A Historical Perspective of the Interagency Ecological Program: Bridging Multi-Agency Studies into Ecological Understanding of the Sacramento-San Joaquin Delta and Estuary for 40 Years

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Acknowledgments

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Preface

The Interagency Ecological Program (IEP) has been in existence in some form for almost 50 years. As the San Francisco Estuary evolved due to natural and man-caused perturbations, the IEP has responded by creating and re-creating itself to ensure the best understanding of the Estuary as it was influenced by water project implementation. The goal of the IEP has always been to provide this understanding to managers responsible for water project implementation in the most protective and efficient manner given social, political, and environmental constraints. On the whole, IEP has done an outstanding job of providing consistently useful data and information in a highly complex environment.

As new programs and constraints are developed to cope with the ever changing natural environment and demands of society, an understanding of the history of IEP is valuable, and to learn from past experience is wise. This descriptive history is meant to document in some detail the development, strengths, and weaknesses of this one-of-a-kind multi-agency consortium that has attempted to bridge the gap between water management and estuarine science in the most significant Estuary on the west coast of North America.

Sources of information for this account are personal interviews with program participants, annual reports, IEP Newsletters, coordinator meeting summaries, director meeting summaries, management team meeting notes, and personal experiences of the author. This history may err on the side of excessive detail, but that has been intentional; the author believes it is important to have detailed information available in a single reference so that interested parties can readily obtain knowledge about IEP. Some individuals may not want to read the entire report, but can easily be guided to topics of interest by consulting Appendix A, which lists significant events that influenced the IEP by page number in the report.

Finally, this is meant to be an objective treatment of IEP's history, but some subjectivity may have crept into the report. Where that has happened, the author alone is responsible. In some cases, findings or "facts" emanating from IEP work reported in this history were eventually revised, or proved to be inaccurate. One such example is the early understanding of the "entrapment zone" that, upon further investigation in the 1990s, was enhanced substantially by USGS workers. There was not always a notation in this report when such factual information evolved through subsequent work within or outside of IEP.

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Contents

The Origins of the Interagency Ecological Program

The 1950s and 1960s in California were the days of planning and development of large water delivery and storage projects operated by both the State of California (Department of Water Resources [CDWR] - State Water Project [SWP]) and the United States Government (Bureau of Reclamation [USBR]-Central Valley Project [CVP]). Plans were made to capture water in northern California, and to store it and move it through the Sacramento-San Joaquin Delta (Delta), when needed, to the dry and thirsty southern part of the state to support the rapidly growing population, industry, and agriculture. In those early years, there was not as much appreciation of the fishery and ecological values of the State's water, or a very good understanding of the impact that large-scale water development could have on those values.

Even though there were no mandates that DWR reimburse the Department of Fish and Game (CDFG) for planning and monitoring activities during the 1950s and early 1960s, CDWR supported a small contract planning unit in CDFG to develop information needed to support water project construction. At about that time, a fisheries biologist with CDFG, Jack Robinson, wrote a report describing fish and wildlife issues associated with water development in the Delta (Robinson 1961), located in the eastern portion of the San Francisco Estuary (Estuary). At the time the "Delta" was legally defined as a roughly triangular area with sides from the "I" Street Bridge in Sacramento south to Vernalis on the Sacramento River, then from Vernalis west to Chipps Island at the confluence of the Sacramento and San Joaquin rivers near Suisun Bay, and then back north to the "I" Street Bridge. Robinson's (1961) report can be considered the precursor to the type of work that would later be done by the Interagency Ecological Program (IEP).

As a result of Robinson's (1961) report, Jack Fraser—then Chief of the Water Projects Branch at CDFG—informed William ("Bill") Warne, who was at that time the Director of CDWR, that there was inadequate information to support construction of any new water delivery projects in the Delta. Bill Warne had previously been with USBR, was appointed Director of CDFG by Governor Pat Brown in 1959, became Director of the California Department of Agriculture nine months later, and was named Director of CDWR in 1961. As a result of the information provided to CDWR by Jack Fraser and Jack Robinson, and after the water bond passed the legislature in 1961, joint studies between CDWR and CDFG were begun. A contract to support a 5-year study was awarded to CDFG, and a "Memorandum of Understanding Between Departments of Water Resources and Fish and Game Regarding Objectives and Scope of Delta Water Project Fish and Wildlife Protection Study" was signed on August 10, 1961; the contract was amended for another 5 years in 1966.

The primary objectives of the Delta Fish and Wildlife Protection Study (as this early effort was known) were listed in the MOU as follows: (1) To make the necessary studies to

determine how the design, construction and operation of the Delta Water Project will affect the fish and wildlife resources and their utilization; (2) To recommend any changes in project plans, facilities or operations which are required to protect the fish and wildlife resources; (3) To recommend means for compensation of any losses to fish and wildlife which would result from construction and operation in the Delta of any State water facilities. First priority would be compensation in the same kind of fish and wildlife as near to the area of loss as possible; and, (4) To recommend measures which may be taken to enhance the fish and wildlife resources in the Delta area in connection with the development, construction, and operation of the Delta Water Project.

