast water of ships is considered one of the main ways that foreign species are transported and spread.

Pros and Cons:

Pros: Ballast water and recreational boats are probably the most significant pathways for introduction of invasive aquatic species, so strong support and education regarding this program will be important to maintain its effectiveness. Introduction of new invasive species could have disastrous ecological effects. The direct benefits of this action are preventing the introduction of new non-native species, thereby maintaining ecosystem integrity.

Indirect benefits include preventing the further decline of native species, and saving the state and water agencies billions per year by preventing the endangerment of native species populations and the further decline of currently listed species.

Cons: Ballast water control is not all inclusive; species are also transported via hull fouling which current ballast water regulations do not address. It also may be difficult to establish TMDLs for exotic species.

Although this action has the potential to protect many species, as well as Delta habitat, and therefore should be fully supported, it would not affect POD species this year.

Time to Implementation: The new ballast regulations went into effect March 22, 2006. Performance standards for ballast water discharge take effect with AB 497 being signed into law, and would be fully implemented on or before January 1, 2008 under the bill.

Costs: Unknown

Next Steps:

- Support CSLC's work to control ballast water by assisting with studies related to the Estuary. DFG is charged with oversight of studies to determine the location and geographic range of NIS in CA estuaries and coastal areas, and to assess the effectiveness of ballast water controls.
- Assist CSLC, DFG, and other agencies with the development of regulations or control measures for hull-fouling.
- Expand ballast water and hull-fouling control measures to trailered vessels.
- Support the implementation of the California Aquatic Invasive Species (AIS) Management Plan (scheduled for completion and Federal approval by spring 2007).

Other Actions

These are actions that do not fit well into any of the previously discussed specific benefit related categories, but would potentially benefit pelagic species through population protection.

Fund the Delta Smelt Culture Lab

Provide consistent, long-term funding for the continued operation of the UC Davis delta smelt culture and conservation laboratory to provide delta smelt for research.

UC Davis is operating the Fish Conservation and Culture Laboratory (FCCL) located on DWR property near the Skinner Fish Facility in Byron, California. With the support of state and federal agencies, the FCCL has successfully established reliable methods for the culture of delta smelt and conducts laboratory research on environmental biology of this sensitive species. The recent expansion of the FCCL ($1.4 million) allows annual production of 10,000-20,000 juveniles and 5,000-10,000 adult smelt. The reliable supply of cultured smelt enables research planning, and the increased production facilitates new research opportunities. Current funding for the culture of delta smelt is provided by DWR and expires June 30, 2007.

Interest in cultured delta smelt stems from the overall decline of smelt in the Delta and the recent sharp decline in the abundance index over the last several years. The FCCL provides a supply of smelt that would otherwise be very difficult to acquire from the wild. The adults are fairly fragile and scarce, and the larvae and juveniles generally do not survive capture.

Cultured delta smelt have been requested over the next few years by DWR, Reclamation, USFWS, UCD, and SFSU. The cultured delta smelt are valuable to management and scientific communities because they:

- provide animals with known rearing history, required for toxicology experiments,
- aid research and design of fish screen efficiency, and pre-screen losses,
- allow investigations into basic biology with application to wild populations, and
- enable the development of a formal delta smelt refuge population.

The development of fish culture techniques for delta smelt, while technical and intensive, is now reliable and can provide known quantities of fish for small scale research projects. Consistent and long-term funding would allow infrastructure investment and multi-year production planning to meet the increasing demand for study fish.

Rationale:

The UC Davis delta smelt culture and conservation laboratory provides fish for research purposes. New funding was secured but ends soon. DWR is providing funds for the laboratory in FY 2006-2007 for the duration of the ongoing IEP Collection, Handling, Transport, and Release study looking at the fish salvage operations at Skinner Fish Facility. However, without more funding the laboratory may not be able to produce enough fish for other delta smelt research, including IEP POD study elements (see section on IEP POD Study Plan).

Long-term, consistent funding would allow a greater time horizon for planning, management and capture of broodstock, and production of larvae and juveniles to meet the demand for research fish.

Pros and Cons:

Pros: The collection and culture of all life stages of delta smelt would provide for continued research in larvae feeding and nutrition, spawning behavior, fish salvage facility evaluations, and would supply the needs of other researchers without additional collection of wild individuals. Fish of known age, size, and history are critical for replicable results in swimming studies for fish screen, toxicology, and other studies.

The delta smelt culture and conservation laboratory is an existing project that only needs funding support to continue operations. Multi-year funding allows long-term planning to best utilize resources needed to meet the demand for fish.

Cons: Though the culture of delta smelt has improved in reliability each year, it is still a highly technical and intensive process and requires highly trained personnel. As with any aquaculture operation, loss of fish through disease, handling, or equipment failure is not unusual.

Time to Implementation: This action can be implemented immediately and operation can continue over the next five years with funding.

Costs: $300,000 - $600,000 per year depending on the level of production required.

Next Steps:

- Seek funding for the next five years.

Develop Delta Smelt Refuge Population

Develop a delta smelt refuge population at duplicate facilities to protect the species.

The culture of delta smelt requires a more labor intensive type of aquaculture than is typically required for food fishes farmed in the United States (i.e. salmon, catfish, and sturgeon). It is a process that has been developed at UC Davis and at the Fish Conservation and Culture Laboratory (FCCL) (located on DWR property near the Skinner Fish Facility in Byron). To preserve genetic variability in the cultured delta smelt for present research, they have captured wild broodfish to produce the F1 generation. They have also reared F2-F4 generations at the facility with no apparent decline in viability.

Development of a formal refuge program, with genetic identification of individuals to parental cross and family groups, would require the development of DNA micro-satellite loci and primers for DNA amplification. Development of these genetic records is also valuable for population management and species identification. Housing of the requisite family groups, likely a population of 20,000 individuals, could be accomplished by modifying the new facility built adjacent to the FCCL for the IEP Collection, Handling, Trucking and Release study. Facilities at Livingston Stone Hatchery near Redding, the USFWS hatchery that maintained a winter run Chinook salmon population, could also be modified to house delta smelt. This hatchery has a great deal of experience in the care and maintenance of a refuge population and could provide an additional location for a population of delta smelt.

Rationale:

Delta smelt numbers have declined precipitously since 2001, raising serious concerns that the species could become extinct in the very near future. To reduce the risk of extinction, a high priority should be placed upon developing and maintaining refuge populations of delta smelt for conservation purposes. USFWS supports the establishment of captive populations of delta smelt, held specifically for conservation purposes, and is working to develop the knowledge and expertise needed to culture and maintain delta smelt for conservation purposes. UC Davis has developed much of this expertise in their efforts to culture delta smelt for experimental purposes. A commitment to developing and maintaining populations for conservation purposes is necessary if these populations are to be used to reduce the risk of extinction.

