DELTA SMELT
Action Plan

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The Resources Agency

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Executive Summary

The San Francisco Bay and Sacramento-San Joaquin Delta (Delta) comprise the largest estuary on the West Coast. The Delta encompasses roughly 1,600 square miles, provides drinking water for more than 70 percent of Californians and facilitates irrigation 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.

While several runs of salmon are still listed under the federal and state endangered species acts, 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 delta smelt and several other pelagic (open water) fish and aquatic organisms.

The state has responded with the Delta Smelt Action Plan, a 14-point program of scientific research activities and studies to identify and understand the causes for this decline, and other actions to benefit the species. The plan describes current and future work that will provide more answers and guide efforts to restore and protect the Delta ecosystem.

The Interagency Ecological Program

The Interagency Ecological Program (IEP) for the San Francisco Bay-Delta is an estuary monitoring and research program conducted by six federal and three state agencies. 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). The program partners work to develop a better understanding of the estuary's ecology.

Work through the IEP is intended to compliment work done through the CALFED Bay-Delta Science Program. The CALFED Bay-Delta Program is a collaborative effort of 25 state and federal agencies to resolve longstanding issues in the Delta. A CALFED technical review panel has been put in place to review the 2005 and

proposed 2006 IEP activities related to the decline in pelagic organisms. Experts in fisheries population biology, primary productivity and trophic energy transfer, systems integration, hydrology, introduced species, contaminants, and biostatistics will review existing IEP program documents and data, consider emerging data and the status of pelagic organisms, and provide input on proposed upcoming IEP POD-related research and monitoring activities. Review panel activities are scheduled to begin in October and to culminate in a report to the IEP Management Team on November 14, 2005. Panel recommendations will be used to refine IEP's 2006 POD workplan.

In the past three years, IEP monitoring has identified declines in numerous pelagic fish in the Delta. The abundance indices from 2002 to 2004 include record lows for delta smelt and young striped bass, and near-record lows for longfin smelt and threadfin shad. In contrast, San Francisco Bay monitoring has not shown significant declines in catches of marine and lower estuary species, and salmon populations, as mentioned above, have returned to levels not seen in the past 20 to 40 years. Based on these findings, the problem appears limited to fish species that are dependent on the Delta.

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.

While several of these declining species have shown evidence of a long-term decline, there appears to be a more dramatic change during the past three years. This was unexpected because the hydrological conditions in the San Francisco Estuary during this period were generally favorable to fish species. The decline in multiple species also makes the changes during this period of particular concern.

These changes are occurring in an estuary that has been impacted over many decades by man-made activities including 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. 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 is essential to fully evaluate any impacts on current conditions.

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 support this effort, DWR and Reclamation authorized an additional $1.7 million in water project funds to augment the $13.5 million annual IEP budget to investigate the causes of this unexpected decline.

The Delta Smelt Action Plan, developed by DWR and DFG, describes the IEP's current activities and planned actions. Although the plan is specific to delta smelt, state and federal agencies recognize that a better strategy is a multispecies approach to species protection through habitat conservation. In general, actions that benefit delta smelt will likely benefit other pelagic organisms and possibly the entire estuarine system.

The Action Plan

The following is a summary of 14 actions that are either currently being implemented or are under consideration by the IEP to protect and enhance the delta smelt. This action plan will be updated to incorporate the results of ongoing scientific studies.

CALFED Bay-Delta Program Actions

Ecosystem Restoration Program Actions:

- ***Delta Actions –*** Prioritize the strategic Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) effort focused on Delta pelagic species; evaluate previously planned targets, actions and milestones (in light of current knowledge) and restoration projects implemented to date. ERP actions for the Delta that are related to this plan include the regional Delta ERP planning effort, the delta smelt culture and conservation laboratory, and ERP monitoring.

Status: The final plan for the DRERIP effort is targeted for completion in December 2005.

Costs: Costs will vary depending on actions pursued. Actual costs cannot be determined at this time. There is up to $3 million for the approved ERP monitoring projects.

- ***Suisun Marsh Actions –*** Update the Ecosystem Restoration Program's (ERP) planning foundation and refine a set of Suisun Marsh-specific restoration actions. Under the ERP, the Suisun Marsh Plan is the second of several regional plans intended to refine the existing planning foundation guiding the long-term implementation of the CALFED Ecosystem Restoration Program element. The Suisun Marsh Plan will update the ERP's planning foundation specific to the Suisun Marsh and refine a set of Suisun Marsh-specific restoration actions through preparation of a programmatic EIR/S.

  Status: Recommend priorities and estimate funding for fiscal year 2006-2007.

  Costs: Up to $5 million for the currently approved restoration projects and up to an additional $5 million for future restoration projects over the next three years. Funding of restoration projects could be leveraged with available Suisun Marsh Preservation Agreement funds. Additional funding of up to $1.5 million is needed to complete environmental documentation for the Suisun Marsh Plan.

- ***Increase Food Web Productivity –*** Enhance freshwater and brackish tidal marsh development and seasonal floodplains to increase food web productivity in north Delta, west Delta, Suisun Marsh and Napa River. Over the past several decades, phytoplankton levels in the Delta have decreased by close to 50 percent. Many zooplankton species have also undergone severe declines. 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.

  Status: Napa Salt Ponds will be undergoing restoration this fall; other actions 2006 and later.

Costs: Varied depending on scope and could range from $5 million-$30 million. Successful implementation depends on adequate funding for capital costs as well as ongoing operation and maintenance costs.

- ***Reduce Entrainment at Power Plants –*** Evaluate the role of power plant water intakes as a stressor for smelt and other pelagic organisms and recommend appropriate changes. Two generation plants operate in the range of delta smelt: Contra Costa and Pittsburg.
  Status: Assessment of power plant effects, December 2005 and later.

  Costs: Contingent upon the types of measures implemented. EPA estimates average costs for Gunderbooms at $7 million for capital costs. Average operations and maintenance costs for this size structure are estimated at $600,000 annually.

Environmental Water Account Actions:

- ***Modified Environmental Water Account –*** Evaluate changes in the size or operation of the EWA. The EWA is designed to provide water to address CALFED's fish protection and restoration-recovery needs. The EWA also provides protection for at-risk species.

  Status: Evaluation will start when IEP analysis results are available, December 2005 and later.

  Costs: These costs are unknown at this time. Historically, costs for the EWA program have ranged from $20 million to $64 million annually.

- ***EWA Decision-Making for Export Curtailments –*** Evaluate changes to the timing of implementation for recommended EWA export curtailments to allow a more rapid response to critical time sensitive issues as they arise. Members of the California Water Policy Council and the California Federal Ecosystem Directorate signed a Framework Agreement in 1994 that initiated the CALFED Bay-Delta Program. The

participants were committed to, among other things, a process for coordinating Central Valley Project and State Water Project operations with endangered species, water quality, and Central Valley Project Improvement Act (CVPIA) requirements.

Status: Evaluate in 2005 and later as information becomes available.

Costs: The additional cost for moving from the current three-day implementation to a three-hour implementation will vary greatly. The short-term power market is driven by weather, gas supplies, and a number of other factors. For example, during February 2005, if export curtailments were implemented in three hours it would have resulted in an incremental increase of $100,000 to $150,000 to EWA. However, if it were implemented the previous week, there may not have been a significant incremental increase in the cost to EWA.

Conveyance Actions:

- ***Conveyance Modifications –*** Consider alternative Delta conveyance in an open, collaborative science-based CALFED process. In the 1990s, CALFED reconsidered options for Delta conveyance. The CALFED programmatic environmental document analyzed three categories of conveyance: use of existing Delta channels with minor modifications, use of existing channels with more significant modifications, and Delta channel modification combined with an isolated conveyance facility. The CALFED preferred alternative included conveyance through the existing Delta configuration, with some modifications. However, there was significant uncertainty over the ability to meet CALFED objectives with through-Delta conveyance. The CALFED decision included a commitment to assess in 2007 whether through-Delta conveyance was meeting CALFED objectives

  Status: CALFED Delta assessment begins fall 2005 and later.

  Costs: Impossible to estimate costs without defining the project, but it would likely be in the billions of dollars.

- ***Modified Barrier Installation at the Head of Old River –*** Evaluate if the spring barrier should be installed at the Head of Old River. DWR installs temporary barriers seasonally at four locations in the south Delta. All of these temporary barriers are constructed from loose rock and do not offer the flexibility that will be available when DWR constructs permanent operable gates through SDIP in place of temporary barriers. The environmental review for SDIP will begin with the release of the Draft EIS/R.

  Status: Evaluate in 2005 through 2007. Construction of operable gates is expected to be completed by 2009.

  Costs: If the temporary spring barrier is not installed, it would result in a cost savings of about $2 million annually from 2006 through 2009. However, installation of permanent gates is estimated to be $75 million.

CALFED Science Program Actions:

- ***CALFED Science Program Proposals –*** CALFED is developing the best scientific information possible to guide decisions and evaluate actions that are critical to its success. Implement CALFED science proposals that will advance relevant knowledge or provide benefits to smelt.

  Status: Proposals funded in 2005; review more actions in 2005-2006.

  Costs: Up to $2.2 million for the approved research projects. Up to $8 million more for research projects over the next three years, if additional funds become available or after modification to eliminate shortcomings identified by selection panels.

Interagency Ecological Program Actions

- ***IEP Pelagic Organisms Decline (POD) Study Plan –*** Carry out the IEP studies that will increase understanding of the causal factors for the decline. The IEP has a long history of monitoring and studying delta smelt.

Status: Currently, 24 studies and monitoring programs are under way. A technical workshop with results from 2005 water year is scheduled for November 2005.

Costs: The 2005 IEP baseline budget was about $13.5 million. Addition of the POD work increased the budget to $15.2 million. Some estimates place the costs of future POD work at $5 million more over baseline, which would bring the annual costs to $20 million.

Water Agency Actions

- ***Export Operational Changes –*** Evaluate the role of water project exports as a stressor for smelt and other pelagic organisms and make appropriate changes. Delta flows are most influenced by tidal action that changes direction four times daily. This tidal action affects the dispersion of fish in the Delta. However, water project operations can affect daily net flow. This in turn has both a direct and indirect impact on fish.

  Status: IEP analysis and modeling to be completed December 2005. Experimental operations changes could begin as early as spring 2006.

  Costs: Contingent on the type of operational changes pursued. Actual costs cannot be determined at this time.

- ***Pelagic Organisms Decline Account –*** Establish a fund to ensure quick implementation of appropriate actions.

  Status: Account established and funded July 2005. Substantial additional funding and agreements with the fishery agencies will be needed to implement many of this plan's actions.

  Costs: The initial annual budget for the POD Account is $2.5 million of SWP funds. Additional funds from other sources will be needed.

Regulatory Agency Actions

- ***Contaminants Management –*** Evaluate the potential role of contaminants in the decline, and recommend appropriate action.

  Status: IEP studies to be completed fall 2005, summer 2006. Recommended actions to follow in 2006.

  Costs: Exact costs for these studies under Additional Actions are not known. However, costs are estimated to be about $200,000 to $500,000 for 2006, and likely more as the program develops.

- ***Control of Invasive Species –*** Coordinate work among the Resources Agency and others to identify any gaps in invasive species programs and strengthen the programs as needed.

  Status: CALFED Non-Native Invasive Species Advisory Committee (NISAC) first met in 1999, more actions recommended December 2005 and later.

  Costs: Additional costs to ensure comprehensive programs are unknown. One of the first responsibilities of the NISAC will be to identify more program needs and related costs.

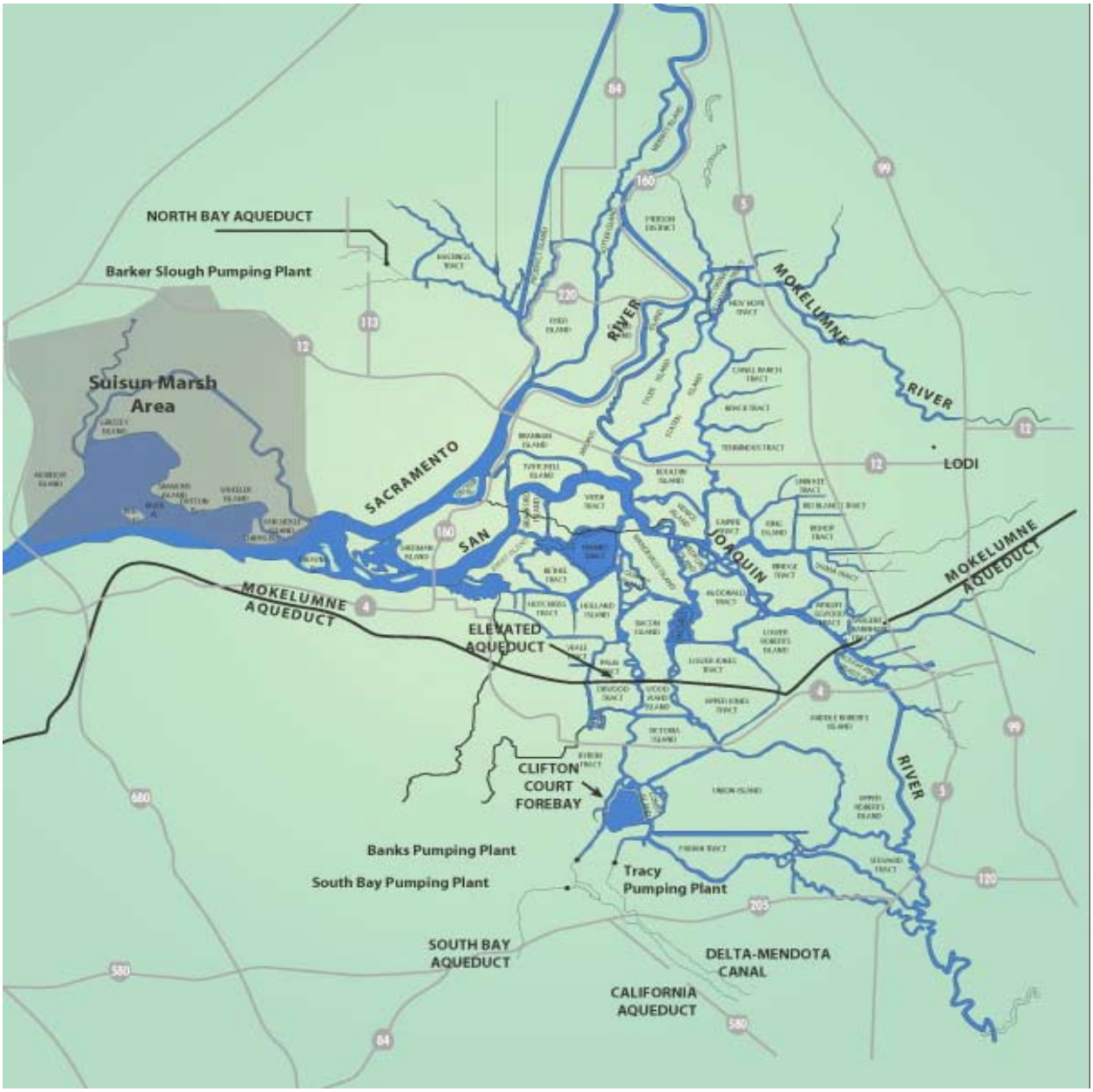

Figure 1. Sacramento-San Joaquin Delta

Background

To better understand the current pelagic organisms decline in the Bay-Delta -- including the challenging task of identifying the causes for the decline and necessary actions to reverse it – it is helpful to describe these circumstances in both a physical and ecological context.

The Bay-Delta

The San Francisco Bay and Sacramento-San Joaquin Delta (Delta) comprise the largest estuary on the west coast of North America and South America, and is an extremely important region of California both environmentally and economically. The Bay-Delta is also a region that is impacted by human activities in the estuary and as a result of actions upstream in the watersheds such as logging practices, dam building, hydraulic mining, urbanization, levee construction and formation of Delta islands, agriculture, introduced species, and changes in water quality and hydrology (Figure 1).