The MOU clearly identified the assumptions, study scope, methods, basic facilities included, and specific features of the cooperative studies. An important provision in the agreement paved the way for inclusion of other agencies in the new program. It stated that, “The studies will be coordinated with all other interested Federal, State, and local agencies. Assistance from all other agencies to provide information, funds, and actually carry out studies on selected segments of fish and wildlife studies needed will be encouraged.” The MOU was signed by William E. Warne, Director of CDWR, and Walter T. Shannon, Director of CDFG.

In partial response to SWP planning activities, the California Water Code, Division 6, Part 3, Chapter 10, established state policy with respect to “Fish and Wildlife and Recreation in Connection With State Water Projects.” Enacted in 1963, legislation known as the “The Davis-Dolwig Act” (Act), provided that the SWP must preserve fish and wildlife in connection with the development and operation of the SWP and that the cost of such measures must be borne by the project beneficiaries. A further purpose of the Act was to “…provide for the planning and construction of water storage, conservation, and regulation facilities and associated fish and wildlife and recreation features consistent with this declaration and to make provision for funds therefore on a continuing basis.” The statute also authorized CDWR to incorporate in the planning and construction of each project any features they determine necessary, but only after “…giving full consideration to any recommendation which may be made by the Department of Fish and Game.” It mandated “…full and close coordination of all planning for the preservation and enhancement of fish and wildlife… by and between the Department of Water Resources…the Department of Fish and Game, and all appropriate federal and local agencies.” Significantly, the legislation established planning as a part of general project formulation activities that CDWR must carry out “…in consultation with…” those agencies. The law also authorized CDWR to establish prices to users that included sufficient amounts “…to repay all costs incurred by the department, directly or by contract with other agencies, for the preservation of fish and wildlife and determined to be allocable to the costs of the project works.” In other words, planning costs contracted to other agencies could be provided by the SWP. Finally, the statute authorized CDFG to “…manage fish and wildlife resources at state water projects… in a manner compatible with the other uses of the project.”

Early interpretations of the new law maintained that CDWR would fund associated planning activities carried out by CDFG since that agency had management responsibility for fish and wildlife associated with the project, and since CDWR could recover funds from project beneficiaries. Such an understanding is reflected in the 1971 Interagency Agreement between CDWR and CDFG, which established the Fish and Wildlife Protection Study. It stated:

> *"State and Federal legislation requires protection and consideration of enhancement of fishery resources in connection with the state and federal water projects and the overall water conservation and development needs to the State. The Delta Fish and Wildlife Protection Study was established to assure adequate protection of the fish and wildlife resources of the Delta area with construction and operation of the State Water Project and any Delta Water facilities…Studies need to be completed to assure the opportunity to protect and enhance the Delta's fishery."*

Most significantly, the agreement listed the authority for this funding, "California Water Code, Division 6, Part 3, Chapter 10" and appropriate sections of the Davis-Dolwig Act that provided the State's legislative basis for the later formation of the Interagency Ecological Program. When the Davis-Dolwig Act was passed in 1963 it merely was codifying a practice (among others) that had been in use for 6–10 years. The understanding that CDWR should support CDFG for studies associated with the water project continued until the late 1970s, and then began to change. In the Delta, CDWR took the position that not all of the fish and wildlife study needs were derived from the SWP. They pushed the point of "shared values" and maintained that other management purposes, such as sport fisheries, existed and that CDFG should be responsible, in part, for those. CDFG agreed and began limited funding using Federal Sport Fish Restoration Act funds.

Bob Jones (CDFG Regional Manager) and Don Kelley (CDFG Senior Fishery Biologist) led the early biological studies needed for SWP planning in the Estuary. At this time, only CDWR and CDFG were involved. These early investigations began with a survey of the San Francisco Bay-Delta Estuary and included the benthic fauna, plankton, and all fish species. The results of these surveys were published in CDFG Fish Bulletin numbers 133 and 136. These publications have become classic descriptions of the early Estuary and are still in demand by estuarine researchers. In addition to the classic field work carried out under the new MOU, work on fish facilities (screens) was also completed under the direction of Dick Painter (CDFG). Rolf Mall (CDFG) headed a wildlife team that addressed the issue of salinity and how it affected food for waterfowl in Suisun Marsh (Marsh). At this time a Marsh program was begun and soon showed that flow reductions in the Estuary, as water was stored in upstream reservoirs or diverted south into the projects, would change salinity in the Marsh and, as a result, waterfowl food production. A significant waterfowl hunting program existed in the Marsh, and some of the hunters were well connected to

national political parties, so this effort received much attention.