Pros and Cons:

Pros: Maintaining a segment of the population in a controlled setting and isolating them from environmental conditions contributing to the decline of the species constitutes a hedge against extinction. Maintaining such refuge populations could allow reintroduction of delta smelt to their native environment, should such an action become necessary.

UC Davis has successfully collected, cultured, and reared delta smelt for experimental purposes at the UC Davis campus and at the FCCL. The UC Davis effort could be expanded to develop a refuge population and maintain delta smelt for conservation purposes.

USFWS at Livingston Stone Hatchery has maintained refuge populations of salmon and the facilities could be modified to accommodate a delta smelt population

Cons: Though the culture of delta smelt has improved in reliability each year, it is still a highly technical and intensive process that is hard to replicate without well trained personnel. As with any aquaculture operation, loss of fish through disease, handling, or equipment failure is not unusual. It would be difficult, though not impossible, to expand the refuge population to other sites. Livingston Stone Hatchery (the USFWS hatchery that maintained a winter run Chinook salmon population) is one location where an alternate population could be maintained.

Time to Implementation: 1-2 years

Costs: The estimated one-time-cost for labor and facility upgrades at FCCL is $115,000 (2007-2008 year). The cost of rearing fish for a breeding program is estimated to be about $110,000 over and above baseline production, once facility upgrades are complete. The baseline production costs are $300,000 to $600,000 depending upon production goals. Total costs may reach $410,000 to $710,000. Costs at USFWS facilities are not known at this time.

Next Steps:

- Seek long-term funding for development of a refuge population.
- Coordinate between USFWS and FCCL/UC Davis on delta smelt efforts.

Assess and Reduce Power Plant Entrainment

Develop better data on current fish losses from Contra Costa and Pittsburg power plants to evaluate potential impacts and develop possible solutions. Implement measures that will reduce direct and indirect impacts to delta smelt and other pelagic species.

Two power-generation plants owned by Mirant Delta, LLC (Contra Costa and Pittsburg generating plants) operate in the range of delta smelt and other pelagic species. The Contra Costa Power Plant (CCPP) is six miles east of where the Sacramento and San Joaquin rivers meet. It currently has two generating units that operate out of the seven units originally built, and the one planned unit. Units 1-5 were retired in 1995, and construction of Unit 8 is anticipated to resume in September 2006 and begin commercial operation by summer 2008. The Pittsburg Power Plant (PPP) is downstream on the south shore of Suisun Bay in Pittsburg, and has three generating units that operate out of seven units originally built. Units 1-4 were retired in 2003.

Prior to retirement of these units, the power plants provided base load power and often ran continuously. Presently, the number of days the cooling water system is in operation varies depending on the demand of California's electricity transmission grid. These units are operated on a "load following" basis, and used when power requirements dictate. However, CCPP Unit 7 and PPP Units 5 and 6 have been designated as a "Reliability Must-Run" (RMR) priority electrical generation units by the California Independent System Operator (ISO). These units are important to the overall stability of the San Francisco Bay Area electrical grid and must be available to provide 100% generating capacity if such power is required by the ISO at any time. CCPP Units 6 and 7 and PPP Unit 7 are considered "Participating Generators" by the Federal Energy Regulatory Commission. ISO has directed all non-hydroelectric generators to offer all available generation to the ISO real-time market at all times. Thus, these units must offer generation during all hours if it is available and not already scheduled to run under another agreement.

The change in operations has altered the amount of water diverted through the cooling pumps. Prior to retiring the units and under the old generating agreements, the two power plants could pump 3,200 cfs through the units. After retirement, the maximum amount of water pumped during full operation is 1,460 cfs, and it is normally much lower than that since the plants are operated only when needed for higher load demands. Additionally, in early 2004, Mirant invested about $500,000 to replace the VSD controls on all of the cooling pumps at both plants with a newer, more reliable variable frequency drive (VFD) system. This system allows better adjustment to match demand of the units for cooling water and decreasing the amount of water pumped from the river. Between January 1 and July 31, 2006, the maximum flow through the two power plants combined was 1,388 cfs, but only averaged 223 cfs. The plants had no flow through the cooling pumps for 109 days of the first 212 days of 2006.

A monitoring plan has been developed and is ready to be implemented through coordination with regulatory agencies and IEP. The Entrainment and Impingement Monitoring Plan for IEP will develop better data on fish losses from both power plants to evaluate potential impacts, develop possible solutions, and examine potential population-level effects to delta smelt (Mirant, LLC 2006). Mirant submitted an initial Entrainment Monitoring Plan (EMP) in May 2005 to fulfill the expanded USFWS monitoring requirement related to the October 2004 Corps permit for dredging at PPP. During review of the EMP, USFWS requested that Mirant work with the IEP POD Work Team to review the plan and address POD concerns. The resulting Entrainment and Impingement Monitoring Plan expands on Mirant's May 2005 plan, and incorporates the results of Mirant's recent discussions with the IEP. This study will provide data to inform the ongoing incidental take authorization process for Mirant's Delta Plant activities and will help to improve the POD Work Team's understanding of plant impacts on aquatic species.

Based on results of the Entrainment and Impingement Monitoring Plan, measures can be developed and implemented to reduce direct and indirect impacts to delta smelt and other pelagic species at the power plants, such as:

- Integrate delta smelt and other pelagic species into the existing Resource Management Program, which was designed to reduce striped bass entrainment loss. Power generation units are operated preferentially, based on either real-time or historic fish monitoring data from May to mid-July, the period of peak striped bass entrainment.
- Use better fish exclusion devices, such as positive fish barriers, at both plants to reduce entrainment.

In addition to working with USFWS, NMFS, CDFG, and the IEP to conduct these studies, Mirant joined the Bay-Delta Conservation Plan (BDCP) steering committee in 2006. The BDCP is intended to create a cooperative, voluntary program for Bay-Delta system water users to obtain incidental take coverage under a joint ESA Habitat Conservation Plan and Natural Community Conservation Plan.

Rationale:

Direct impacts to delta smelt, and other fish and aquatic life, result from their entrainment in the cooling water during diversion operations. Although all intakes at both power plants are screened for debris removal, fish less than 38 mm (about 1.5 inches) long may be entrained and larger fish may be impinged (pulled up against the screens).