The Bay-Delta supports more than 750 plant and animal species. Delta fish species have received much attention due to their economic importance and because of conflicts between protection of Delta fish and other activities in the Bay-Delta and its watersheds. The Bay-Delta is home to both anadromous and resident fish species. Anadromous fish spend much of their life in the ocean or bays, and pass through the Bay-Delta to upstream areas to spawn. These fish include striped bass, Chinook salmon, steelhead trout, green sturgeon and white sturgeon. While several runs of salmon are still listed under the federal and state endangered species acts, salmon populations in general have rebounded to levels not seen in 20 to 40 years. Resident fish species spend their entire life in the Bay-Delta and include the Sacramento splittail, longfin smelt, and delta smelt. Two important introduced fish species are striped bass, introduced in 1879 as a game fish, and threadfin shad, introduced in 1953 as a forage fish. Most of the other familiar fish of the Bay-

Water Systems	CVP	SWP
Average water deliveries per year (acre feet)	6.7 million	2.4 million
Acres of agriculture served	3.0 million	750,000
Number of people served	2.9 million	23 million
Number of dams	20	28

Figure 2. State and federal water projects in California

Delta were also introduced, including American shad, largemouth bass, smallmouth bass, crappie, bluegill, white and channel catfish, and brown bullhead.

The Bay-Delta watershed is critical to California's economy, supplying drinking water for two-thirds of Californians and irrigation water for more than 3.7 million acres of the most highly productive agricultural land in the world. The Bay-Delta is also the hub of California's two largest water distribution systems - the Central Valley Project (CVP), operated by Reclamation and the State Water Project (SWP), operated by DWR. In addition, at least 7,000 other permitted water diverters, large and small, have developed water supplies from the watersheds feeding the Bay-Delta estuary. All told, these water development projects divert about 20 percent to 70 percent of the natural flow entering the watersheds of the Bay-Delta estuary, depending on the amount of runoff available in a given year. Figures 2 and 3 show some of the water projects in the State, including those in the Central Valley.

The estuary has a long history of disturbance. During California's gold rush, hydraulic mining was used to extract gold from the Sierra foothills. As a result, entire hillsides were washed away. From 1853 to 1884 when the practice was outlawed by federal injunction, huge amounts of silt washed into the streams feeding the Bay-Delta estuary. This silt raised the bed level of rivers and channels in the system, and covered the floor of San Francisco Bay. Mercury, used in gold extraction, was also carried downstream in the silt, leaving a toxic legacy that remains today.

Starting about 1869, settlers began to dike and drain the lands in the estuary. Islands were created by building levees to protect parcels of land from surrounding channels. Fertile peat soils and an abundant water supply made the region attractive to farmers. Within a generation, the Delta was converted from a sea of tules ringed by riparian forest to one of the garden baskets of California. The Suisun Marsh was converted from a mosaic of marshland vegetation and tidal channels into diked areas for farming, and subsequently, into managed wetlands creating one of the state's premier waterfowl hunting areas and the largest contiguous brackish water marsh in the western United States. These changes impacted delta smelt habitat in the estuary. The Delta lands

continue to be significant contributors to California's agricultural economy. The Suisun Marsh also continues to provide abundant recreational opportunities as it serves as a resting and feeding ground for thousands of waterfowl migrating along the Pacific Flyway, as well as a waterway passage for fishes between the ocean and upstream tributaries.

Peat soils are very fertile, but fragile. Once drained, the high proportion of organic matter in the soil is subject to oxidation, wind erosion, and even fire. This has resulted in a loss of soil over the past century. Today, some islands in the Bay-Delta are more than 18 feet below sea level, and are surrounded by channels that carry flood flows during most winters. Levee maintenance and repair has become a significant expense for those who depend on the integrity of Bay-Delta levees and channels.

Another disturbance to the Bay-Delta system has been the proliferation of aquatic- and terrestrial-introduced species, which can rapidly colonize a new area. The Bay-Delta system has become a haven for introduced species, including both intentional and accidental introductions. Nearly every new species survey turns up new organisms in the Bay-Delta, so an accurate count is impossible. A thorough review of exotics in the system completed in 1995 put the tally at 212 new species (Cohen and Carlton 1995). Large organisms such as fish are more noticeable in the surveys, but introduced invertebrates such as clams and zooplankton (tiny animals that drift or swim in the water and serve as food for small fish) may have a much more profound effect on the food web and ecological processes. The diversity of introduced species is astonishing and their effects on native biota are likely significant through predation and competition.

Human activities have also caused significant changes in water quality of the Bay-Delta. Natural hydrology historically included very high winter-spring flows that flushed salt out into San Francisco Bay, and low summer-fall flows that allowed salt water to move well up into the Delta. Operation of the SWP, CVP and local projects have reduced winter-spring flows and increased summer-fall flows. This altered flow regime has advantages and disadvantages. Delta water has lower salinity in the summer, which is beneficial

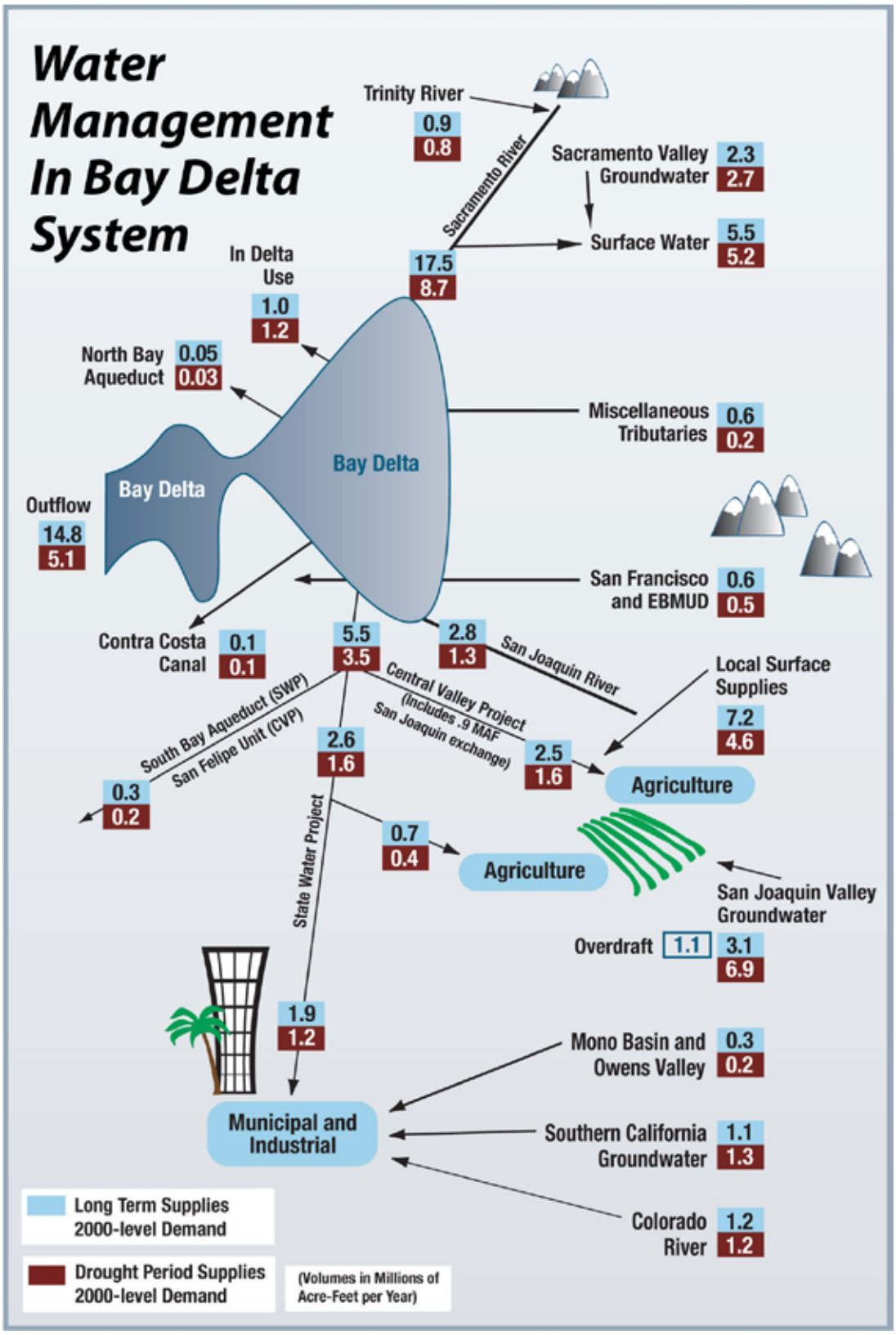

Figure 3. Water management in the Bay-Delta system

for farming in the Delta and drinking water quality, but provides a regulated salinity that may favor some introduced organisms over native species. Higher summer-fall flows also reduce the residence time of water in the Delta during the biologically productive summers. Warm, slow moving water facilitates the production of microorganisms that form the foundation of the food web. Water that flows more quickly is not as conducive to this biological production. Certain pesticides and urban runoff entering waterways of the Bay-Delta also have an effect on biota. The effect may be most pronounced on tiny organisms at the base of the food web.

The Interagency Ecological Program

Initial ecological studies, conducted by DFG and DWR, began in the 1950s and 1960s. The IEP was implemented in the 1970s. The IEP is a multi-agency effort that conducts cooperative ecological investigations in the Bay-Delta. A primary purpose of the IEP is to monitor baseline conditions and to assess ecological effects of the SWP and the CVP. Monitoring conducted by the IEP is a requirement of the projects' water right permits from the State Water Resources Control Board (SWRCB). In addition to monitoring, the IEP conducts special studies to increase understanding of ecological processes and species life histories in the Bay-Delta.

The IEP consists of nine member agencies. The three state agencies are DWR, DFG and SWRCB. The six federal agencies are U.S. Fish and Wildlife Service (FWS), Reclamation, U.S. Geological Survey (USGS), U.S. Army Corps of Engineers (Corps), National Oceanographic and Atmospheric Administration-National Marine Fisheries Service (NOAA Fisheries), and Environmental Protection Agency (EPA). One nongovernmental organization, The San Francisco Estuarine Institute, is an ex-officio member. These 10 partners work together to develop a better understanding of the estuary's ecology and the effects of the SWP and CVP operations on the physical, chemical, and biological conditions of the Bay-Delta estuary. In 2005, the IEP budget totaled about $15.2 million, including $1.7 million in additional funding provided by DWR and Reclamation to address recent fish declines. Most IEP funding consists of special state and federal water project funds.

The IEP represents one of the most comprehensive estuarine

monitoring programs in the United States. The evolution of the IEP fish monitoring program occurred in stages, with some monitoring predating the establishment of the formal program. This evolution tracks the shifting concern for select fish species and the programmatic response of IEP. The initial program in the 1950s and 1960s had two geographically broad surveys (Summer Townet and Fall Midwater Trawl) to sample the distribution and abundance of juvenile striped bass and the pelagic fish community in the Delta and upper estuary. Also in the 1960s, more narrowly targeted surveys were added to monitor the abundance of select sport fish, white sturgeon and striped bass. In the 1970s, three new surveys were added (FWS Beach Seine, the Sacramento River Trawl, and the Chipps Island Trawl) which focused on tracking the timing and abundance of emigrating juvenile Chinook salmon. Beginning in the 1970s, data from the SWP and CVP fish salvage facilities were regularly used to estimate the salvage of striped bass and salmon resulting from Delta exports. Analyses of data from existing surveys continued to focus heavily on sport fish abundance trends, particularly striped bass and Chinook salmon.

Two new fish community surveys, the Bay Study and Suisun Marsh survey, were initiated in the 1980s to monitor fish communities in under-sampled areas of the estuary. From the 1960s to early 1990s, striped bass was considered the key indicator fish species for the upper estuary and Delta, and much of the analyses of fish monitoring data focused on this species. Concerns about increased water exports also led to analyses of flow effects on the abundance of a suite of sport and native species, concluding in the first X2 publications. X2, the location of 2 parts per thousand (ppt) bottom salinity, is used as a species habitat indicator whose position is influenced by outflow, and is positioned where it may be more beneficial to aquatic life as required in the SWRCB Water Quality Control Plan.

In the 1990s, several native fish were listed as threatened (delta smelt, Sacramento splittail, Central Valley and coastal steelhead, and spring-run Chinook salmon) or endangered (winter-run Chinook salmon) under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA). These listings resulted in a shift in IEP's analysis and reporting with greater emphasis on listed species in particular, and native species in general. In

addition, IEP added several new surveys (20 mm Survey, North Bay Aqueduct Survey (discontinued in 2004), and Spring Kodiak Trawl) that targeted delta smelt, and expanded others (Fall Midwater Trawl expanded geographically and temporally, into spring). Surveys for Chinook salmon were expanded temporally (Beach Seine, and Chipps Island, Sacramento and Mossdale trawls).

This concern for the decline of several native fish during the 1980s and early 1990s led FWS to initiate the development of the Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes. The Recovery Plan represents the efforts of state and federal IEP agencies, universities and consultants to develop a comprehensive plan to address the needs of eight target fish: delta smelt, Sacramento splittail, longfin smelt, green sturgeon, spring-run Chinook salmon, late fall-run Chinook salmon, San Joaquin River fall-run Chinook salmon, and Sacramento perch. Since the release of the Recovery Plan, its primary use has been to help track whether recovery criteria have been met for listed species. Many of the recovery actions have been incorporated into the CALFED Bay-Delta Program.

The CALFED Bay-Delta Program

History of Conflict

The effects of human activity on the Bay-Delta ecosystem system have long placed management and use of the system at odds with species protections. By 1993, listings and proposed listings of Bay-Delta fish species under the federal ESA resulted in restrictions on the operations of the SWP and CVP. There was a significant effect on the amount of water the projects could deliver, without further magnifying the problems in the estuarine environment.

To reduce this conflict, the CALFED Bay-Delta Program was created in 1994. CALFED is a collaboration of 25 state and federal agencies to improve water management and restore the ecological health of the Bay-Delta system. In 2000, the agencies drafted a 30-year plan described in the CALFED Record of Decision (ROD). The plan, as set forth in the ROD, addresses ecosystem health, levee system integrity, drinking water quality and water supply reliability in the Bay-Delta. The ROD lays out broad actions and investments

to meet CALFED program goals and a strategy for implementing them. The plan describes a science-based planning process through which the agencies can make better, more informed decisions on projects and programs in their jurisdictions.

These four CALFED program objectives are further addressed through 11 major program elements as a way of sustaining CALFED's balanced and comprehensive approach. These program elements include water management, storage, conveyance, water use efficiency, water transfers, environmental water account, drinking water quality, watershed management, levee system integrity, ecosystem restoration, and science.

In 2002, the California Legislature passed the California Bay-Delta Authority Act that adopted the plan's objectives as state policy. The Bay-Delta Authority Act also created a new state agency, the California Bay-Delta Authority (CBDA), to oversee the program. Finally, the Act assigned responsibility for each program element to one or more agencies. DFG, FWS, and NOAA Fisheries are the implementing agencies responsible for the Ecosystem Restoration Program (ERP) and the Environmental Water Account (along with DWR and Reclamation). DWR and Reclamation are the state and federal agencies responsible for the water supply reliability, storage, and conveyance elements of the program. In 2004, Congress passed the Water Supply Reliability and Environmental Improvement Act that adopted the CALFED plan as a general framework for the federal agencies.

The CBDA provides the agencies a forum to share information, resolve disputes, measure their cumulative progress, and maintain a shared vision. The fundamental notion of the CALFED program is that each agency can better meet its individual responsibilities when it understands how its actions affect, and are affected by, the other agencies.

In late January 2005, DFG provided individual briefings to IEP agency directors over two weeks regarding the pelagic organism decline. On February 9, 2005, IEP scientists first announced their observation of a pelagic organism decline at a public CBDA meeting. At the time, analysis of 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 apparent troubling trend to the public and to agency policymakers in this forum was a sign of the improved communication that CALFED has fostered.

CALFED Bay-Delta Actions

Many CALFED actions in the Bay-Delta are in their planning or early stages of implementation. These include the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP), the Habitat Management, Preservation, and Restoration Plan for Suisun Marsh (Suisun Marsh Plan), the Delta Risk Management Strategy, and the Delta Improvements Package, including the South Delta Improvement Program (SDIP). More than $512 million has been awarded for over 400 ecosystem restoration projects.

DFG is leading the CALFED Ecosystem Restoration Program (ERP) effort to develop the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP). The DRERIP is the first of four regional plans intended to refine the existing planning foundation guiding the long-term implementation of the ERP element. The DRERIP will update the ERP planning foundation specific to the Delta, refine existing Delta-specific restoration actions and targets, and provide Delta-specific implementation guidance, program tracking, performance evaluation and adaptive management feedback. Preparation of the DRERIP is a collaborative effort among the ERP implementing agencies: DFG, NOAA Fisheries, and FWS, along with ERP and CALFED Science Program staff, the ERP Science Board, and other CALFED agencies, local interests, stakeholders, and academics.

A related ERP effort, also lead by DFG, is the development of a Habitat Management, Preservation, and Restoration Plan for Suisun Marsh. The Suisun Marsh Plan is the second of four regional plans, and intends to balance implementation of the CALFED Program, Suisun Marsh Preservation Agreement (SMPA), and other management and restoration programs within Suisun Marsh in a manner responsive to the concerns of stakeholders and based upon

voluntary participation by private landowners. The Suisun Marsh Plan will be consistent with the CALFED Multi-Species Conservation Strategy to address recovery needs of threatened and endangered species, protect and enhance habitat for migratory birds and other wildlife, improve levees, restore tidal marshes and other ecosystems, and improve water quality in the Suisun Marsh. The Suisun Marsh Plan will include specific actions relative to an amendment to the SMPA and strategies to resolve permitting issues related to past and ongoing maintenance and management activities, including a Regional General Permit. In addition to the ERP, the Suisun Marsh Plan will address other CALFED Program elements such as the Levee Program, the Drinking Water Quality Program, and Science Program. Preparation of the Suisun Marsh Plan is a cooperative effort by DFG, Reclamation, FWS, NOAA Fisheries, DWR, CBDA, Suisun Resource Conservation District, and private landowners.

Another CALFED action contained in the ROD is the completion of a Delta Risk Management Strategy (DRMS) that would assess major risks to the Delta resources from floods, seepage, subsidence and earthquakes. The DRMS would also evaluate the consequences and develop recommendations to manage the risk. The current DRMS is an outgrowth of the risk management program element described in the ROD. It is intended to accomplish the goals originally set forth in the ROD for the risk management strategy and to provide a set of alternative risk-reduction plans that would be considered in subsequent decision and implementation phases. Risk reduction measures that would be common to all alternative plans would be recommended for immediate implementation. The DRMS is being jointly conducted by DWR and the Corps in conjunction with DFG and is scheduled for completion in Fiscal Year (FY) 2006-07.

State and federal agencies expect to implement many actions in the Delta over the next few years. These agencies recognize that many of the proposed actions are interrelated. Decisions on key components must be coordinated and implementation must be balanced. To ensure coordination and balance, the agencies have developed the Delta Improvements Package (DIP) including an Implementation Plan that clarifies the roles, responsibilities and commitments of the agencies in certain programs, projects, evaluations and monitoring focused on the Delta region. Some of the actions included in the DIP are SWP/CVP Integration, San

Joaquin River Salinity Management Plan, Vernalis Flow Objectives, San Joaquin River Dissolved Oxygen, Frank's Tract Investigations, Delta Cross Channel Investigations, Long-term Environmental Water Account (EWA), DRERIP, DRMS, and the SDIP.

The SDIP proposed by DWR, working with Reclamation, would replace existing seasonally-installed rock barriers with permanent operable gates and conduct limited dredging in south Delta channels. A third aspect of SDIP is a proposed change in permitted pumping capacity. The program would increase the maximum rate at which the SWP is permitted to divert water from the Delta using the existing pumps. This increase will provide operational flexibility through the use of more capacity to increase water supplies for regions south of the Delta, or through the shift in timing of pumping, which may avoid harming fish when they are near the pumps, or both. Actual ability to use this capacity will remain limited by hydrologic and environmental conditions. The capacity can only be used when water is available while meeting all required Delta standards. The capacity will be further restricted to when conditions allow increased diversions without adversely affecting other water users or the environment.

DWR will release a draft environmental impact statement and report (EIS/EIR) for the SDIP project describing two major project components: a physical/structural component related to operable gates and dredging, and an operational component describing alternatives for operation of the SWP pumps. The draft EIS/EIR will specify a preferred structural/physical component for the permanent operable gates and dredging. The agricultural gates and dredging are important to protect water levels and quality for farmers in the south Delta, and the gates at the Head of Old River are critical to protect salmon in the San Joaquin River during the spring and fall. No preferred operational component will be identified for modified operation of the pumps. Instead, DWR will use the draft EIS/EIR as a focus for public discussions of the best ways to protect fish populations as the SWP is operated to maintain reliable water supplies.

Export operations would not change substantially until the new gates are installed and operating. This will take three to four years.

This gives the CALFED agencies time to gather more information, conduct new research, and improve understanding of the factors affecting populations of Delta species to assist DWR and Reclamation in selecting a preferred operational component for SDIP.

CALFED Science Program

A key goal of the CALFED Science Program is to establish a body of knowledge relevant to CALFED actions and their implications that is unbiased, relevant, authoritative, integrated across program elements, and communicated to the scientific community, CALFED agency managers, stakeholders, and the public. Toward this end, the Science Program led an effort to develop a series of white papers to summarize the available information on target species and habitats. The white papers are intended to provide the conceptual basis for CALFED research, restoration and other activities. To date, white papers have been published on the California Bay-Delta Authority Science website (http://science.calwater.ca.gov/white_papers.shtml) for splittail, open-water processes, and phytoplankton regulation in the lower San Joaquin River.

While this Action Plan and the steps described in the following sections deal with the total Delta pelagic zone, it is placed in the context of actions to specifically benefit delta smelt. However, state and federal agencies recognize that that a better strategy is a multispecies approach to species protection through habitat conservation. In general, actions that benefit delta smelt will likely benefit other pelagic organisms and possibly the entire estuarine system.

Overview

Pelagic Organism Decline (POD)

In the past few years, the abundance indices calculated by the IEP Fall Midwater Trawl survey (MWT) show marked declines in numerous pelagic fish in the upper San Francisco Estuary (Figure 4). 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 MWT 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 (Hieb and others 2004; Hieb and others 2005). Based on these findings, the problem appears to be limited at this time to fish dependent on the Delta.

In addition to the declines in fish species, IEP monitoring also found declining abundance trends for zooplankton with a substantial drop in calanoid copepod abundance in 2004 (Figure 5). Calanoid copepods such as Eurytemora affinis and Pseudodiaptomus forbesi are the primary food for larval pelagic fish in the upper estuary (IEP 1987; Meng and Orsi 1991; Nobriga 2002), as well as 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 MWT 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.

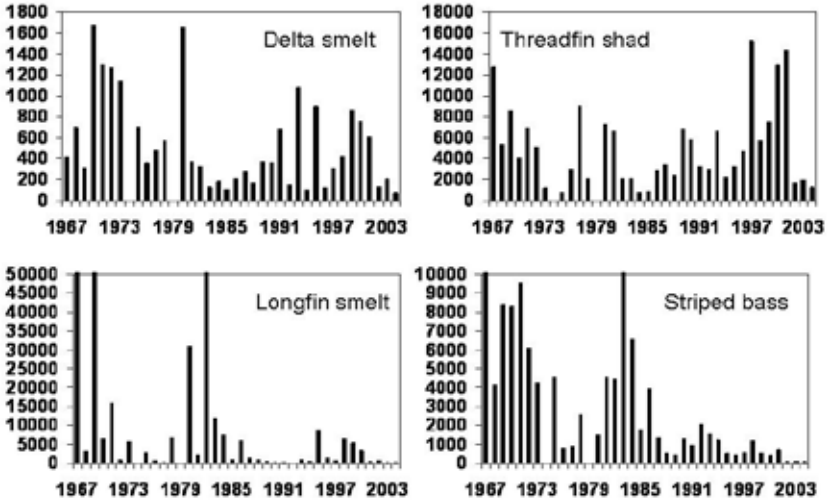

Figure 4. Fish trends depicting organism decline (Source: DFG data)

Zooplankton Trends

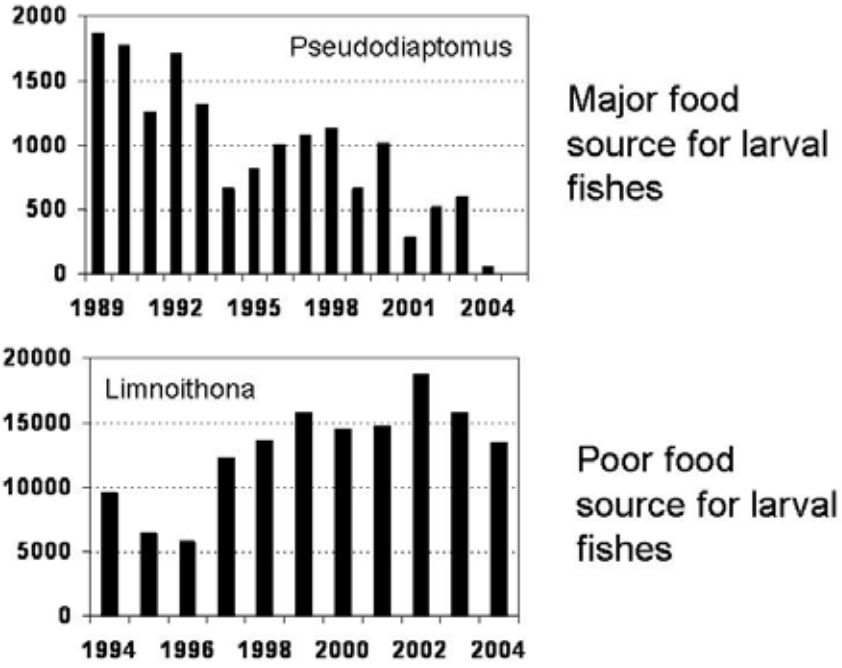

Figure 5. Abundance indices of competing food sources for larval fish (Source: Mecum 2005)

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 should have supported at least modest production.

Multiple pelagic species at more than one trophic level seem to show the 2002-2004 step decline is of particular concern. This decline has taken place even as the CALFED program has taken efforts to improve the traditionally recognized factors that have affected fish abundance indexes. This indicates more needs to be done to identify what factors limit pelagic fisheries production 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 to provide added fish protection and ERP habitat restoration projects were undertaken to improve fish populations.

Conceptual Model of Decline

IEP has 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 6). The conceptual model in Figure 6 uses these factors to illustrate the potential pathways by which pelagic species in the Delta could be affected. 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. Not all of the organisms shown in each box are necessarily responsible for each of the mechanisms.

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

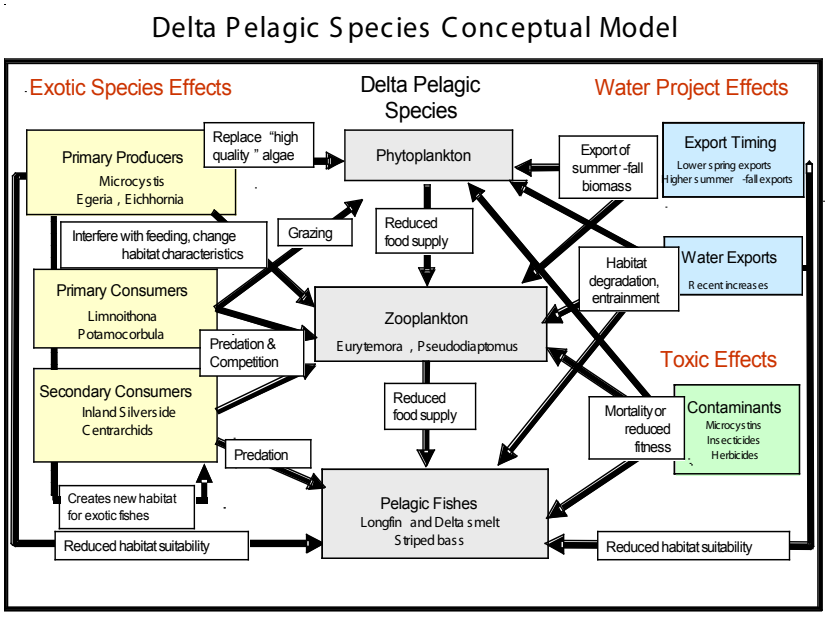

Figure 6. Delta pelagic species conceptual model
(Source: IEP 2005)

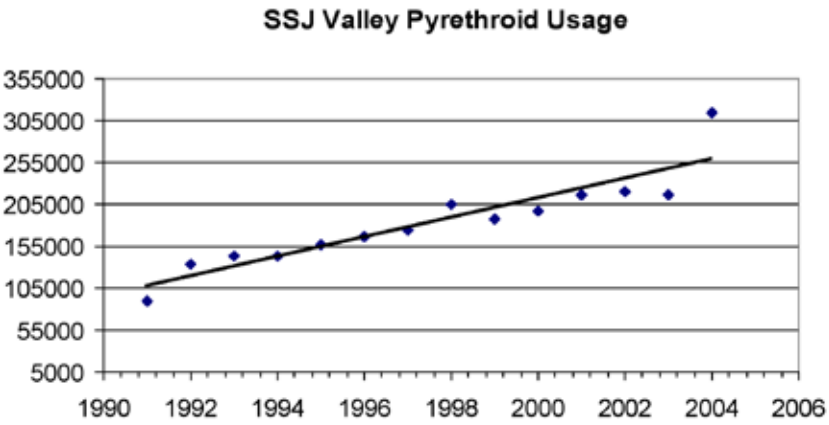

Figure 7. Total reported application of pyrethroid pesticides in the Sacramento and San Joaquin Valley. Yearly data was obtained from the CDPR PUR Database. Data from 2004 is preliminary but not expected to significantly change.
(Source: McQuirk 2005)

affect organisms at higher trophic levels through bioaccumulation (Lehman and others 2005).

A shift in pesticide use has 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 7 and 8 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

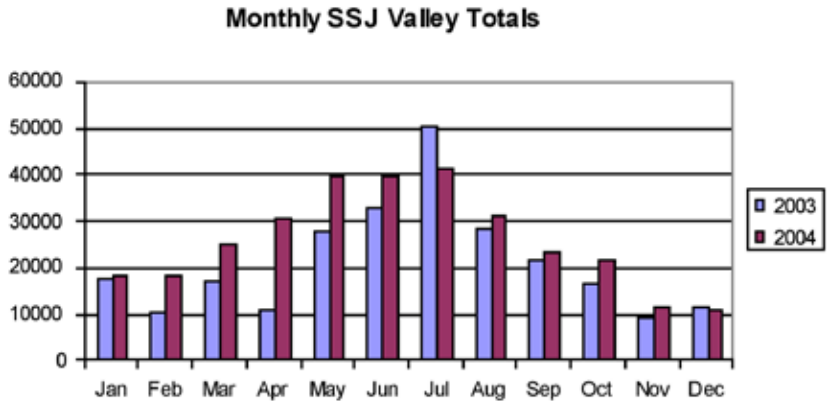

Figure 8. Monthly total pyrethroid pesticides applied in the Sacramento and San Joaquin Valley (Source: McQuirk 2005)

300 percent greater than the level of use in 1991 with the largest jump between 2003 and 2004. 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 the recent changes in the use of pyrethroids and aquatic herbicides.