Indirect impacts result from an increase in receiving water temperature when water that warmed as it passed through the generating plants cooling system is discharged back into the estuary. Thermal effects may result in death, behavioral attraction, avoidance, blockage of passage, or increased predation. The overall effect of thermal discharges on delta smelt is not known, but limited data appear to indicate that there is no behavioral attraction.

Pros and Cons:

Pros: Monitoring will develop better data on current fish losses from the power plants to evaluate potential impacts and develop possible solutions. More investigation is needed on the feasibility of additional measures to reduce power plant entrainment and other potential impacts. Any measures that need to be taken to reduce the level of entrainment at the cooling pumps will lower entrainment mortalities of several fish species, including delta smelt.

Cons: Entrainment and impingement studies could result in some level of incidental take for delta smelt.

Although this action has the potential to benefit many species, including delta smelt, it would not affect POD species this year.

Time to Implementation: The monitoring plan was completed in July 2006 and is being implemented. Reports are expected to be completed by January 2008. Measures to reduce take will be implemented according to monitoring results.

Costs: Mirant costs for monitoring thermal effects, impingement, and entrainment are expected to be $800,000 to $1,500,000 per year for the two power plants for a two-year study, depending on the sample frequency. The sample frequency is dependent upon how often the plants run and how many 24-hour sampling regimes have to be performed.

IEP project coordination to develop data, evaluate impacts, and develop possible solutions will cost about $70,000 per year for 2 years, assuming the effort will require an Environmental Scientist at 50% time. Costs of measures to reduce impacts are unknown.

Next Steps:

- Update the White Paper on aquatic impacts of the Pittsburg and Contra Costa power plants being prepared by DWR.
- Implement the Entrainment and Impingement Monitoring Plan for IEP.
- Develop possible solutions and implement measures to reduce direct and indirect impacts to delta smelt and other pelagic species based on monitoring results.

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Appendix I

Completed Actions

The following are some of the actions specified in the Delta Smelt Action Plan that have been completed:

Expedite CALFED, ERP, POD-related grants (2005 PSP)
DFG prioritized and expedited the contracting for the ERP monitoring proposals recommended for funding that were specific to delta smelt issues, habitat, food resources, or stressors.

Prioritize and expedite CALFED Science POD-related grants (2005 PSP)
Prioritized and expedited contracting of research proposals recommended for funding that were specific to delta smelt and other pelagic species issues, habitat, food resources, or stressors.

Review unfunded CALFED Science 2005 proposals
The POD work team reviewed the unfunded Science Program proposals for any that could be improved and funded as directed actions.

Fund completion of the Suisun Marsh Habitat Management, Preservation and Restoration Plan
Fully funded the Suisun Marsh Plan development and environmental documentation to expedite implementation actions.

Complete IEP ops analysis
Expedited the IEP analysis of recent changes in Delta water operations, independently reviewed results, and quickly published results and recommended changes in Delta operations.

Improve decision-making process for export curtailments
Improved the EWA decision-making process to make more efficient use of the EWA with quicker responsiveness to delta smelt salvage changes.

Establish the POD Account
Established funding mechanism related to the Four Pumps Agreement between DWR and DFG to quickly address near-term pelagic fish issues related to the POD (including delta smelt), such as special studies related to factors possibly affecting pelagic fish populations, and the enhancement and restoration of these species.

Appendix II

Other Considered Actions

There are a number of POD related actions that were considered as Year 2006-2007 Actions for this report, but did not meet the criteria for inclusion. These criteria were that the actions could be implemented within this year, were politically, technically, and scientifically feasible, and there was enough scientific support to indicate that the reported benefit would be achieved. Other considerations included whether there may be redirected impacts from the action, that the action was actually a study or assessment, and whether there was adequate funding.

Many of these actions will continue to be studied and evaluated for future implementation. The list is organized into Other Considered Actions and Studies, Assessments, and Planning.

Water Project Operations

Implement actions under the POD Account - *Fund projects to quickly address near-term pelagic fish issues related to the POD (including delta smelt), such as special studies related to factors possibly affecting pelagic fish populations and the enhancement and restoration of these species. Funds could be accounted for under the Four Pumps Agreement on terms to be negotiated between DWR and DFG.*

Increase periods of open Delta Cross Channel in fall and winter - *Alter central Delta flows by opening the Delta Cross Channel (DCC) in fall and winter to increase Q-west (a calculated value used as an index of net flow in the lower San Joaquin River at Jersey Point, an area generally dominated by tidal flow).*

Install operable gates under SDIP - *Install operable gates under SDIP to allow for more flexible operation than the current use of temporary barriers. Requires completion of environmental review and Section 7 consultation. Environmental review and permitting are underway.*

Modify seasonal exports to protect pelagic fish - *Based on IEP analysis, reduce or change exports during summer and fall, or at other times, to protect pelagic fish species.*

Increase fall flows (2006) - *There is a relationship between delta smelt habitat and summer production in that higher total Delta outflow in the fall may increase the amount of habitat for delta smelt. Fall 2006 flows are forecasted to be low compared to other years (likely 7,000 cfs outflow). Increasing flows would help move X2 (the location of 2 parts per thousand bottom salinity) to Chipps Island and reduce salinity at Jersey Point. The DSWG has not recommended this action for fall 2006 due to the uncertainty of the benefit of this proposed action.*

Increased winter flows - *Higher total Delta outflow during late winter may increase the amount of habitat for delta smelt by maximizing the physical area wherein conditions are presumed to be optimal for growth and survival.*

Increased spring flows - *Higher total Delta outflow during spring may increase the amount of habitat for delta smelt, building and supporting the food web by transporting nutrients and phytoplankton biomass from the tributaries to the Delta.*

Increased summer flow - *Higher total Delta outflow during summer may increase the amount of habitat (lower salinity, somewhat higher turbidity) for delta smelt by both maximizing physical area and supporting the food web.*

Increased San Joaquin River flows - *Increase San Joaquin River flow to Suisun Bay to deliver more phytoplankton and zooplankton to support adults and egg production in fall, adults in winter, and young smelt in spring and summer. This may also reduce entrainment losses in winter and spring due to a resultant shift to less negative (upstream) or more positive (downstream) Old and Middle River flow. The recent San Joaquin Settlement Agreement may enable increased flows and positively affect flows for habitat though this mechanism. Timing and costs will need to be evaluated before implementation.*

Food Web

Enhance tidal marsh development in north Delta (Liberty Island, Yolo Bypass, Cosumnes) - *Enhance freshwater and brackish tidal marsh development in the north Delta on flooded islands that are undergoing natural conversion to freshwater tidal marsh.*