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 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 (Potamocorbula 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 and others in press). 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

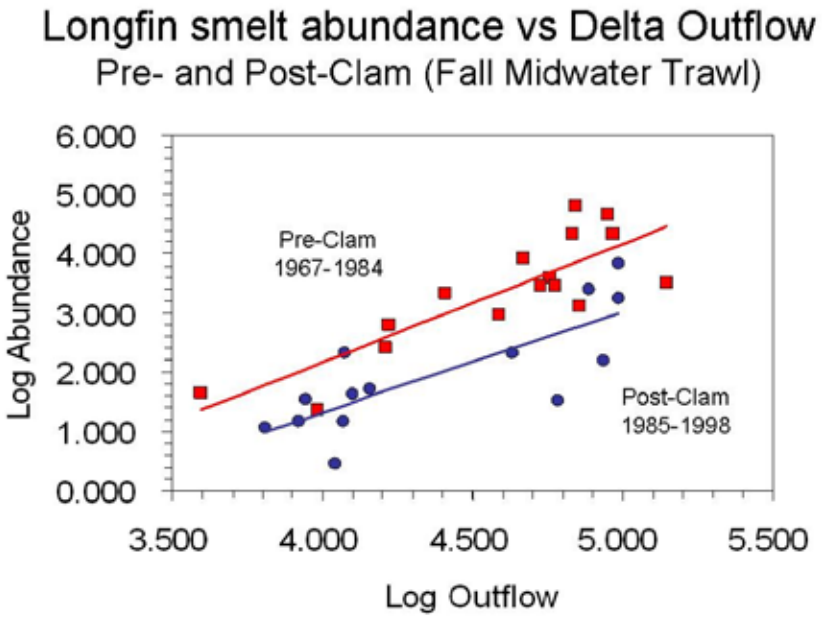

Figure 9. A comparison of longfin smelt abundance relative to Delta outflow pre- and post-introduction of the Asiatic clam
(Source: DFG and DWR data)

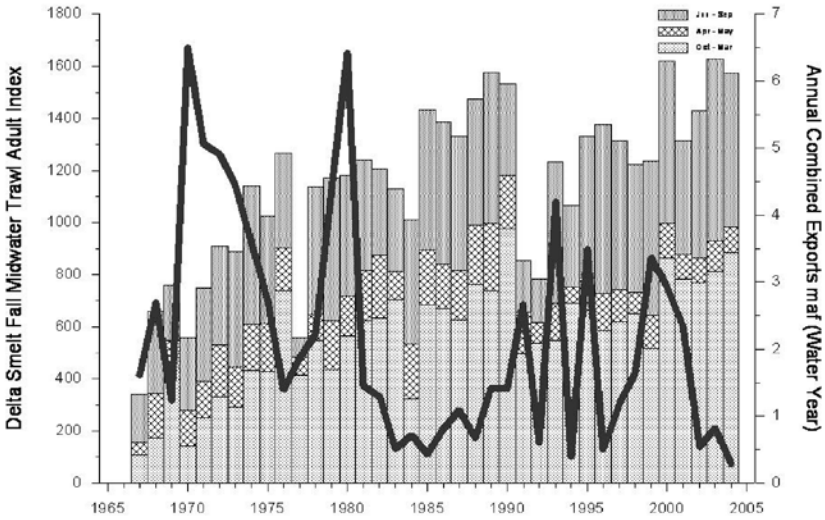

Figure 10. Annual combined exports (SWP and CVP, bar graph) and adult delta smelt midwater trawl index (black line)
(Source: DWR and DFG data)

drop in longfin smelt abundance over a range of environmental conditions (as indicated by outflow) before and after the invasion of the clam (Figure 9). At this time, limited information exists about quantitative aspects of the estuarine food web needed to estimate Potamocorbula grazing rates or predict whether nearshore and pelagic food webs are coupled in ways relevant to the production of pelagic fish.

Water Project Operations: Total annual exports are only slightly higher now than they were in the 1980s as seen in Figure 10. Lower exports in the early 1990s were the result of dry-year

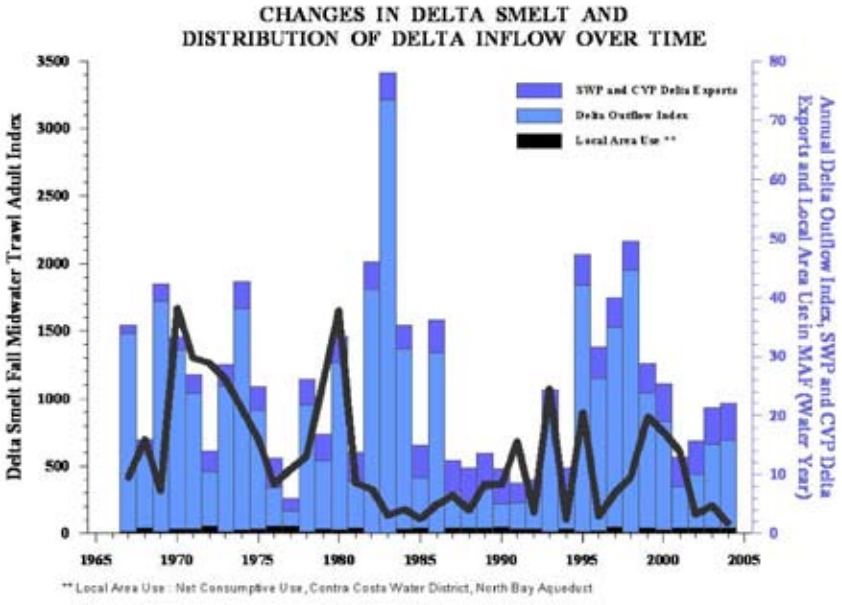

Figure 11. Annual Delta inflow, combined exports, and adult delta smelt midwater trawl index (black line)
(Source: DWR and DFG data)

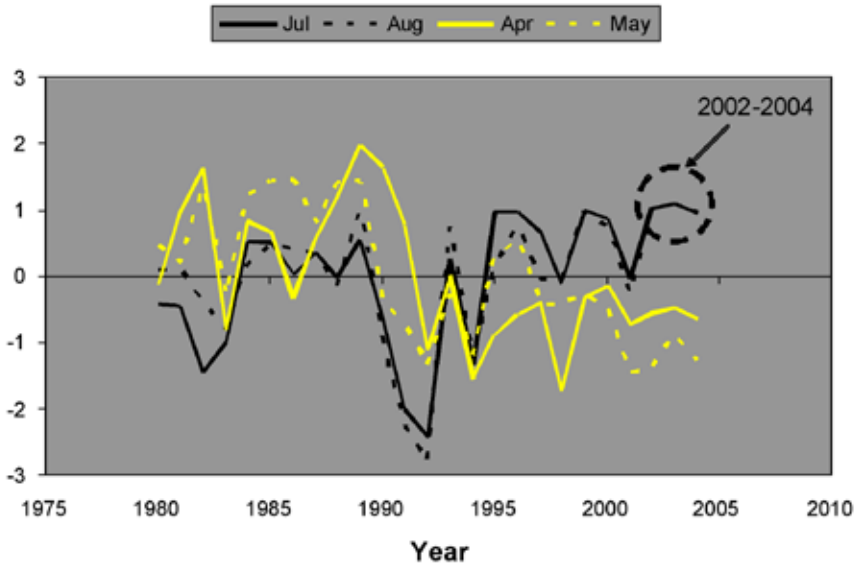

Figure 12. Seasonal shift in combined SWP and CVP diversions. The units shown (anomalies) represent the amount of deviation from the long-term mean.
(Source: DWR and DFG data)

conditions and lower Delta inflow (Figures 10 and 11). Figure 10 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 to protect fish and actions that were taken by all the CALFED Water Operations and Management Team agencies to better protect fish. Figure 12 shows the drop in the exports from the 1980s to the early 1990s in April and May and the higher summer exports in the late 1990s to the present. This shift was based on the assumption that it would be more protective to sensitive early life stages of key estuarine fish

and invertebrates. However, it is possible that higher exports during summer has unanticipated food web effects by exporting 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.

IEP Study Plan

To address the declines in fish and zooplankton abundance, a new IEP working group was organized. It is known as the Pelagic Organisms Decline Project Work Team (POD PWT). The POD PWT explores the causes of the recent declines in abundance and provides policymakers with recommendations on what can be done to improve abundance. DWR and Reclamation have authorized $1.7 million more in water project funds to augment the current $13.5 million IEP budget to evaluate the causes of this unexpected decline. Extensive work will be needed to identify the causes for the decline. It took a few years to develop an understanding of the previous step decline in productivity seen in the estuary in the 1980s.

The approach recommended by the POD PWT for 2005 is a triage model to better define the degree to which toxics, exotic species and water project operations may be responsible individually, in sequence, or in concert for the apparent long-term abundance declines and step-changes (IEP 2005). The triage model has been used for many applications including habitat restoration, information technology and peer review (Vener and others 1993; Samways 2000). The triage model involves an initial screening to try and identify the most likely problems and to assign resources for follow-up investigations. The major benefit of triage is that it allows a rapid response and helps optimize the use of resources, which are typically limited. This type of focus is critical to evaluate likely causes, expedite answers, and eliminate factors that are not causes. Resource optimization is a major issue as each species may have a different group of stressors implicated in its decline, making it difficult to comprehensively evaluate each stressor. IEP believes the study plan is sufficiently flexible to address many factors or different

factors affecting species in different ways. Stressors that show a major change in the past few years will receive closer scrutiny than those showing earlier changes or more gradual trends. Note that the triage approach is not intended as a substitute for a traditional detailed scientific study. Rather it is an initial step that will help guide more focused research studies that will be needed in 2006 and beyond. IEP anticipates that these studies will narrow the range of factors that need scrutiny each year – assuming additional major ecosystem perturbations do not occur.

The study plans build upon the extensive $13.5 million (2005 budget) a year IEP program to evaluate the Bay-Delta Ecosystem and represent an interdisciplinary, multiagency effort including staff from DFG, DWR, Reclamation, EPA, USGS, and University of California, Davis. Project components were selected based on their ability to differentiate the three major groups of stressors, and their feasibility in terms of methods, staffing, costs, timing and data availability. The proposed work falls into four types: 1) an expansion of existing monitoring (four expanded surveys); 2) analyses of existing data (nine studies); 3) new studies (six studies); and 4) ongoing studies (four studies). Much of the rationale for 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). Some of the IEP activities were redirected to accommodate the POD work, but all existing mandated monitoring programs will continue. The initial cost estimate for 2005 is about $1.7 million.

The POD PWT will develop, direct, review and analyze the results of the work. The program will yield such things as management briefs, publications and reports, Web-based monitoring data, and presentations at conferences, workshops and meetings. Work completed in 2005 will be reported in a POD summary report and will be the topic for a public technical workshop in November 2005 presenting the results from the 2005 POD studies. It also will guide the development of work for 2006 and beyond.

Action Plan

DWR and DFG are taking several steps to address the pelagic organism decline. In addition to providing the IEP with funding for the POD studies, the departments are developing an action plan through this document specifically for the protection and enhancement of delta smelt. DWR and DFG will coordinate all actions developed from this plan. This action plan will be updated periodically, pending the results of the on-going 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. A ready source of funding is needed so that early actions can be taken as information about the cause or causes of this decline are identified from studies. DWR is establishing a separate fund to quickly address near-term pelagic fish issues. Initially, this fund will be established with State Water Project funds, but ultimately, others are expected 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.

The goal of this plan is to identify actions to increase and sustain the delta smelt population. Although this action plan is specific to delta smelt, the agencies recognize that this species cannot be isolated for evaluation given the great number of scientific uncertainties and ecological complexity of the estuarine system of the Delta and Suisun Bay. In general, actions that benefit delta smelt will likely provide multispecies benefits to other pelagic organisms, and possibly to the entire system.

Potential Actions

Potential actions for the protection and enhancement of delta smelt were considered, and are presented in brief summaries in this document. Many of these actions are related and could fall under several of the programs or areas listed below, but were placed in the most appropriate area. For example, there may be references to CALFED or IEP actions under Water Agency or regulatory actions. Following are a list of potential actions and their status:

CALFED Bay-Delta Program Actions

- Ecosystem Restoration Program Actions
    - Delta Actions – Ongoing
    - Suisun Marsh Actions – Ongoing
    - Increase Food Web Productivity – Evaluating
    - Reduce Entrainment at Power Plants – Evaluating

- Environmental Water Account Actions
  - Modified Environmental Water Account – Evaluating
  - EWA Decision-Making for Export Curtailments – Evaluating
- Conveyance Actions
  - Conveyance Modifications – Evaluating
  - Modified Barrier Installation at the Head of Old River – Ongoing

CALFED Science Program Actions

- Science Program Proposals – Ongoing; Evaluating

Interagency Ecological Program Actions

- IEP POD Study Plan – Ongoing

Water Agency Actions

- Export Operational Changes – Evaluating
- Pelagic Organisms Decline Account – Ongoing; Evaluating

Regulatory Agency Actions

- Contaminants Management – Established new work team; Evaluating
- Control of Invasive Species – Ongoing

These actions can be categorized into three areas related to the conceptual model of the POD study – toxins, invasive species, and water project operations (Table 1). Several actions described in this plan, IEP studies and a POD Account to fund actions, are already in place. Other actions in this plan vary in the amount of time needed to begin. Others require a range of times for study and planning. Preliminary schedules are shown in Figure 13, 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 implementing it. The schedule will be updated regularly.

CALFED Bay-Delta Program Actions

Over the past 10 years, the CALFED Bay-Delta Program has considered delta smelt issues during the planning and implementation of many of its programs and actions. These include ecosystem restoration and water management aimed at protecting delta smelt and restoring its habitat similar to those detailed elsewhere in this action plan. They also include support for monitoring and research intended to assess the efficacy of ecosystem restoration and

	Hypotheses Addressed by Potential Actions		
Potential Actions	**Toxins**	**Invasive Species**	**Water Project Operations**
CALFED Actions			
ERP Actions			
Delta Actions	♦	♦	♦
Suisun Marsh Actions	♦	♦	♦
Increase Food Web Productivity	♦	♦	♦
Power Plants	♦		♦
Environmental Water Account Actions			
Modified EWA			♦
EWA Export Curtailments			♦
Conveyance Actions			
Conveyance Modifications			♦
Head of Old River Barrier			♦
CALFED Science Program Actions			
Science Program Proposals	♦	♦	♦
IEP Actions			
IEP POD Study Plan	♦	♦	♦
Water Agency Actions			
Export Operational Changes			♦
Pelagic Organism Decline Account	♦	♦	♦
Regulatory Agency Actions			
Contaminants Management	♦		
Invasive Species		♦	

Table 1. Potential actions for the protection and enhancement of delta smelt

management, such as the Environmental Water Account, and to gain a better understanding of delta smelt biology and ecology.

Ecosytem Restoration Program Actions

The ERP is one of several CALFED programs that have considered delta smelt issues over the past 10 years. In general, ecosystem restoration actions help restore and improve the health of the Bay-Delta system for all native species, including delta smelt, while reducing its water management constraints. ERP goals include:

- Recover 19 at-risk native species and contribute to the recovery of 25 additional species
- Rehabilitate natural processes related to hydrology, stream channels, sediment, floodplains and ecosystem water quality
- Maintain and enhance fish populations critical to commercial, sport and recreational fisheries
- Protect and restore functional habitats, including aquatic, upland and riparian, to allow species to thrive
- Reduce the negative impacts of invasive species and prevent additional introductions that compete with and destroy native species
- Improve and maintain water and sediment quality to better support ecosystem health and allow species to flourish

ERP actions that are directly related to this plan include Delta actions, Suisun Marsh actions, increased food web productivity, and reduced entrainment at power plants. The actions are described in the sections that follow.