Enhance tidal marsh development in West Delta, Suisun Marsh and Napa River - *Enhance freshwater and brackish tidal marsh development in the west Delta, Suisun Marsh, and Napa River.*

Rice field discharge pilot project -*Increase in production of phytoplankton, zooplankton, and small invertebrates by pumping water off Delta rice fields into adjacent channels.*

Habitat Improvement

Support tidal restoration of Hill Slough West, Suisun Marsh - *Support tidal restoration of the Hill Slough West project, which ERP has funded to develop a restoration plan and complete the environmental documentation.*

Acquire lands and restore to tidal action in Suisun Marsh - *Complete acquisition of lands suitable to restore to tidal action using the ERP grant funding provided to the DFG. Complete tidal restoration within three years.*

Support future installation of Suisun Marsh fish screens - *Support future installation of fish screens on high priority diversions in the Suisun Marsh.*

Contaminants Management

Continue support of IEP Contaminants Project Work Team - *Direct IEP to continue support for the Contaminants Project Work Team, established under the POD work plan.*

Control Aquatic Herbicide Use - *If aquatic herbicides are linked to the POD, develop and implement alternative methods to control non-native macrophytes, such as mechanical removal, alternative compounds, or timing of applications to avoid sensitive periods.*

Invasive Species

Develop rapid response program for new invasive species - *Develop a rapid response program to eradicate or control the potential spread of newly discovered invasive species. Once a new population is identified and delineated, a rapid response increases the likelihood of successful eradication or control.*

Develop public outreach and education - *Fund development and implementation of public outreach and education to increase stakeholder awareness of invasive species and their role in preventing new species from entering the state.*

Implement programs to remove northern Pike from Lake Davis - *If this introduced, highly predatory fish gets into the Sacramento River System it could have devastating effects, not only on delta smelt, but on a host of fish species in the Delta and upstream. DFG released the Draft EIR/EIS for the Lake Davis Pike Eradication Project for public comment. Eradication treatment is expected in 2007.*

Modify Delta fishing regulations to control predators - *Modify Delta bass fishing regulations to harvest the top predators and reduce their population size; catch and non-release of introduced predatory Delta fishes; remove length or season restrictions; reduce or eliminate the cost for a fishing license in the Delta on these fish.*

Remove non-native macrophytes in Delta - *Mechanical or chemical removal of aquatic macrophytes from Delta and Delta tributaries.*

Other Actions

Implement Delta fish screen installations - *Prioritize and install fish screens in areas that have a high risk of pelagic organism entrainment.*

Limit conversion of Delta habitat - *Limit conversion of Delta habitat to housing and urban development.*

Delta smelt hatchery -*Culture large numbers of delta smelt to supplement the Delta population.*

Sturgeon Hatchery in Suisun Bay - *Develop a hatchery in Suisun Bay for white sturgeon, or utilize commercial hatchery-produced sturgeon for release in Suisun Bay, to increase sturgeon populations to increase predation on introduced clams.*

Studies, Assessments, and Planning

IEP POD Study Plan - *Implement the 2006 Study Plan to investigate the recent dramatic declines in pelagic organisms in the Delta. The execution of the Plan is ongoing.*

Prioritize CALFED DRERIP actions - *The ERP implementing agencies will prioritize the strategic DRERIP effort focused on Delta pelagic species and other “R” Delta fish. DRERIP staff will coordinate with IEP staff in this effort.*

Develop alternatives to provide and transfer EWA water - *Depending on results of the IEP analysis, explore alternative ways to provide and transfer EWA water supplies. For example:*

1. *Decrease purchases upstream of Delta and increase water stored south of Delta.*
2. *Develop EWA storage in the export service area, that is, south of Delta, to increase the ability to transfer and store EWA water in wet years.*

Assess Delta conveyance - *Support a public CALFED assessment of current approaches to management of the Delta, as called for in the CALFED ROD.*

Monitor and evaluate benefits of Suisun Marsh habitat restoration - *Conduct monitoring and evaluation of habitat restoration actions and evaluate benefits to delta smelt and other pelagic species.*

Identify and Prioritize Toxicity Studies - *Direct CALFED and other proposal solicitors to reevaluate and identify proposals that focus on toxicity, source monitoring, tracking, transport, fate, and reduction of compounds that have known toxicity to delta smelt and the food chain.*

Develop Aquatic Nuisance Species Plan - *Develop statewide plan to ensure that comprehensive invasive species programs are in place, recommend more actions, and coordinate with other agencies that have invasive species responsibilities.*

Implement early detection of invasive species - *Fund and implement early detection of incipient populations to control or eradicate these populations. Early detection requires aggressive monitoring, data collection, data analysis, and mapping in order to determine if control or eradication is an option.*

Fund invasive species research - *Fund research to increase the knowledge base on invasive species and the economic consequences of invasions to help develop more effective prevention, control, and overall management programs (such as an evaluation of the utility of variable Delta salinity as a control mechanism).*

EXHIBIT R

TO SWANSON DECLARATION

Delta Smelt Working Group Meeting Notes

June 11, 2007

Participating: Gonzalo Castillo (USFWS), Mike Chotkowski (USBR), Kevin Fleming (CDFG), Erin Gleason (CDFG), Lenny Grimaldo (CDWR), Bruce Herbold (USEPA), Tracy Hinojosa (CDWR), Ann Lubas-Williams (USBR), Ryan Olah (USFWS), Ted Sommer (CDWR), Jim White (CDFG) and Victoria Poage (USFWS, convener and scribe)

For Discussion:
1. Assessment of entrainment risk following the current action

Recommendation for WOMT: Results of salvage monitoring, recent surveys, and particle tracking modeling (PTM) completed June 11, 2007 indicate that most juvenile delta smelt are outside the entrainment foot print, should the Projects wish to increase export pumping to 2500 cfs combined. If any delta smelt are taken at the export facilities, Project operations should immediately be modified to achieve a net flow in Old and Middle Rivers as close to zero as possible, and the Working Group should be convened.

Handout: Particle tracking model output

Notes:
At the June 8 meeting, the Delta Smelt Working Group requested that DWR provide additional PTM runs to assess the risk of delta smelt entrainment should the Projects resume, using the same injection points as in the May 22 model runs, using the following hydrology:

1. current conditions (e.g., with the present action in effect)
2. expected conditions if Projects increase export rates to their proposed operation (e.g., 2500 cfs combined pumping)
3. conditions which would apply if the Projects went to maximum operations allowed under the 1995 Water Quality Control Plan

The Working Group decided to use a 30% difference in particle fates as a threshold criterion of significance, as it has in evaluating previous PTM runs. Results are summarized for selected injection points in the table below.

Date	Station	CVP	SWP	Past Chipps	In Delta
16 June	704	0, 0, 0*	0, 0, 0*	9.8, 12.9, 25.4	90.2, 87.1, 74.4
	815	0, 0, 0	0, 0, 0	0, 0, 0	100, 99.9, 99.6
	902	0, 0, 17.9	0, 0, 5.9	0, 0, 0	97.5, 96.9, 67.7
	910	0, 0, 0	0, 0, 0	0, 0, 0	98.8, 98.9, 98.5
20 June	704	0, 0, 0	0, 0, 0	27.6, 30.9, 38.5	72.4, 68.8, 60.9
	815	0, 0, 2.8	0, 0, 0.6	0.1, 0, 0	99.9, 99.8, 95.6
	902	0, 7.4, 28.1	0, 2.2, 18.7	0, 0, 0	89.5, 74.1, 38.3
	910	0, 0, 6.7	0, 0, 2.3	0, 0, 0	97.8, 97.3, 88.2

Date	Station	CVP	SWP	Past Chipps	In Delta
24 June	704	0, 0, 0.1	0, 0, 0	28.9, 33.8, 41.5	71.0, 65.8, 57.9
	815	0, 0.1, 8	0, 0.1, 3.7	0, 0.1, 0	00.5. 99.0, 86.4
	902	2.3, 15.4, 30.2	0, 7.6, 27.0	0, 0, 0	79.1, 57.3, 26.3
	910	0, 1.3, 17.6	0, 0.3, 10.6	0, 0, 0	96.3, 94.7, 67.5
28 June	704	0, 0, 0.2	0, 0.1, 0.1	42.3, 48.6, 53.7	57.4, 50.9, 45.4
	815	0.1, 1.6, 11.5	0, 0.6, 8.2	1.3, 1.6, 1.3	96.8, 94.6, 75.8
	902	10.0, 18.2, 31.1	0.3, 12.6, 31.9	0.6, 0.4, 0.1	65.0. 46.6, 20.0
	910	0.5, 6.7, 22.0	0, 2.1, 19.6	0, 0, 0	95.1, 86.1, 53.0
1 July	704	0, 0, 0.2	0, 0.1, 0.2	65.8, 68.4, 73.6	33.9, 31.0, 25.1
	815	1.2, 2.7, 13.9	0, 1.4, 10.3	6.3, 7.3, 5.7	90.1, 86.2, 66.0
	902	13.2, 19.1, 31.9	0.3, 14.9, 33.1	2.2, 2.6, 1.5	58.7, 39.5, 16.0
	910	2.8, 9.1, 25.8	0.2, 4.3, 25.1	0, 0, 0	91.4, 80.2, 42.0
5 July	704	0.1, 0.2, 0.2	0, 0.2, 0.2	73.2, 75.3, 78.3	26.3, 23.7, 20.4
	815	2.1, 3.8, 16.0	0, 2.5, 13.4	13.3, 12.8, 9.1	81.3, 76.4, 56.4
	902	15.6, 20.4, 32.4	0.8, 18.0, 34.9	6.2, 4.5, 2.1	50.4, 31.3. 12.7
	910	6.5, 12.3, 31.3	0.3, 8.3, 31.8	0.1, 0, 0	84.2, 69.5, 28.0

*Value sets are reported as 1250 cfs, 2500 cfs, 5000 cfs combined pumping

The selected stations exhibited the greatest differences in particle fates among the PTM runs conducted.

DFG biologists are still in the process of sorting net samples from Survey 7 of the 20-mm trawl survey, conducted last week. To date, the survey collected one delta smelt at each of stations 705 (Decker Island), 716 (Cache Slough) and 809 (SJR west of Franks Tract). The CVP has salvaged no delta smelt since May 30; the SWP reported 27 delta smelt salvaged on June 10 (Sunday) and 9 on June 11 (today), but since the radial gates at Clifton Court Forebay were not operated, those delta smelt were already present in the Forebay. The SWP plans to operate the radial gates June 12 and 13; if salvage of delta smelt occurs at either the State or the Federal facility, the Working Group recommends that Project operations immediately be modified to achieve a net flow in Old and Middle Rivers as close to zero as possible, and the Working Group convene.

<u>Next Scheduled Meeting</u>: Monday, June 18 at 3:00 pm via conference call

<u>Attachments</u>:
1. PTM output data tables
2. Addendum, dated 13 June 2007

Submitted,

VLP

Attachment 1.

Scenario C, 2500 cfs Combined Exports, Ag Barriers Gates Tied Open, DXC Open on Weekends, Sac River flow 11400 cfs