Title of Action: Delta Actions

ERP actions for the Delta that are related to this plan include the regional Delta ERP planning effort, the delta smelt culture and conservation laboratory, and ERP monitoring. The laboratory and monitoring actions are described later in this section.

Under the ERP, the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP), a component of the Delta Improvements Package, is the first of several regional plans intended to refine the

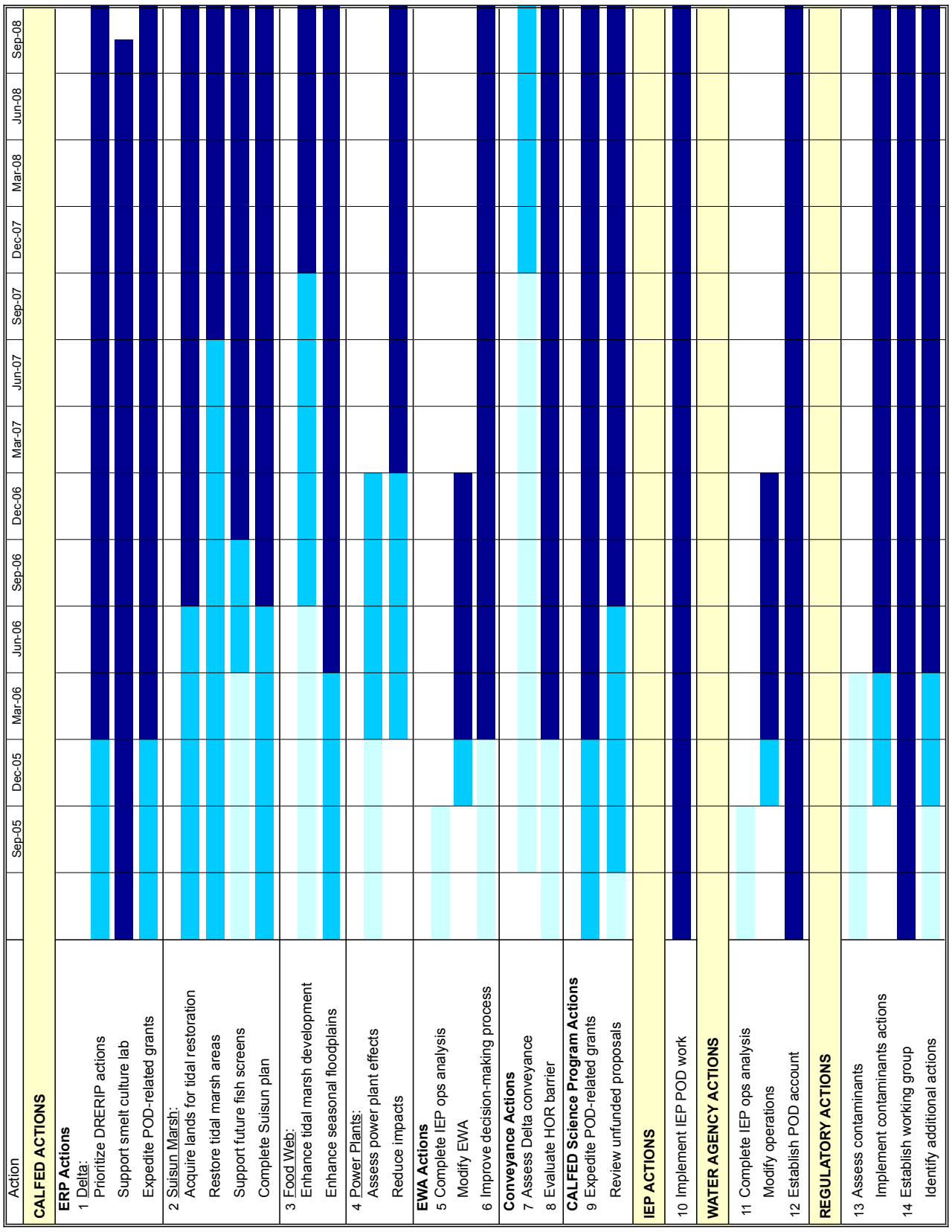

Figure 13. Delta Smelt Action Schedule

existing planning foundation guiding the long-term implementation of the CALFED Ecosystem Restoration Program element. The DRERIP will update the ERP's planning foundation specific to the Delta, refine existing Delta-specific restoration actions and guidance for Delta-specific tracking, performance evaluation, and adaptive management feedback.

The DRERIP will evaluate previously planned targets, actions and milestones in light of the current state of knowledge and restoration projects implemented to date. Current knowledge of species life histories and how the system works (ecosystem processes, habitats and stressors) will be captured in conceptual models, which serve as the tools for evaluating actions. The DRERIP Adaptive Management Planning Team (AMPT), which is coordinating DRERIP science input, has completed the processes and framework necessary to develop the conceptual models and conduct the scientific evaluation of actions. The conceptual models would be developed prior to evaluation, feasibility assessment, and prioritization.

Recognizing the current management attention on the recent marked declines in numerous pelagic fishes (some of which are Multi-Species Conservation Strategy (MSCS) species designated for "Recovery" or "R" species) and zooplankton in the upper San Francisco estuary (Delta and Suisun Bay), the DRERIP effort will focus on assembling and evaluating current scientific knowledge underlying proposed ERP actions that target the recovery of these estuarine species. DRERIP's goal is to quickly produce tools to assist with these urgent management needs, including conceptual models of the species and the ecosystem components on which they depend and a list of scientifically evaluated Delta ERP restoration and research actions in year six. The ERP proposes to build on the IEP POD efforts in a unified approach to address the Delta pelagic fish decline.

This strategic DRERIP effort will:

- Complete life history conceptual models for the MSCS "R" fish species and striped bass (delta smelt, longfin smelt, and green sturgeon models are completed; salmon, steelhead, Sacramento splittail and striped bass models are to be completed).

- Develop relevant ecosystem conceptual models.
- Identify proposed ERP actions that are directly relevant to MSCS "R" fish and striped bass. These actions include those addressing contaminants, non-native invasive species, increasing food web production, and habitat restoration.
- Identify cross-cutting issues between proposed ERP and non-ERP actions that are directly relevant to Delta management.
- Scientifically evaluate ERP actions using the peer-reviewed conceptual models.
- Provide ERP and other implementing agency managers with a list of restoration actions with likely population level benefits and research needed to reduce scientific uncertainties to further ERP goals for these species.

In addition to the DRERIP effort, CALFED funding has supported ERP actions aimed at protecting delta smelt and restoring its habitat. One of these actions is the UC Davis delta smelt culture and conservation laboratory near the SWP's Skinner Fish Facility, which provides fish for research purposes. CALFED funding for the laboratory ends October 2005, and no new funding has been secured. DWR is providing funds for the laboratory for the duration of the ongoing IEP Collection, Handling, Transport, and Release (CHTR) 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).

Recently, the ERP and the CALFED Science Program solicited monitoring and research proposals, respectively. Some of these proposals were relevant to delta smelt (also see section on CALFED Science Program Actions). These include proposals specifically about delta smelt biology and management, as well as proposals related to delta smelt food resources, habitat, and stressors. The proposals underwent rigorous scientific and agency reviews and many received high ratings. Since the POD had been discovered and publicized during this time, the reviewers also gave consideration to the usefulness of each project in understanding or reversing the POD.

The ERP proposals recommended for funding – after revisions are made in response to independent review – include one focused on monitoring the response of delta smelt to habitat restoration in the estuary. This review of the revised proposal is being coordinated with IEP and the applicant, who is doing work on the pelagic organism decline, to ensure a seamless transition from the current IEP pelagic organism decline work to the ERP proposal.

Actions:

Support the following actions over the next three years or possibly longer:

1. 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.

2. Support UC Davis delta smelt culture and conservation laboratory.

3. DFG will prioritize and expedite the contracting for the ERP monitoring proposals recommended for funding that are specific to delta smelt issues or its habitat, food resources, or stressors.

Pros & Cons:

Pros: The DRERIP will evaluate previously planned targets, actions and milestones in light of the current state of knowledge and restoration projects implemented to date. The ERP proposes to coordinate the DRERIP effort directly with the IEP POD evaluation of the recent marked decline of Delta pelagic fish and prey resources. The focused year six DRERIP efforts will add value to the POD effort by providing the pertinent species life history and ecosystem conceptual models, and by evaluating currently proposed actions to provide managers with a list of full- and pilot-scale scientifically-based implementation actions determined to have likely population level benefits to pelagic species and other "R" Delta fish.

Many critical uncertainties remain regarding delta smelt biology and ecology as well as about the efficacy of restoration and management actions for sustaining delta smelt. Resolving these uncertainties and incorporating this new knowledge into adaptive restoration and management is critical for saving the species. The DRERIP component will provide additional insight into research needed for reducing uncertainties for these species. In addition,

several proposals recently recommended for CALFED funding would likely significantly contribute to resolving uncertainties. These proposals already underwent rigorous reviews. Some additional Science Program proposals may hold merit.

Cons: In spite of all the information gathered by CALFED agencies and the management actions taken to protect delta smelt, their abundance remains at critically low levels and has declined to its lowest levels in the most recent years. The CALFED agencies and investments have thus been criticized as being ineffective. Without previous CALFED investments and IEP work, there would be many more scientific uncertainties about delta smelt.

Costs:
DRERIP costs will vary depending on actions pursued. Actual costs cannot be determined at this time. There is up to $3 million for the approved ERP monitoring projects.

Timing of Implementation:
The final plan for the DRERIP effort is targeted for completion in December 2006. Monitoring proposals are anticipated to be funded in 2005 with implementation of proposals 2005-2008.
Title of Action: Suisun Marsh Actions

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Under the ERP, the Suisun Marsh Plan is the second of several regional plans intended to refine the existing planning foundation guiding the long-term implementation of the CALFED Ecosystem Restoration Program element. The Suisun Marsh Plan will update the ERP's planning foundation specific to the Suisun Marsh and refine a set of Suisun Marsh-specific restoration actions through preparation of a programmatic EIR/S. The plan will recommend priorities, estimate funding needs, and be completed in fiscal year 2006-2007. The Suisun Marsh Plan will also provide for the tracking, performance evaluation, and adaptive management of ERP actions undertaken in the Suisun Marsh.

The current planning process proposes to enhance managed wetlands and restore tidal wetlands to benefit multiple species including delta smelt.

The Suisun Marsh Plan effort will:

- Complete conceptual models for tidal wetlands, seasonal wetlands, levees and water quality, and sub-tidal aquatic habitat. These models will address MSCS "R" fish and wildlife species and wintering waterfowl as well as ecological processes that support them and their habitats.
- Complete a programmatic EIR/S in support of a preferred implementation of the ERP.
- Identify proposed ERP actions that are directly relevant to MSCS "R" fish. These actions include those addressing contaminants, non-native invasive species, increasing food web production, and habitat restoration.
- Identify cross-cutting issues between proposed ERP and non-ERP actions such as management of the Suisun Marsh levee system that are directly relevant to the management of the Suisun Marsh.
- Integrate continued implementation of the Suisun Marsh Preservation Agreement (SMPA) and regulatory actions such as the U.S. Army Corps of Engineers Regional General Permit #3 and related federal biological opinions with ecosystem restoration in the Suisun Marsh.

SMPA actions have included species-specific actions such as setting aside conservation areas for the salt marsh harvest mouse. The SMPA is now focusing on a multispecies approach to protecting and restoring areas to benefit multiple species including delta smelt. In addition, more than 2,000 acres set aside as conservation areas for the salt marsh harvest mouse, SMPA actions include protecting 300 acres of tidal wetland acquired by SRCD, acquisition and planned restoration of the 70-acre Blacklock project, and tidal restoration of 200-acre Hill Slough West. Other actions that are occurring in the Suisun Marsh include the Montezuma Wetlands Project, which is converting 1,800 acres of managed wetlands to tidal wetlands.

Actions:

Support the following actions over a one- to three-year period with some actions taking possibly longer:

1. Support tidal restoration of the Hill Slough West project, which ERP has funded to develop a restoration plan and complete the

environmental documentation. Site restoration is anticipated to be completed within two years.

2. Restore tidal action to the Blacklock property within the next six months to two years.

3. Complete acquisition of the proposed Meins Landing project and complete its restoration to tidal action within three years.

4. 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.

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

6. Fully fund the Suisun Marsh Plan development and environmental documentation to expedite implementation actions.

7. Conduct monitoring and evaluation of habitat restoration actions and evaluate benefits to delta smelt

Pros & Cons:

Pros: Many critical 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. The multispecies approach of the Suisun Marsh Plan may result in a healthier ecosystem and provide benefits to other species of concern through the proposed actions. The results of these actions would be monitored over time to quantify habitat improvements for delta smelt.

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.

Cons: In spite of all the information gathered by CALFED agencies and the management actions taken to protect delta smelt based on this information delta smelt abundance remains at critically low levels and has declined to its lowest levels in the most recent years. The investment by CALFED in long-term actions has not yet resulted in large scale implementation in Suisun Marsh. Additional investments are needed to complete certain projects to realize the benefits, and those benefits may not be immediately visible in delta smelt numbers.

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 Plan.

In years when delta smelt are less abundant in the Suisun Marsh, fish screens may offer less direct benefits or protection to this species. Data are lacking to support population benefits from diversion screening.

Costs:
Up to $5 million for the currently approved restoration projects and up to an additional $5 million for future restoration projects over the next three years. Funding of restoration projects could be leveraged with available SMPA funds. Additional funding of up to $1.5 million is needed to complete environmental documentation for the Suisun Marsh Plan that would provide for the tracking, performance evaluation, and adaptive management of ERP actions undertaken in the Suisun Marsh.

Timing of Implementation:
The plan will recommend priorities, estimate funding needs, and be completed in fiscal year 2006-2007. Proposals were funded August 2005, review of additional actions occurred in September 2005. Implementation of proposals 2005-2008.

Title of Action: Increase Food Web Productivity

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 may be considered one of the causes for the decline in pelagic fishes, including the delta smelt. Based on a CALFED study, 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 smelt, and lists several tidal marsh and floodplain restoration projects as priorities in its most recent multiyear program plan.

Inundated floodplains and tidal marsh are highly productive ecosystems. However, most of these areas have been reclaimed in the Delta due to levee construction and agriculture during the past 100 years. Enhancing or creating these habitats could greatly increase phytoplankton primary productivity and help create a more robust food web to support pelagic species. Increased production of zooplankton for delta smelt in all life stages is critical to their survival. Increasing the amount of inundated floodplain, tidal wetlands, marsh, and freshwater sloughs may be an effective means to accomplish this.

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

Note, however, that a key goal of this action is to create habitat that will generate high quality phytoplankton for increased food

web and smelt production. Presently, many parts of the Delta are 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 generate high quality species of phytoplankton such as diatoms and certain flagellated algae.

Actions:

Areas within the estuary for consideration should be upstream of or adjacent to delta smelt populations.