12-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLD	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	0	0	0	0	0	0	0	0	100	0
	sta906	0	0	0	0	0	0	0	0	100	0
	sta815	0	0	0	0	0	0	0	0	100	0
	sta902	0	0	0	0	0	0	0	0	100	0
	sta812	0.1	0	0	0	0	0	0	0	99.9	0
	sta711	0.1	0	0	0	0	0	0	0	99.9	0
	sta704	0	0	0	0	0	0	0	0	100	0
	sta809	0	0	0	0	0	0	0	0	100	0
	sta513	0	0	0	0	0	0	0	4.4	95.6	0
16-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLD	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	1.2	0	0	0	0	0	0	0	98.8	0
	sta906	0.5	0	0	0	0	0	0	0	99.5	0
	sta815	0.1	0	0	0	0	0	0	0	99.9	0
	sta902	1.7	0.5	0.9	0	0	0	0	0	96.9	1.4
	sta812	0.3	0	0	0	0	0	0	0	99.7	0
	sta711	0.4	0	0	0	0	0	0	0	99.6	0
	sta704	0	0	0	0	0	0	0.3	12.9	87.1	0
	sta809	0.3	0	0	0	0	0	0	0.5	99.2	0
	sta513	0	0	0	0	0	0	5.8	63.8	36.2	0
20-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLD	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	2.7	0	0	0	0	0	0	0	97.3	0
	sta906	1	0	0	0	0	0	0	0	99	0
	sta815	0.2	0	0	0	0	0	0	0	99.8	0
	sta902	7.2	3.1	6	0	7.4	2.2	0	0	74.1	9.1
	sta812	0.3	0	0	0	0	0	0	0.3	99.4	0
	sta711	0.5	0	0	0	0	0	0	1.2	98.3	0
	sta704	0.3	0	0	0	0	0	1.3	30.9	68.8	0
	sta809	0.4	0	0	0	0	0	0	3.9	95.7	0
	sta513	0.1	0	0	0	0	0	12.1	67.4	32.5	0
24-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLD	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	3.7	0	0	0	1.3	0.3	0	0	94.7	0
	sta906	1.3	0	0	0	0.6	0.1	0	0	98	0
	sta815	0.7	0	0	0	0.1	0.1	0	0.1	99	0
	sta902	10	3.3	6.4	0	15.4	7.6	0	0	57.3	9.7
	sta812	0.8	0	0	0	0	0	0	0.6	98.6	0
	sta711	0.9	0	0	0	0	0	0.1	4.9	94.2	0
	sta704	0.4	0	0	0	0	0	4.1	33.8	65.8	0
	sta809	0.5	0	0.1	0	0	0	0.4	7.6	91.8	0.1
	sta513	0.2	0	0	0	0	0	18.6	63.7	36.1	0
28-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLD	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	4.9	0.1	0.1	0	6.7	2.1	0	0	86.1	0.2
	sta906	1.8	0.3	0.4	0	4.3	1.1	0	0.2	91.9	0.7
	sta815	1.1	0.2	0.3	0	1.6	0.6	0.3	1.6	94.6	0.5
	sta902	11.9	3.6	6.7	0	18.2	12.6	0	0.4	46.6	10.3
	sta812	1	0	0	0	0.6	0.1	0.2	3	95.3	0
	sta711	1.1	0	0	0	0.1	0.1	3.2	15.9	82.8	0
	sta704	0.4	0	0	0	0	0.1	16.6	48.6	50.9	0
	sta809	0.6	0	0.2	0	0.1	0.1	3.8	18.1	80.9	0.2
	sta513	0.2	0	0	0	0	0	36.5	74.9	24.9	0
1-Jul-07		DIVERSION_AG	DIV_CCC_AT_OLD	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	6	0.2	0.2	0	9.1	4.3	0	0	80.2	0.4
	sta906	2.5	0.4	0.6	0	6.4	2.3	0.1	0.8	87	1
	sta815	1.8	0.2	0.4	0	2.7	1.4	0.8	7.3	86.2	0.6
	sta902	13.5	3.7	6.7	0	19.1	14.9	0.4	2.6	39.5	10.4
	sta812	1.5	0	0.2	0	0.9	0.3	0.7	8.6	88.5	0.2
	sta711	1.1	0	0	0	0.1	0.1	7.7	37.2	61.5	0
	sta704	0.5	0	0	0	0	0.1	27.8	68.4	31	0
	sta809	0.9	0	0.3	0	0.2	0.1	9	38	60.5	0.3
	sta513	0.2	0	0	0	0	0	49.1	88.3	11.5	0
5-Jul-07		DIVERSION_AG	DIV_CCC_AT_OLD	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	8.9	0.5	0.5	0	12.3	8.3	0	0	69.5	1
	sta906	5.1	0.6	1.1	0	8.9	4.9	0.1	2	77.4	1.7
	sta815	3.5	0.3	0.7	0	3.8	2.5	1.4	12.8	76.4	1
	sta902	15	3.9	6.9	0	20.4	18	0.5	4.5	31.3	10.8
	sta812	2	0.2	0.3	0	1.2	0.6	1.5	13.4	82.3	0.5
	sta711	1.2	0	0.1	0	0.6	0.3	12.5	49.4	48.4	0.1
	sta704	0.6	0	0	0	0.2	0.2	35.5	75.3	23.7	0
	sta809	1.1	0.1	0.3	0	0.6	0.4	15.2	51.2	46.3	0.4
	sta513	0.1	0	0	0	0	0	69.1	96.4	3.5	0

Scenario D, 1250 cfs Combined Exports, Ag Barriers Gates Tied Open, DXC Open on Weekends, Sac River flow 11400 cfs

12-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLI	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	0	0	0	0	0	0	0	0	100	0
	sta906	0	0	0	0	0	0	0	0	100	0
	sta815	0	0	0	0	0	0	0	0	100	0
	sta902	0	0	0	0	0	0	0	0	100	0
	sta812	0.1	0	0	0	0	0	0	0	99.9	0
	sta711	0.1	0	0	0	0	0	0	0	99.9	0
	sta704	0	0	0	0	0	0	0	0	100	0
	sta809	0	0	0	0	0	0	0	0	100	0
	sta513	0	0	0	0	0	0	0	4.4	95.6	0
16-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLI	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	1.2	0	0	0	0	0	0	0	98.8	0
	sta906	0.5	0	0	0	0	0	0	0	99.5	0
	sta815	0	0	0	0	0	0	0	0	100	0
	sta902	1.6	0	0.9	0	0	0	0	0	97.5	0.9
	sta812	0.1	0	0	0	0	0	0	0	99.9	0
	sta711	0.4	0	0	0	0	0	0	0	99.6	0
	sta704	0	0	0	0	0	0	0.2	9.8	90.2	0
	sta809	0.3	0	0	0	0	0	0	0.5	99.2	0
	sta513	0	0	0	0	0	0	5.2	63	37	0
20-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLI	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	2.2	0	0	0	0	0	0	0	97.8	0
	sta906	0.9	0	0	0	0	0	0	0	99.1	0
	sta815	0	0	0	0	0	0	0	0.1	99.9	0
	sta902	4.5	0.3	5.7	0	0	0	0	0	89.5	6
	sta812	0.4	0	0	0	0	0	0	0	99.6	0
	sta711	0.6	0	0	0	0	0	0	0.5	98.9	0
	sta704	0	0	0	0	0	0	1.1	27.6	72.4	0
	sta809	0.7	0	0	0	0	0	0	5.9	93.4	0
	sta513	0.1	0	0	0	0	0	12.4	69.1	30.8	0
24-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLI	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	3.7	0	0	0	0	0	0	0	96.3	0
	sta906	1.3	0	0	0	0	0	0	0	98.7	0
	sta815	0.5	0	0	0	0	0	0	0	99.5	0
	sta902	8.7	1.1	8.8	0	2.3	0	0	0	79.1	9.9
	sta812	0.9	0	0.1	0	0	0	0	0.6	98.4	0.1
	sta711	1	0	0	0	0	0	0.2	3.3	95.7	0
	sta704	0.1	0	0	0	0	0	3.2	28.9	71	0
	sta809	0.9	0	0	0	0	0	0.3	8.6	90.5	0
	sta513	0.1	0	0	0	0	0	19.1	67	32.9	0
28-Jun-07		DIVERSION_AG	DIV_CCC_AT_OLI	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	4.4	0	0	0	0.5	0	0	0	95.1	0
	sta906	2	0	0.1	0	0.1	0	0	0.1	97.7	0.1
	sta815	1.2	0	0.6	0	0.1	0	0.1	1.3	96.8	0.6
	sta902	11.8	1.8	10.5	0	10	0.3	0.1	0.6	65	12.3
	sta812	1.3	0	0.1	0	0.1	0	0.2	2.3	96.2	0.1
	sta711	1.3	0	0	0	0	0	1.8	14	84.7	0
	sta704	0.3	0	0	0	0	0	14.7	42.3	57.4	0
	sta809	1	0	0.1	0	0	0	4.8	21.9	77	0.1
	sta513	0.1	0	0	0	0	0	36.2	74.3	25.6	0
1-Jul-07		DIVERSION_AG	DIV_CCC_AT_OLI	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	5.3	0.2	0.1	0	2.8	0.2	0	0	91.4	0.3
	sta906	2.6	0.1	0.2	0	2.3	0	0	0.8	94	0.3
	sta815	1.6	0	0.8	0	1.2	0	0.7	6.3	90.1	0.8
	sta902	12.6	2	11	0	13.2	0.3	0.4	2.2	58.7	13
	sta812	1.8	0	0.1	0	0.2	0	1	8.7	89.2	0.1
	sta711	1.3	0	0	0	0	0	7.6	36	62.7	0
	sta704	0.3	0	0	0	0	0	25.6	65.8	33.9	0
	sta809	1.1	0	0.1	0	0.1	0	11.2	44.6	54.1	0.1
	sta513	0.1	0	0	0	0	0	50	86.8	13.1	0
5-Jul-07		DIVERSION_AG	DIV_CCC_AT_OLI	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	8.2	0.3	0.4	0	6.5	0.3	0	0.1	84.2	0.7
	sta906	4.2	0.4	1	0	4.8	0.2	0.1	2.4	87	1.4
	sta815	2.1	0.1	1.1	0	2.1	0	1.8	13.3	81.3	1.2
	sta902	13.8	2.1	11.1	0	15.6	0.8	0.7	6.2	50.4	13.2
	sta812	2.2	0	0.3	0	0.6	0	3	14.9	82	0.3
	sta711	1.4	0	0	0	0.1	0	12.4	50.7	47.8	0
	sta704	0.4	0	0	0	0.1	0	33.4	73.2	26.3	0
	sta809	1.1	0	0.1	0	0.3	0	17.6	55.1	43.4	0.1
	sta513	0.1	0	0	0	0	0	58.1	90.7	9.2	0