1. Enhance freshwater and brackish tidal marsh development in the north Delta, west Delta, Suisun Marsh, and Napa River. The north Delta includes both flooded islands that are undergoing natural conversion to freshwater tidal marsh and off channel areas that are separated from channels. Examples of areas that should be considered include Liberty Island, Little Holland Tract, and the Cosumnes-Mokelumne system. The west Delta represents one of the most important habitats for maturing delta smelt. Examples of areas that could be considered for tidal marsh include Sherman Island, Chipps Island, and Dutch Slough. Suisun Marsh represents a historical area for delta smelt that may provide primary and secondary production for Suisun Bay, a part of the core distribution of smelt. While the Delta and Suisun Bay represent the central portion of the range of delta smelt, the Napa River has also been recognized as a contributor to the population in some wet years. For each of these regions, the suite of actions to enhance the development of productive marsh may include:

   a. Make select breaches in the levees and create channels for water flow. This could increase the area of actively forming marsh considerably as well as increase flood conveyance.

   b. Create channels through and adjacent to tidally inundated marsh.

   c. Restore prime areas to freshwater tidal marsh adjacent to flooded islands.

d. Remove abandoned agricultural infrastructure on previously farmed islands to bring up to appropriate standards as a restoration site.

e. Develop setback levees throughout the Delta consistent with the concepts identified in CALFED's "Levee System Integrity" document. Channel widening in the form of setback levees could create several miles of tidally inundated 'terraces' that could greatly improve primary productivity. This could also result in improved flood control through mproved channel capacity during high flow events.

2. Enhance seasonal floodplain habitat in the north Delta. The north Delta includes substantial areas of seasonal floodplain including Yolo Bypass and Cosumnes River. The suite of actions to enhance the development of productive seasonal floodplain includes:

   a. Manage flooding to increase the area and time of inundation during winter and early spring. The Yolo Bypass presently floods in about 60 percent of water years. 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; for example, agriculture and wildlife area operations. Note that managed seasonal flooding is already conducted in autumn and early winter by private and public landowners to support waterfowl. More 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 in 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 tributaries within the Bypass could create "mini deltas" that could enhance food web production.

Pros & Cons:

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

The marshes in and around areas such as Liberty Island already exist, and only require taking measures to access and expand the desired habitat. Non-flooded areas adjacent to the island are at the elevation where establishment of marshland would occur by simply inundating the area.

In Suisun Marsh, DWR and DFG are planning restoration projects such as Hill Slough West, Blacklock, and Miens Landing. The western Delta's Dutch Slough is also in late planning stages by DFG, DWR, the Coastal Conservancy, and the city of Oakley. On Lower Sherman Island, removal of the remaining levees around the island would provide more shallow-water habitat suitable for food organisms consumed by adult delta smelt, but these food organisms would have to disperse to open water in order to be of benefit to delta smelt.

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 currently 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.

Projects can be phased so as to provide opportunities to monitor the outcomes and assess whether later actions are likely to fulfill expectations.

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 make it into the food chain. Restoration of local habitats may provide increased nutrients, but these nutrients may not be available to local delta smelt.

As adults, delta smelt are located in waters of less than 2 parts per thousand (ppt) salinity as larvae and juveniles, they are found in fresher water. Restoration of more saline habitats (i.e., downstream of the smelt) will not serve to increase productivity of food organisms for delta smelt.

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. 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 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.

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 methyl mercury or increased dissolved organic carbon and could be detrimental to some long-lived fish species. Water rights would be an issue if seasonal floodplain actions require additional water.

Purchasing marshland in areas such as Suisun Marsh is expensive, and would need to be coordinated with duck hunting interests. This would need to be on a willing-seller basis, but there are clubs currently for sale.

Costs:
Varied depending on scope and could range from $5 million-$30 million. Successful implementation depends on adequate funding for capital costs as well as ongoing operation and maintenance costs.

Timing of Implementation:
Napa Salt Ponds will be undergoing restoration this fall, but need funds to monitor effects on smelt and estuarine productivity. If made a priority, some of the other areas in public or private ownership, such as Cosumnes River, Suisun Marsh's Blacklock and Hill Slough projects, and Dutch Sough, could begin implementation within two years. Restoration of sites where planning is less advanced, such as Liberty Island, Little Holland Tract, Suisun Marsh's Meins Landing, and Sherman Island, may take longer. New purchases and restoration in other areas, such as additional Suisun Marsh areas, could take up to 5-10 years.

Title of Action: Reduce Entrainment at Power Plants
Two power-generation plants operate in the range of delta smelt: Contra Costa and Pittsburg generating plants. Mirant Delta LLC energy company owns both of these plants, which they bought from Pacific Gas and Electric (PG&E) in 1999. Mirant Delta LLC was formerly Southern Energy Delta.

As the prior owners, PG&E entered into a Section 2090 Management Authorization (now Section 2081 of the California Fish and Game Code) with DFG in December 1997 to address PG&E's impacts to state-listed species under CESA. PG&E also prepared its last Habitat Conservation Plan in 1998 as a condition of the regular permitting process and to obtain an incidental take permit from the FWS for federally listed species under the ESA. This authorization and permit allow for the take of endangered species, threatened species, and candidate species. Mirant also consulted with FWS and NOAA Fisheries in 2001-2002 through the Corps and a biological opinion was issued by FWS in 2002. The project description of this biological opinion included the construction of a Gunderboom fabric curtain to screen fish from entrainment, as well as tidal marsh restoration. Since that time, Mirant has determined that use of the Gunderboom is infeasible and the FWS has recommended that the Corps reinitiate ESA consultation, since the project description has changed.

The Contra Costa plant is 6 miles east of where the Sacramento and San Joaquin rivers meet. This plant has two operating power generators out of eight total units. The Pittsburg plant is downstream

on the south shore of Suisun Bay in Pittsburg, and has seven power generators. The power generators at each plant use a cooling tower and water diverted from the estuary for condenser cooling. This diverted cooling water creates a thermal plume of warmer water when it is discharged back into the estuary. Potential impacts of power generators to aquatic life fall into two categories – direct and indirect.

Direct impacts to delta smelt, and other fish and aquatic life, result from their entrainment with the cooling water during diversion operations, which may be as high as 1,500 cubic feet per second (cfs) at the Contra Costa plant and 1,600 cfs at the Pittsburg plant. Diversion rates are often significantly lower under normal operation. 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, that is pushed up against the screens.

Indirect impacts result from an increase in water temperature when the warmed, cooling water is released back to 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.

Actions:

1. Complete the White Paper on aquatic impacts of the Pittsburg and Contra Costa power plants being prepared by DWR.

2. Develop better data on fish losses from the Contra Costa and Pittsburg power plants to evaluate potential impacts and develop possible solutions, and examine potential population-level effects to delta smelt.

3. Implement measures to reduce direct and indirect impacts to delta smelt at Contra Costa and Pittsburg power plants, such as:

    a. Integrate delta smelt into the resource management program to reduce striped bass entrainment loss. Power generation units are operated preferentially based on fish monitoring data from May to mid-July, the period of peak striped bass entrainment.

b. Use better fish exclusion devices, such as positive fish barriers, at both plants to reduce entrainment.

Pros and Cons:

Pros: Some of these actions may be fairly feasible given that similar programs for monitoring and entrainment reduction appear to be in place for other species, and the apparent support for environmental stewardship by the current power plant owners. Mirant's corporate policies include an Environmental Policy that defines its commitment to environmental stewardship. Many of its environmental stewardship projects are accomplished through partnerships with local non-profit groups and conservation groups. Mirant's Lovett generating plant in New York uses innovative Gunderboom technology to prevent fish eggs, larvae, and other aquatic life from entering into the cooling water or industrial intake structures. Mirant's Chalk Point Generating Plant in Maryland includes in its numerous wildlife and fishery programs, an aquaculture program that has been raising 150 Atlantic sturgeon for the Maryland Department of Natural Resources for a dozen years. DFG has authority to require mitigation actions at the power plants through the Section 2081 Memorandum of Understanding.

Cons: More investigation is needed of the feasibility of additional measures to reduce power plant entrainment and other potential impacts. State or federal actions to reduce effects of these power plants on endangered species could include "take" actions under ESA or unreasonable diversions under SWRCB water right authority.

Costs:

Contingent upon the types of measures implemented. EPA estimates average costs for Gunderbooms at $7 million for capital costs for a simple floating Gunderboom structure to handle 347,000 gallons per minute, or about 775 cfs (www.epa.gov/waterscience/316b/technical/ch2.pdf). Average operations and maintenance costs for this size structure are estimated at $600,000 annually. Actual costs for the Mirant locations have not yet been determined.

Timing of Implementation:

An evaluation of the role of power plant water intakes as a stressor for smelt and other pelagic organisms will be completed by

December 2005. Actions that may be a change to a program may be done quickly. Other actions that require more investigation and development would take longer.

Environmental Water Account (EWA)

The EWA is designed to provide water to address CALFED's fish protection and restoration-recovery needs. The EWA provides protection for at-risk species of fish and helps to avoid reaching the ESA Section 7 reconsultation level of take for listed species by reducing export pumping during periods of peak abundance of these species in the Delta. It is also designed to enhance the predictability of CVP and SWP operations and improve the confidence in and reliability of water allocation forecasts. EWA resources and operational flexibility are used as both a fish management tool to improve the passage and survival of at-risk fish in the Delta and to reduce pumping when fish are vulnerable to entrainment at the CVP and SWP Delta pumps.

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

Title of Action: Modified EWA

The EWA described in the CALFED Record of Decision (ROD) is a four-year program, which the EWA agencies have been doing since water year 2001 and have extended it through 2007. However, the EWA agencies believe a long-term EWA is critical to meet increased water supply reliability to water users, while assuring the availability of enough water to meet fish protection-recovery needs.

EWA acquires water from willing sellers both upstream of the Delta and in the export service area to offset pumping curtailments to benefit at-risk fish. Prior to reaching the level of impact for listed species that necessitates formal reconsultation, the Project Agencies' and Management Agencies' staff discuss the extent of the take, the relative abundance and distribution of the particular species of concern, and any relevant information on in-stream and Delta conditions. Water acquired upstream of the Delta is less costly than water from the export service area, and is transferred through the Delta primarily from July to September. These transfers use the 500 cfs capacity allocated to EWA at the Banks Pumping Plant during the summer, and can use any added capacity that is not used by the projects. The IEP work plan includes the evaluation of a hypothesis that stressor effects have increased during the summer relative to historical data, and includes the task of analyzing recent changes in Delta water operations to better understand their effect on Delta hydrology and pelagic fish abundance (see Export Operational Changes).

The effects of EWA actions on the populations of at risk species needs to be better understood. The EWA agencies have taken 1.4 million acre-feet of fish actions, mostly targeted at delta smelt, at a cost of $166 million with no apparent effect on delta smelt abundance. Other factors beyond SWP and CVP export pumping may be having an effect on delta smelt, which appear to be making EWA fish actions less effective than anticipated. Better estimates of the effects of EWA actions on population levels of fish are needed.

Actions:

A careful analysis of the impact on the fish species that are the focus of the EWA would be required before substantial changes

are made in operation of the EWA Program.

1. Develop estimates of delta smelt population levels.

2. Develop models to understand the effects of past and future EWA actions on populations of at risk fish species.

3. Evaluate alternative EWA actions taken earlier in the year to protect juvenile delta smelt.

4. Evaluate delta smelt recommendations from the EWA Technical Review Panel that may be presented at the EWA workshop in December 2005.

5. Expedite the IEP analysis of recent changes in Delta water operations, independently review results, and quickly publish results and recommended changes in Delta operations.

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

   a. Decrease purchases upstream of the Delta and increase water stored south of the Delta.

   b. Develop EWA storage in the export service area, that is, south of the Delta, to increase the ability to transfer and store EWA water in wet years.

Pros and Cons:

Pros: The EWA has provided a flexible way to increase water for the environment. The EWA may have the potential to extend some of these benefits to the pelagic species when the declines are better understood. Population models for delta smelt are being developed as part of the CALFED Science Program.

Cons: Costs could be high depending on the types and costs of water acquisition and conveyance and storage facilities modifications. Current conveyance and storage options and funding may limit the size and efficacy of the EWA. Changes in EWA purchasing patterns would significantly increase program

costs, increase demands for water transfers in the export service area, affect water market costs, and increase the pumping of groundwater in the San Joaquin Valley. More new or expanded storage facilities would have cost and environmental issues that would need to be addressed.

Costs:
Future costs are unknown at this time. Historically, costs for the EWA program have ranged from $20 million to $64 million annually.

Timing of Implementation:
2006 and beyond, depending on what actions are identified as effective, and contingent upon available funding.

Title of Action: EWA Decision-Making for Delta Smelt Export Curtailments

Members of the California Water Policy Council and the California Federal Ecosystem Directorate signed a Framework Agreement in 1994 that initiated the CALFED Bay-Delta Program. The participants were committed to, among other things, a process for coordinating CVP and SWP operations with endangered species, water quality, and Central Valley Project Improvement Act (CVPIA) requirements. The CALFED Operations (Ops) Group was created to facilitate this coordination, and was given additional emphasis with the signing of the Bay-Delta Principles for Agreement later in 1994. The CALFED Ops Group is an open stakeholder group that meets monthly to review the adjustments made in export levels to minimize endangered species take or to improve fishery conditions in general; operation of the Delta Cross Channel; and changes in the point of diversion to improve fishery conditions or make up losses to water supply caused by previous operational changes. The objective is to make positive changes in operations with no net loss of water supply (see Export Operational Changes).

Under the CALFED Ops Group process, there is a hierarchy of groups that work to reach consensus at a technical level. The Data Assessment Team (DAT) is a CALFED Ops technical sub-group that analyzes real-time Delta fish monitoring, water quality, and flow data in the context of existing fish protection and project

operations. DAT is composed of federal and state agency and stakeholder biologists and SWP and CVP operators, which meet weekly from October through June, and otherwise as needed. Field offices summarize and transmit data to the DAT e-mail reflector, or to a DWR repository for further summarization, in time for distribution for the weekly meeting.

The purpose of the DAT is to make technical level recommendations if necessary to change project operations, to protect fish and to estimate the resulting costs to water supply. Other CALFED Ops sub-groups coordinate closely with DAT, including the Operations and Fisheries Forum and Delta Smelt Working Group (DWSG). Many of these group's participants are also DAT participants. The DAT forwards pertinent information and any recommended operational changes to the WOMT.

WOMT is composed of operations and management representatives of the water project and fishery agencies (DWR, Reclamation, DFG, USFWS and NOAA Fisheries). It is a management team developed to make rapid management decisions on fish, water quality and water supply protection issues. WOMT convenes weekly and otherwise as needed. The WOMT management participants use the real time knowledge of environmental and operational conditions to make rapid decisions related to changes to water project operations in order to address fishery issues in the Delta. If they cannot agree on a course of action, the issue is elevated to the agency Directors to resolve. There are several areas in the process where improvements could be made:

- The agencies have encountered staff limitations that preclude processing and distribution of data. As a result, data that DAT receives may not be current to that day, and some decisions require the most current data before making a decision. This can cause a delay in the development of recommendations.
- Immediate export reductions can adversely affect power scheduling causing agencies to defer implementation of an export reduction to avoid extreme costs.
- If WOMT is unable to reach consensus, the issue is elevated to a higher management level. This occurs rarely, but can delay important actions.

Actions:

The delay between the collection of field data and the resulting export reductions based on this data may take up to five to seven days. During this time, delta smelt may move farther into the south Delta where survival, even if not entrained, can be poor. Actions need to be taken quickly during critical times in order to reduce the movement of delta smelt into the south Delta. This could be done in the following ways:

1. Update information for the DAT calls every Monday so that the DAT group has the most current information for its Tuesday meetings. This may require more staff.

2. Convene the DAT more frequently than once a week during critical times and be prepared to convene a WOMT meeting/ conference call if conditions warrant. This currently can and does occur, but should be planned regularly and in advance.

3. If the DAT and WOMT recommendations are made and Executive level concurrence occurs immediately, a decision could be made on whether the situation warrants quicker implementation, with consideration of estimated costs for a three-hour, one-day, and two-day implementation schedule.

Pros and Cons:

Pros: Actions taken quickly during critical times may reduce the movement of delta smelt into the south Delta, reducing the direct and indirect effects to at-risk fish. Analysis of project operations and costs may yield information on specific operational changes that would reduce these impacts.

Cons: This action could have a significant fiscal impact. It will be essential to have results about the movement of delta smelt into the south Delta before significant economic costs are incurred.