Scenario E, 5000 cfs Combined Exports, Ag Barriers Gates Tidally Operated, DXC Open on Weekends

12-Jun-07		DIVERSION_AG	DIV_CCC_AT_OL	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	0	0	0	0	0	0	0	0	100	0
	sta906	0	0	0	0	0	0	0	0	100	0
	sta815	0	0	0	0	0	0	0	0	100	0
	sta902	0.1	0	0	0	0	0	0	0	99.9	0
	sta812	0	0	0	0	0	0	0	0	100	0
	sta711	0.1	0	0	0	0	0	0	0	99.9	0
	sta704	0	0	0	0	0	0	0	0	100	0
	sta809	0	0	0	0	0	0	0	0	100	0
	sta513	0	0	0	0	0	0	0	4.7	95.3	0
16-Jun-07		DIVERSION_AG	DIV_CCC_AT_OL	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	1.5	0	0	0	0	0	0	0	98.5	0
	sta906	0.8	0	0	0	0	0	0	0	99.2	0
	sta815	0.4	0	0	0	0	0	0	0	99.6	0
	sta902	3.3	3	2.2	0	17.9	5.9	0	0	67.7	5.2
	sta812	0.3	0	0	0	0	0	0	0	99.7	0
	sta711	0.4	0	0	0	0	0	0	0.2	99.4	0
	sta704	0.2	0	0	0	0	0	0.2	25.4	74.4	0
	sta809	0.5	0	0	0	0	0	0	0.9	98.6	0
	sta513	0	0	0	0	0	0	6.5	66.5	33.5	0
20-Jun-07		DIVERSION_AG	DIV_CCC_AT_OL	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	2.5	0.3	0	0	6.7	2.3	0	0	88.2	0.3
	sta906	1.5	0	0.1	0	3.1	0.8	0	0	94.5	0.1
	sta815	0.8	0	0.2	0	2.8	0.6	0	0	95.6	0.2
	sta902	5.9	3.3	5.7	0	28.1	18.7	0	0	38.3	9
	sta812	0.7	0	0	0	0.2	0	0	1.6	97.5	0
	sta711	0.6	0	0	0	0	0	0.1	12.7	86.7	0
	sta704	0.2	0	0.1	0	0	0	1.8	38.8	60.9	0.1
	sta809	0.8	0	0	0	0.1	0.2	0.1	4.7	94.2	0
	sta513	0.1	0	0	0	0	0	14.2	73.1	26.8	0
24-Jun-07		DIVERSION_AG	DIV_CCC_AT_OL	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	3.9	0.4	0	0	17.6	10.6	0	0	67.5	0.4
	sta906	2.4	0.1	0.4	0	12.5	7	0	0	77.6	0.5
	sta815	1.2	0.1	0.6	0	8	3.7	0	0	86.4	0.7
	sta902	7.5	3.3	5.7	0	30.2	27	0	0	26.3	9
	sta812	1.2	0.1	0	0	2.5	0.6	0.2	1.3	94.3	0.1
	sta711	0.8	0	0	0	0.1	0.2	1.4	17.9	81	0
	sta704	0.4	0	0.1	0	0.1	0	5.7	41.5	57.9	0.1
	sta809	1	0	0.1	0	0.4	0.3	0.1	7.6	90.6	0.1
	sta513	0.2	0	0	0	0	0	21.7	69.5	30.3	0
28-Jun-07		DIVERSION_AG	DIV_CCC_AT_OL	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	4.9	0.5	0	0	22	19.6	0	0	53	0.5
	sta906	3.4	0.2	0.5	0	22.5	15.2	0	0	58.2	0.7
	sta815	2.1	0.1	1	0	11.5	8.2	0.3	1.3	75.8	1.1
	sta902	7.8	3.4	5.7	0	31.1	31.9	0	0.1	20	9.1
	sta812	2	0.2	0.3	0	4.1	2.1	1.2	3.3	88	0.5
	sta711	0.9	0.1	0	0	0.9	0.3	9.8	29.5	68.3	0.1
	sta704	0.4	0	0.2	0	0.2	0.1	21.3	53.7	45.4	0.2
	sta809	1.3	0	0.1	0	0.6	1.1	4.2	18.6	78.3	0.1
	sta513	0.2	0	0	0	0	0	40	76.8	23	0
1-Jul-07		DIVERSION_AG	DIV_CCC_AT_OL	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	6.5	0.6	0	0	25.8	25.1	0	0	42	0.6
	sta906	4.4	0.3	0.5	0	26.5	21.2	0	0.3	46.8	0.8
	sta815	2.7	0.2	1.2	0	13.9	10.3	1	5.7	66	1.4
	sta902	8.4	3.4	5.7	0	31.9	33.1	0.1	1.5	16	9.1
	sta812	2.6	0.2	0.4	0	5.6	4	2.3	8.1	79.1	0.6
	sta711	1	0.1	0	0	1	0.6	17.3	51.2	46.1	0.1
	sta704	0.7	0	0.2	0	0.2	0.2	32.8	73.6	25.1	0.2
	sta809	1.3	0	0.1	0	1	1.3	10.1	37.6	58.7	0.1
	sta513	0.2	0	0	0	0	0	52	88.6	11.2	0
5-Jul-07		DIVERSION_AG	DIV_CCC_AT_OL	DIV_CONTRA_CC	DIV_NORTH_BAY	EXPORT_CVP	EXPORT_SWP	PAST_MTZ	PAST_CHIPPS	IN_DELTA	DIV_OTHER
	sta910	8.2	0.6	0.1	0	31.3	31.8	0	0	28	0.7
	sta906	5.5	0.4	0.6	0	32	30	0	0.6	30.9	1
	sta815	3.3	0.3	1.5	0	16	13.4	1.6	9.1	56.4	1.8
	sta902	8.8	3.4	5.7	0	32.4	34.9	0.3	2.1	12.7	9.1
	sta812	3.4	0.3	0.4	0	7.3	6.5	3.4	12.4	69.7	0.7
	sta711	1	0.1	0	0	1.2	0.9	24.8	58.4	38.4	0.1
	sta704	0.7	0	0.2	0	0.2	0.2	39.1	78.3	20.4	0.2
	sta809	1.5	0	0.1	0	1.5	1.8	15.1	47.8	47.3	0.1
	sta513	0.2	0	0	0	0	0	58.7	91.3	8.5	0