Costs:

The additional cost for moving from the current three-day implementation to a three-hour implementation will vary greatly. The short-term power market is driven by weather, gas supplies, and a number of other factors. For example, during February 2005, if export curtailments were implemented in three hours it

would have resulted in an incremental increase of $100,000 to $150,000 to EWA. However, if it were implemented the previous week, there may not have been a significant incremental increase in the cost to EWA. Therefore, there should be a greater emphasis on providing optimum fish protection while minimizing the incremental increase in costs to the EWA by the project operators. Costs for a one- or two-day implementation schedule would be less than that described for the three-hour implementation.

Timing of Implementation:
Evaluate changes to the decision-making process for export curtailments prior to 2006.

Conveyance Actions

Californians have struggled for 50 years to achieve consensus on the best way to convey water across the Delta. Original planning for the State Water Project in the 1950s included a peripheral canal, but this component of the project had lower priority than the reservoir at Oroville and the California Aqueduct and was not built. An environmental impact report on the peripheral canal was prepared in the 1970s and initial planning was done. In 1982, California voters rejected the peripheral canal, due to concern about cost of the aqueduct and its potential environmental impacts. In the 1990s, CALFED reconsidered options for Delta conveyance.

Title of Action: Conveyance Modifications
The CALFED programmatic EIR/S analyzed three alternatives for conveyance: use of existing Delta channels with minor modifications, use of existing channels with more significant modifications, and Delta channel modification combined with an isolated (peripheral) conveyance facility. The CALFED preferred alternative included conveyance through the existing Delta configuration, with some modifications. However, there was significant uncertainty over the ability to meet CALFED objectives with through-Delta conveyance. The CALFED decision included a commitment to assess in 2007 whether through-Delta conveyance was meeting CALFED objectives. CALFED agencies included a list of 10 assurances that would need to accompany any future isolated conveyance.

Although the 2007 assessment is still two years off, it appears that CALFED will fall short of several program objectives that could be affected by the method of Delta conveyance. Funding for water quality has been far less than expected, limiting progress in this area. Work by the CALFED Independent Science Board suggests that a levee program that is adequately funded to achieve CALFED objectives might still leave the Delta vulnerable to catastrophic flooding as a result of earthquakes or global climate change. Now, delta smelt and other pelagic organisms are experiencing marked decline instead of recovery.

All of these factors must be considered in any future examination of Delta conveyance. It is likely that any change in the CALFED conveyance approach would depend on significant evidence and public consensus that a change would lead to improvements in meeting several objectives. Further, any change in approach would need to be accompanied by very strong assurances such as those proposed by CALFED in 2000.

Therefore, any decision to change Delta conveyance in order to reduce the hydrologic effect of project operations on the interior Delta is several years away, and would likely be made on the basis of several factors, not just delta smelt protection. If Californians agree to change Delta conveyance, it would require another decade or more to complete the planning and permitting and to make the change.

Action:

1. Support a public CALFED assessment of current approaches to management of the Delta, as called for in the CALFED ROD.

Pros and Cons:

Pros: A change in Delta conveyance from through-Delta to a peripheral canal could reduce the hydrologic effect of project operations on the interior Delta, and move project intakes to near the edge of delta smelt range on the Sacramento River. This could minimize fish losses at diversion points, increase river residence times, and increase food web productivity.

Cons: Isolated conveyance was rejected by California voters in 1982 and by CALFED in 2000. Any decision to change Delta conveyance would likely be made based on several factors, not just delta smelt protection. Implementation would take more than a decade.

Costs:
Impossible to estimate costs without defining the project, but it would likely be in the billions of dollars.

Timing of Implementation:
Any recommendation to change Delta conveyance would likely be made as part of Stage 1 of the CALFED process that ends in 2007.. In addition, AB 1200 which was recently passed by the legislature and signed by the Governor calls for the development of a long-term vision for the Delta by January 1, 2008. Implementation will take at least another decade.

Title of Action: Modified Barrier Installation at Head of Old River

DWR installs temporary barriers seasonally at several locations in the south Delta. Three of these barriers are installed in order to maintain water levels and circulation in south Delta channels to facilitate irrigation diversions. These barriers are located in Old River at Tracy, Middle River, and Grant Line Canal. A fourth barrier is installed to protect San Joaquin River fall-run Chinook salmon and steelhead. This barrier is installed at the Head of Old River (HOR) where Old River branches from the San Joaquin River. The barrier is installed in the fall to improve dissolved oxygen in the San Joaquin River to benefit returning adult spawners. All of these temporary barriers are constructed from loose rock and do not offer the flexibility that would be available when DWR constructs permanent operable gates through SDIP in place of temporary barriers. Environmental review of SDIP will begin with the release of a Draft EIR/S in October this year. Construction of operable gates could be completed by 2009.

In addition, Reclamation installs the HOR barrier each spring as required under the federal Central Valley Project Improvement Act (Section 3406 (b)(15) to keep outmigrating salmon smolts in the

San Joaquin River and away from the SWP and CVP pumping plants.. The spring HOR barrier is a component of the Vernalis Adaptive Management Plan (VAMP), a multiyear spring experiment to assess the effect of SWP and CVP project operations on San Joaquin salmon. The VAMP is a core action of the San Joaquin River Agreement between Resources Agency, DWR, DFG, U.S. Department of Interior, Reclamation, FWS, and many water interests on the San Joaquin River and entities dependent upon Delta exports. In addition, the SWRCB has accepted the VAMP as a key element in providing environmental benefits in the lower San Joaquin River and Delta equivalent to the San Joaquin River Portion of the 1995 Water Quality Control Plan. In addition to the HOR barrier, the VAMP includes a month-long pulse of high flow on the San Joaquin River and reductions in the level of pumping at the SWP and CVP pumping plants in the south Delta.

The spring HOR barrier restricts the amount of San Joaquin River flow entering the south Delta and causes proportionately more water to be drawn from the central Delta toward the south Delta and the SWP and CVP pumping plants. Delta smelt are often present in the central Delta in the spring when the HOR barrier is in place. These fish can be drawn to the south Delta by this hydraulic effect. Delta smelt in the south Delta are more vulnerable to the direct effects of the pumps.

Actions:

1. Evaluate whether the HOR barrier should be installed in the spring in the years before operable gates are installed. If the barrier is not installed, water from the San Joaquin River would flow down Old River toward the water project pumps instead of flowing northward. This would reduce the proportion of water drawn towards the pumps from the central Delta and potentially reduce project effects on delta smelt.

2. Install operable gates under SDIP to allow for more flexible operation than the current use of temporary barriers.

Pros and Cons:

Pros: This action would provide greater protection to young delta smelt in the central Delta and reduce the hydraulic effect of project pumping on these fish in the central Delta.

Cons: The absence of a HOR barrier in the spring could have a significant effect on San Joaquin River salmon, and would face legal and institutional hurdles. This action could draw more salmon smolts toward the pumps and increase entrainment of these fish. Although the pulse flow and export reductions of VAMP could still be implemented, failure to install the HOR barrier would be a significant change in the experimental design of the VAMP. In addition, the population benefits to delta smelt of this proposed change in flow patterns should be evaluated with better population models of delta smelt.

Costs:
If the temporary spring barrier is not installed, it would result in a cost savings of about $2 million annually from 2006 through 2009.

Timing of Implementation:
Evaluate whether the HOR barrier should be installed in spring 2006 through 2009. Construction of operable gates is expected to be completed by 2009. Costs for permanent barriers, $75 million.

CALFED Science Program Actions

A key goal of the CALFED Science Program is to establish a body of knowledge relevant to CALFED actions and their implications that is unbiased, relevant, authoritative, integrated across program elements, and communicated to the scientific community, CALFED agency managers, stakeholders, and the public. By integrating world-class science and peer review into every aspect of the Bay-Delta Program, CALFED is developing the best scientific information possible to guide decisions and evaluate actions that are critical to its success. The Science Program is seeking to invest in projects that develop new knowledge about how water use and management activities interact with and affect key aquatic species and environmental processes across spatial and temporal scales (http://science.calwater.ca.gov/).

Title of Action: Science Program Proposals

Recently, the ERP and the CALFED Science Program solicited monitoring and research proposals, respectively. Some of these proposals were relevant to delta smelt. These include proposals specifically about delta smelt biology and management, as well as proposals related to delta smelt food resources, habitat, and stressors. The proposals underwent rigorous scientific and agency reviews and many received high ratings. Since the POD had been discovered and publicized during this time, the reviewers also gave consideration to the usefulness of each project in understanding or reversing the POD.

The Science Program proposals recommended for funding include several related to delta smelt, including one on modeling the delta smelt population and another on their food sources. The development of a comprehensive delta smelt model that integrates the effects of various stressors on delta smelt life stages is essential. Due to new funding constraints within the CALFED Science Program, the amount of funding initially appropriated for this recent proposal solicitation has been significantly reduced, and it may be worthwhile to reconsider unfunded or partially funded proposals that have potential in understanding or reversing the POD. Some of these proposed projects may be suitable for funding as directed actions after modification to eliminate shortcomings identified by selection panels.

Actions:

Support the following actions over three years or possibly longer:

1. The CALFED Science Program will prioritize and expedite the contracting for the research proposals recommended for funding that are specific to delta smelt issues or its habitat, food resources, or stressors.

2. As part of the POD 2006 work plan development, the POD work team will review the unfunded Science Program proposals for any that could be improved and funded as directed actions.

Pros and Cons:

Pros: Many critical uncertainties remain regarding delta smelt biology and ecology as well as about the efficacy of restoration

and management actions for sustaining delta smelt. Resolving these uncertainties and incorporating this new knowledge into adaptive restoration and management is critical for saving the species. Several proposals recently recommended for CALFED funding could significantly contribute to resolving uncertainties. These proposals already underwent rigorous reviews. Some additional proposals may hold merit.

Cons: In spite of all the information gathered by CALFED agencies and the management actions taken to protect delta smelt based on such information as Environmental Water Account actions, delta smelt abundance remains at critically low levels and has declined to its lowest levels in the most recent years. The CALFED agencies and investments have thus been criticized as being ineffective. Without previous CALFED investments and IEP work, there would be many more scientific uncertainties about delta smelt.

Costs:
Up to $2.2 million for the approved research projects. Up to $8 million more for research projects over the next three years, if additional funds become available or after modification to eliminate shortcomings identified by selection panels.

Timing of Implementation:
Research proposals are anticipated to be funded in 2005 with implementation of proposals in 2005-2008.

Interagency Ecological Program (IEP) Actions

The IEP is a multiagency effort that has conducted cooperative ecological investigations in the Bay-Delta estuary since 1970. A primary purpose of the IEP is to monitor baseline conditions and assess ecological impacts of the SWP and the CVP. Monitoring conducted by the IEP is a requirement of the projects' water right permits from the State Water Resources Control Board (SWRCB). In addition to monitoring, the IEP conducts special studies to increase understanding of ecological processes and species life histories in the Bay-Delta. The IEP has a long history of monitoring and studying delta smelt. A comprehensive review of ongoing and historical IEP delta smelt work is under way.

Title of Action: IEP POD Study Plan

Scientists from several IEP agencies have developed a plan to investigate the recent dramatic declines in delta smelt and other pelagic organisms in the Delta. This "2005 Pelagic Organism Declines (POD) workplan" builds and expands on previous and ongoing IEP work. Sufficient funding and agency support for IEP delta smelt monitoring and special studies, including a continuation of the 2005 POD work, are essential for tracking and evaluating the effects of management and for gaining a better understanding of the causes of the observed delta smelt declines. Further actions are expected based on the results of the POD investigations.

Actions:

Fund more studies and monitoring identified by IEP that will improve understanding of the delta smelt population dynamics and the recent decline. These include current, enhanced, and new actions.

Current actions (up to and including 2005 and beyond):

1. Long-term IEP monitoring of the distribution and abundance of delta smelt juveniles and adults in their natural range. Data is collected in 12 ongoing fish surveys conducted by DFG, FWS, UCD, DWR, and Reclamation.

2. Review of IEP delta smelt program elements. This review is intended to examine the scientific soundness and usefulness of IEP delta smelt work. It is conducted by IEP staff under FWS leadership and will also involve independent review by the IEP Science Advisory Group (SAG).

3. IEP special studies related to delta smelt, including South Delta, fish facilities, and ecological processes. These studies are conducted by scientists from several agencies and universities and provide important information about the factors and processes driving delta smelt abundance and distribution.

Enhanced current actions (POD 2005 and beyond):

1. In the 2005 POD work plan, three of the established fish surveys are expanded to include monitoring of more variables or an expanded geographical range. If proven useful, this expanded monitoring should be continued.

2. In 2005, ongoing IEP delta smelt special studies were complemented by several more studies described in the POD work plan.

New actions (2006 and beyond):

1. Larval delta smelt monitoring. This should become a new routine IEP fish survey. A pilot survey was successfully conducted by DFG in early 2005. The distribution and abundance of larval delta smelt is a critical scientific uncertainty.

2. New (2006+) POD studies, possibly other new IEP special studies – by directed action or solicited via proposals.

3. More monitoring and analysis equipment would be needed. Improved maintenance for IEP and other interagency delta smelt monitoring and research equipment is also needed. Delta smelt and other Delta monitoring and studies depend on an appropriate and well-maintained fleet of research vessels. IEP urgently needs more consistent funding and contracts for vessel maintenance and for purchasing another mid-sized boat. Also in the next five years, one of its aging larger research vessels will likely have to be replaced.

As described in the 2005 POD work plan, the IEP has formed a separate POD Project Work Team (POD PWT) made up of both agency scientists and stakeholders who want to help the POD study. The water community is bringing expertise and resources to help advance the science in specific areas of the collaborative POD. Independent scientific peer review of the POD study is coordinated by the CALFED Science Program. A POD Management Team (POD MT) of agency scientists meets weekly to assure progress and provide the agency deputy directors with weekly updates on the POD data and information as it becomes available. Data and information gathered by the POD study will be used to develop information to assist the agencies in taking appropriate management actions to address this recent decline in pelagic organisms.

Pros and Cons:

Pros: The IEP has a proven track record of successful monitoring and special studies related to delta smelt. Delta smelt data and

information collected by the IEP is used regularly for making decisions about water project operations and the federal and state listing of delta smelt. Most of the understanding about the biology and ecology of delta smelt is based on IEP monitoring and study. The ongoing delta smelt review may yield recommendations for improving IEP delta smelt work. If adequate funding is provided, IEP delta smelt work is likely to keep yielding highly relevant, high-quality results.

Cons: In spite of all the information gathered by the IEP and the management actions based on this information, delta smelt abundance remains at critically low levels and has declined to its lowest levels in recent years. IEP scientists are unable to pinpoint the causes for the most recent declines based on existing information. It could thus be argued that IEP delta smelt work is not exhaustive enough., The 2005 IEP POD work plan, the 2005 IEP delta smelt review, the new IEP larval delta smelt monitoring, and more work planned for 2006 and beyond are all intended to specifically address program weaknesses and fill existing knowledge gaps. However, causes may be difficult to determine because the system continues to change, due to the introduction of invasive species and new pesticides,.

Costs:
The 2005 IEP baseline budget is about $13.5 million. Addition of the POD work increased the budget to $15.2 million. Some estimates place the costs of future POD work at $5 million more over baseline, which would bring the annual costs to $20million.

Timing of Implementation: _
Immediate/Ongoing; 24 studies and monitoring programs now under way.

Water Agency Actions

DWR and Reclamation are taking several specific actions related to state and federal water projects. Currently, the water agencies are evaluating changes in export operations. In addition, DWR and Reclamation are providing the initial funding for the POD account.

Title of Action: Export Operational Changes

Water management in the watershed of the Bay-Delta system has a profound effect on the hydrology of the estuary. Upstream diversions for consumptive use reduce inflow to the system, flood control reservoirs reduce peak flows and alter the timing of inflows, and water systems supplying Bay Area communities remove water from the system far upstream of the estuary. Operation of the CVP and SWP are of particular concern because of the magnitude of the projects' diversions – they are the first and second largest diverters from the Bay-Delta system – and because the location of the diversions in the south Delta causes unique and pronounced effects on the upper estuary.

Simply, the projects operate by capturing high flows in the Delta or in upstream reservoirs and releasing water from upstream reservoirs such as Shasta, Folsom, and Oroville and pumping it from the south Delta to customers in the South Bay, San Joaquin Valley, and Southern California. Project operations shift some Bay-Delta inflow from winter and spring when it would occur naturally to other times when the water can be pumped. Delta flows are most influenced by tidal action that changes direction four times daily. This tidal action affects the dispersion of fish in the Delta. However, water project operations can affect daily net flows. Project operations shift net flow patterns in the estuary from a generally east-to-west net flow to a pattern that also includes significant north-to-south net flow. Summer reservoir releases and Delta pumping also reduce the residence time of water in the estuary.

Generally, project operations have direct and indirect effects on Bay-Delta fish. Direct effects occur when fish are entrained, that is, removed from the Delta along with exported water. Direct effects are hard to quantify because of concerns with sampling protocol and the inability to estimate pre-screen mortality. Tiny larval fish are more difficult to detect than larger fish so estimates of direct effects on larval life stages may be low. Indirect effects on fish may

be caused by changes in the quantity and timing of flow, reduced residence time, and the tendency for fish to be diverted into the interior Delta at Reclamation's Delta Cross Channel and through natural channels, such as Georgiana Slough, where they may be more prone to predation or other stressors. Indirect effects are acknowledged, but much more difficult to quantify than direct effects.

The CVP and SWP pumping impacts are minimized or mitigated by several regulatory or institutional mechanisms. The SWRCB imposes Delta standards that prescribe minimum outflows, export-inflow ratios, and maximum salinities. All of these criteria are met by regulating upstream releases and project pumping rates. Delta standards imposed by SWRCB at the beginning of the CALFED era in 1995 are significantly more protective than previous standards. Biological opinions issued by the FWS and NOAA Fisheries prescribe maximum allowable take of endangered or threatened species. The SWP further mitigates direct project effects to salmon, steelhead, and striped bass through the Delta Pumping Plant Fish Protection – Four Pumps – Agreement with DFG. Mitigation measures often benefit other species as well.

Export operations have changed in two ways over the past few years that could have contributed to the pelagic organism decline. Total combined CVP and SWP exports have been slightly higher than they were in the 1980s. Also, there has been a shift in timing of exports from spring to more pumping in the summer and fall, in the belief that this would have less impact on Delta fish species. The IEP work plan includes an evaluation of the hypothesis that stressor effects have increased during the summer relative to historical data, and includes the task of analyzing recent changes in Delta water operations to better understand their effect on Delta hydrology and pelagic fish abundance.

Actions:

Actions to protect and restore delta smelt and other pelagic organisms include:

1. Expedite the IEP analysis of recent changes in Delta water operations and particle tracking modeling; independently review and publish results. Recommend changes in Delta

operations quickly that could benefit pelagic fish.

2. Based on the IEP analysis, reduce or change exports during summer and fall or at other times to protect pelagic fish abundance.

If changes in Delta export volume or timing are recommended, some strategies may be available to minimize economic impact. The Environmental Water Account, along with actions required under 3406(b)(1)(A) of the CVPIA should be among the first tools considered to alter project operations. The EWA may need increased funding and other assets to accomplish this (see section on EWA Modifications). In the longer term, more storage or modified Delta conveyance may be useful tools to minimize project impacts on pelagic organisms or reduce the hydrologic effect of the projects on the interior Delta (see section on Conveyance Modifications). Also, regulatory actions could be taken to require changes in exports.

Pros & Cons:

Pros: Project operations have direct and indirect effects on aquatic life in the system. Analysis of project operations may yield information on specific operational changes that would reduce these impacts.

Cons: This action could have a significant economic impact. There is no data to support possible actions. It will be essential to have results and guidance from the IEP work plan before significant economic costs are incurred.

Costs:

Contingent on the type of operational changes pursued. Actual costs cannot be determined at this time.

Timing of Implementation:

Physical implementation could be done quickly on an experimental basis once the needed actions are known, perhaps in 2006. However, institutional mechanisms to direct the action, such as a SWRCB order or FWS reconsultation on the biological opinion for delta smelt, would involve long processes.

Title of Action: Pelagic Organisms Decline Account

In a July 8, 2005, letter to DFG Director Ryan Broddrick, DWR Director Lester Snow proposed expanding the scope of the Delta Pumping Plant Fish Protection (Four Pumps) Agreement to establish a separate fund to quickly address near-term pelagic fish issues related to the POD, including declining abundance of delta smelt. These funds could be accounted for under the Four Pumps Agreement on terms to be negotiated between DWR and DFG. These negotiations have not yet occurred. The funds would be reserved for special studies related to factors possibly affecting pelagic fish populations, including delta smelt, and for enhancement and restoration of these species.

Actions:

1. Establish the Pelagic Organism Decline Account.

2. Negotiate terms between DWR and DFG to account for these funds.

Pros and Cons:

Pros: The funding is immediately available from State Water Project funds. The Four Pumps Agreement has been in place for almost 20 years and has proven to be a successful mechanism to mitigate direct impacts of SWP pumping at the H.O. Banks Delta Pumping Plant for the three species covered under the agreement. The SWP could take mitigation credit for funding these actions to protect and enhance delta smelt.

Cons: Negotiations between DWR and DFG have not yet occurred concerning delta smelt and the POD Account. Some sport fishing organizations have indicated that the Four Pumps Agreement has not gone far enough to mitigate direct and indirect fisheries impacts to the Bay-Delta system from operation of the Banks Delta Pumping Plant. There is a high possibility that these groups may continue to press this opinion despite the efforts within this plan, particularly if sport fish are not directly addressed in actions resulting from this funding.

Costs:

The initial annual budget for the POD Account is $2.5 million of SWP funds. Additional funds from other sources will be needed.

Timing of Implementation:
Account established and funded July 2005. Substantial additional funding will be needed to implement many of the actions in this plan.

Regulatory Agency Actions

Some types of actions are part of or related to CALFED and IEP efforts, but are primarily more regulatory in nature and need to be considered outside of these programs. Contaminants management and the control of invasive species are two of these types of actions.

Title of Action: Contaminants Management
The IEP POD investigations are focusing on two areas based on recent changes in pesticide use. The focus is on:

1) The expanded use of pyrethroids in agriculture and urban pest management, 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.

2) The use of aquatic herbicides in the Delta to control invasive weed problems.

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 agriculture to urban, issues of storm water runoff and treated wastewater will continue to grow in the Delta watershed.

Actions:

1. Clean Water Act Enforcement – U.S. Environmental Protection Agency (EPA) and the California Environmental Protection Agency have a primary role in the enforcement of limiting pollution discharge. If pyrethroids or other contaminants were found to contribute to the decline in pelagic organisms or components of the food chain, then these agencies would take immediate and appropriate regulatory actions to reverse these effects. Other mechanisms available to the regulatory agencies include:

   a. 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.

   b. Best Management Practices (BMPs) for runoff – Develop and require on-site cultural practices (the methods and techniques of farming a particular crop) to reduce transport of pesticides 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, Department of Pesticide Regulation, DFG, Department of Food and Agriculture, and the Central Valley Regional Water Quality Control Board are funding work to develop BMPs for pesticides, as well as other protection measures for aquatic organisms. It could also include looking at application methods to minimize transport.

   c. Pesticide shift, BMPs - Identify alternative pesticides that might substitute for pyrethroids. Also, apply Integrated Pest Management to reduce pesticide use.

2. Aquatic herbicides – Invasive weeds have created many problems in the Delta. The presence of macrophytes may be contributing their own negative effect on fish by choking waterways and reducing dissolved oxygen.

3. Pesticide shift, BMPs - If aquatic herbicides are linked to the decline, then alternative methods, such as mechanical removal, alternative compounds, or timing of applications to avoid sensitive periods, should be encouraged.

Additional Actions:
Regardless of the results of the 2005 POD studies, the following actions could be taken:

1. 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. Coordinate with other agencies to identify and rank this work.

2. Direct IEP to continue support for the Contaminants Project Work Team, established under the POD work plan. Provide an additional component of funding to IEP to fund studies that link the research and regulation of contaminants directly with IEP programs related to biotoxicity. Assign a Senior Central Valley Regional Water Quality Control Board staff person acceptable to the IEP to lead the Contaminants Project Work Team as a full-time assignment.

Pros and Cons:
Pros: If the decline is linked to the contaminants these actions could be started immediately and have a direct and beneficial effect on pelagic organisms. This 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 would be resistance from the agricultural community and the pesticide manufacturers due to loss of productivity or potential loss in net income.

Costs:
Exact costs for these studies under Additional Actions are not known. However, costs are estimated to be about $200,000 to $500,000 for 2006, and likely more as the program develops.

Timing of Implementation:
IEP studies completed fall 2005, summer 2006. Recommended actions in 2006 with some actions implemented immediately and others to follow.

Title of Action: Control of Invasive Species

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.

Many of the large game fish already introduced to the system can prey on larval or adult smelt. Other species such as the northern pike (Esox Lucius) introduced into Lake Davis could further impact the system if it becomes established in the Delta. Northern pike are near shore predators that prefer areas containing submerged aquatic vegetation (Craig 1996). Other fish species (both native and introduced) using these vegetated areas for cover, rearing and feeding may be impacted by predation and competition for food. Delta smelt, which use more open water areas as adults, may be impacted by predation at this stage, but to a lesser extent. Introduced pelagic fish species such as the inland silverside (Menidia beryllina) may be contributing to the delta smelt decline through predation on delta smelt eggs or larvae and competition for food such as copepod prey (Bennett and Moyle 1996). Filter feeders such as Potamocorbula amurensis compete with smelt for food, efficiently removing plankton from the water column. The introduced copepod Limnoithona tetraspina is poor prey for smelt, and it preys on other copepods. Introduced aquatic plants such as Egeria densa and water hyacinth (Eichhornia crassipes) can choke Delta channels and completely exclude native floating and submerged vegetation, shade out habitat, change water temperature, and deplete dissolved oxygen. These dense mats of vegetation also provide cover for predators.

For marine and estuarine environments, the ballast water of ships is considered one of the major ways that foreign species are transported and spread. The 1999 Ballast Water Management for Control of Non-indigenous Species (NIS) Act (Assembly Bill 703) charged the California State Lands Commission (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.

Another significant potential pathway for introduction of invasive species is recreational boats. The California Department of Food and Agriculture operates agricultural inspection stations at major points of entry into California. One potentially devastating invasive species that has been detected attached to trailered boats at the inspection stations 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 and space. 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. Adequate staffing and vigilance at agricultural inspection stations is essential to keeping this invasive species out of California, where it could cause ecological and economic disaster.

Other responsibilities related to invasive species are distributed among departments in the Resources Agency and other agencies including CalEPA. Many departments play active roles, but there has not been sufficient coordination to ensure adequate efforts related to prevention, detection, control, and education.

Actions:

1. Empower the existing CALFED Non-Native Invasive Species Advisory Committee (NISAC) by finalizing a Memorandum of Understanding among participating agencies, identifying appropriate decision makers for the Committee, and providing staffing.

2. Develop an aquatic nuisance species plan for the state, ensure that comprehensive invasive species programs are in place;

recommend more actions; and coordinate with other agencies that have invasive species responsibilities.

3. Support low-cost solutions to prevent invasive species from entering the state, such as staffing agricultural inspection stations. Higher-cost control and eradication programs will not be needed if species that are potentially invasive are kept out of the state.

4. Support 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.

5. Adopt mandatory performance standards for ballast water treatment technologies. CSLC will be incorporating recommendations into a report due to the Legislature in January 2006.

6. 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.

7. Support 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.

8. Support public outreach and education to increase stakeholder awareness of invasive species and their role in preventing new species from entering the state.

9. 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 other fish species in the Delta and upstream.

Pros and Cons:

Pros: Invasive exotic species represent one of the three factors hypothesized to be the cause of the POD. Ensuring comprehensive programs and good coordination among agencies is one of the most cost-effective ways to minimize the effect of 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, recreational and commercial boating interests.

Cons: More than 200 invasive species are already in the system, and some additional introductions will be impossible to prevent. Species established in the Bay-Delta will be impossible to eradicate.

Costs:

Additional costs for the NISAC are unknown. The addition of one full time scientist should be included in any cost estimate to identify more needs and related costs.

Timing of Implementation:

The Resources Agency established the Invasive Species Task Force in July 2005, and designated DFG as the manager. Recommendations are expected from the Task Force by December 2005.

Next Steps

Response to the POD must include several strategies. The IEP POD work plan is designed to increase knowledge of the factors that may be causing the recent step decline in pelagic organisms by new monitoring, studies, and analysis. It is also designed to gain more information from data and samples already available. This plan is intended to apply existing and new knowledge as it becomes available. The plan identifies a range of actions aimed at reducing stressors or improving conditions for delta smelt and other pelagic organisms.

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

Key factors for successful implementation are information and funding. First, we must increase our knowledge based on new information and enhanced analysis of information so that subsequent actions can be more effective. For that reason, the actions in this plan emphasizes the need to continue ongoing scientific programs and studies and to expand these programs to address the emerging issues associated with the POD. In addition, DWR and DFG must have a ready funding source to pay for developing this science, and enable appropriate actions to be taken as they are identified. One of the actions described in this plan, a new POD account, is designed to provide start-up funding so that projects can begin quickly.

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. The project manager will continue to make adjustments to these actions based on the latest information from IEP studies. The project manager will work with organizations of the Water Operations Management Team and the EWA team (known as EWAT), which already provide for a good mix of agency management and staff to help coordinate the smelt action plan. Oversight of the plan will be managed by DWR and DFG, in close coordination with FWS, NOAA Fisheries, and CBDA Science Program staff. All these agencies are also involved in IEP and the IEP POD work plan.

Rapid peer review of proposed actions will be sought through the CBDA science program and the CALFED Independent Science Board. This will help ensure selection of the most appropriate actions and the best project design. We are faced with three hypothesized causes for the POD. Until more information is available to narrow the range of potential causes, our response will necessarily include actions that have a high degree of acceptance in the scientific and agency communities. These are actions that will likely improve the Bay-Delta system or help achieve CALFED objectives, even if it is ultimately shown that they do not address the direct causes of POD.

Additional actions will be more specific as more information becomes available. Regular consultation with the IEP POD PWT will ensure rapid feedback and appropriate adjustment of actions.

Regular reports on the status of the IEP work plan and the smelt action plan will be made at public meetings of the Bay-Delta Authority.

Special attention will be paid to administration and funding. A POD Account has been established in the existing Four-Pumps funding process to ensure the ready availability of funds for POD actions. The primary use of the account will be to provide start-up funds so that selected actions can be started quickly while other funding sources are arranged. If no other funding sources are available to begin a particular action, the POD account may be used to fully fund the action as approved by the agencies. More funding from outside the POD Account will be sought from various sources as necessary.

The POD Account will be managed by DWR, along with other funds managed under the Four Pumps Agreement. DWR will provide administrative support of the account in the same way it does for other Four Pumps funds. Use of this support will help ensure smooth implementation. Depending on the number and complexity of transactions involving the POD Account, more funding may be needed for administrative costs.

Several actions described in this plan, IEP studies and a POD Account to fund actions, are already in place. Other actions in this plan vary in the amount of time needed to begin. Others require a range of times for study and planning. Preliminary schedules are shown in Figure 13, 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 implementing it. The schedule will be updated regularly.

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