Addendum to DSWG Notes from June 11, 2007

Task: On June 12, 2007 the WOMT asked the Delta Smelt Working Group to provide further biological and technical information to support their recommendation that Project operations be modified such that net flows in Old and Middle Rivers are as close to zero (or positive) as possible if delta smelt are salvaged following their proposed increase in operations.

Recent delta smelt salvage at SWP

Date	SWP salvage	Acre Feet	Density
5/24/2007	0	24	0.00
5/25/2007	2	710	0.00
5/26/2007	22	711	0.03
5/27/2007	24	516	0.05
5/28/2007	20	636	0.03
5/29/2007	58	624	0.09
5/30/2007	46	624	0.07
5/31/2007	40	517	0.08
6/10/2007	27	178	0.15
6/11/2007	9	179	0.05
6/12/2007	30*	176	0.17

*15 expanded salvage plus 5 actual count from secondary flush

There has been no salvage of delta smelt at the CVP since May 30.

Considerations for WOMT: With only a few data to consider the Working Group was not able to determine whether the delta smelt salvaged on June 12 had resided in Clifton Court Forebay since May 31 or were drawn into it when the radial gates were opened on June 12. Given this uncertainty, the Working Group currently believes that an entrainment risk still exists under the pumping regime now in place. Following the decision criteria submitted to WOMT on June 11, the Working Group advises that water project operations be modified to maintain non-negative daily net OMR flow.

Sources of Uncertainty:

1. Fish Numbers

Indices of delta smelt abundance generated from survey data have exhibited a sharp decline in recent years. All of the last five Fall Mid-Water Trawl indices have been below the median value and four of the last five Summer Tow-Net indices have been below the median value. The 2007 20-mm Survey, which samples for larval fishes, collected numbers of larval delta smelt which were an order of magnitude below previous survey numbers. While robust population estimates for delta smelt do not exist, the downward trend in these three surveys creates a compelling case that delta smelt numbers are at an all-time and potentially critical low level.

2. Fish Distribution

Delta smelt tend to distribute themselves near or just upstream of the 2 parts per thousand salinity isohaline, referred to as X2 and expressed as kilometers distance from the Golden Gate Bridge. Presently, X2 is at approximately 80 km, just west of Collinsville. Preliminary results from Survey 7 of the 20-mm Survey, conducted during the week of June 4 and presently in the process of sorting samples, indicates that the bulk of larval delta smelt are distributed near or upstream of X2 in the lower Sacramento and San Joaquin River;

however, to date only six larval delta smelt have been collected. With delta smelt at such apparent low numbers, confidence in the ability of the survey to adequately sample for delta smelt is questionable; further, such low numbers severely limit the validity of inferences that may be drawn from the survey data. As an example, surveys have not collected delta smelt at south Delta stations, but larval delta smelt have been salvaged at both the State and Federal facilities, which means that they occur in south Delta channels below levels at which they can be reliably detected by routine survey sampling.

3. Risk of Entrainment

Given the position of X2 and consideration of what is known of their preferred position, it seems unlikely that delta smelt will move further downstream. The results of the particle tracking modeling referred to in the June 11 notes indicates that at the level of Project pumping that was communicated to the Working Group on June 8 (2500 cfs combined), particles injected at stations 704 and 809 exhibited a low risk of entrainment at the export facilities and a very high likelihood of either remaining in the Delta or moving past Chipps Island through the end date of the run on July 5. Stations 704 and 809 approximate the distribution of delta smelt in Survey 7 of the 20-mm survey, indicating a relatively low risk of entrainment under present conditions. However, as hydrologic conditions change, these results will no longer represent the risk of entrainment of juvenile delta smelt near the confluence. Further, uncertainty with regard to distribution increases the risk that the estimated risk of entrainment is understated.

4. Population-Level Effects

As previously stated, robust population estimates for delta smelt do not exist and at present there is no model of the delta smelt life cycle that can adequately assess the effect of entrainment of delta smelt at the export facilities. However, analyses have indicated that the effects of entrainment may at times be significant. As apparent abundance decreases, it becomes more likely that any one mortality event can have a significant impact on the population.