In January 1966, Pete Chadwick replaced Don Kelley at CDFG as the lead of the SWP-funded studies in the Delta, and George Warner replaced Bob Jones as Regional Manager for CDFG. One of the significant issues at this time was the need to expand agency involvement in the early studies program. As a result, a new contract was signed by CDWR and CDFG to address concerns about *Neomysis* (an important fish food [shrimp] in the Delta), striped bass, Suisun Marsh, and fish facilities related to screening fish from water diversions. The 1961 MOU had noted the desirability of coordinating the studies "…with all other interested Federal, State and local agencies." Since USBR was developing, implementing, and operating the CVP at this time, it was important for that agency be involved in the emerging studies program. Even though there was an agreement that the agencies should share costs to build a project in the Delta according to the Bond act, USBR wrote a letter to CDWR agreeing to retroactively share planning costs for Delta water facilities, but not the costs of fish and wildlife studies. The USBR contended that no new fish and wildlife work was needed.

Concurrent with these events, the State Water Resources Control Board (SWRCB) held a water rights hearing to establish Delta water rights for the state and federal water projects in the Delta. All of the new information collected during the CDWR-CDFG cooperative efforts was presented at the hearing and, as a result, a new understanding was emerging regarding the importance of fresh water and fisheries resources in the system, and how they would be impacted by proposed development projects. During these proceedings, CDFG did not initially give recommendations to the SWRCB. In response to a SWRCB request, however, CDWR and CDFG jointly developed and provided a set of recommendations. At this time CDWR often prevailed over CDFG in developing State positions. After the hearing, Water Right Decision 1379 (D-1379) was rendered by the SWRCB, thereby setting limitations on the projects in the Delta based on the relative wealth of biological information presented by CDFG and CDWR. Significantly, from an environmental point of view, D-1379 mandated a standard be set for *Neomysis* and a water flow standard to protect striped bass spawning. These were some of the first biological standards in the country, and they stemmed from the early cooperative work between CDWR and CDFG.

Data presented during the hearing impressed the engineers at the Metropolitan Water District of Southern California (MWD), a major user of the SWP. MWD hired Don Kelley (formerly with CDFG) to provide testimony on their perspective of the new data. USBR also was surprised by the implications of the new information. Armed with the new water right decision based on data collected jointly by CDFG and CDWR, Pete Chadwick and Ted Perry (U.S. Bureau of Sport Fisheries - Portland) in 1970 convinced USBR managers to participate in the new cooperative program. Data presented at the hearing made the case, and USBR became a partner and formally joined the program. USBR asked that the

U.S. Bureau of Sport Fisheries also become involved. As a result, a new MOU was signed in 1970, and the effort became what was commonly referred to as the Four Agency Program, and was the official beginning of the cooperative state and federal interagency program that later became known as the IEP.

The 1970 Four Agency MOU outlined provisions for the performance of studies, annual review requirements, progress report requirements, funding, and assignment of studies. The purpose of the agreement was to "… provide for the performance of studies necessary to obtain a thorough understanding of the requirements of fish and wildlife resources in the Estuary." The agreement resulted from a common recognition that fish and wildlife problems existed in the Estuary and that a factor affecting those problems is the operation of the Central Valley Project and the State Water Project. At this time, there was consensus that, "…a thorough understanding of resource requirements is necessary to define design and operating criteria for those projects, so protection of the resources can be assured." Basically, the fishery agencies were responsible for the biological studies and the water development agencies were responsible for the engineering studies. The MOU included an Exhibit A entitled, "Studies Necessary to Evaluate Ecological Effects of Water Development on the Sacramento-San Joaquin Estuary" (CDFG et al. 1970). This document outlined specific agency responsibilities and funding expectations. The funding for the 1970-71 fiscal year was approximately $858,000 and estimated annual future costs were set at about $1,144,000.

Program Expansion and Maturation

The 1970s were a time for the new Four Agency Program to expand and for its administration to mature and become more independent within the internal structure of each member agency. In 1973, Ed Whitsel (USFWS) co-located with CDFG staff in Stockton and represented the Service in the program. This was the first time USFWS had full time staff dedicated to the program. Bob Jones acted as Branch Chief for CDFG Delta studies until about 1965. He was replaced by George Warner in 1973, when Pete Chadwick became the leader of the CDFG Bay-Delta Program. Chadwick was assigned to a new CDFG position called the Bay-Delta Program Manager and shared responsibilities with Paul Jensen, who was Chief of the Anadromous Fisheries Branch. In this capacity, Chadwick reported directly to the CDFG Deputy Director. Prior to this time, the Bay-Delta Program and staff were part of the CDFG Environmental Services Division (ESD), the chief of which reported to the Deputy Director. This new reporting structure demonstrated the increasing importance of Delta activities within CDFG and the other agencies.

The USFWS reporting structure was similar to that of CDFG in that Whitsel, the local lead for the IEP, was part of the fisheries program in Portland. The USFWS also had a local office, the River Basins Office, in Sacramento. The River Basins Office was similar to CDFG's ESD in that it also was involved in Delta water issues. This dual structure in the

fisheries agencies soon led to internal “competition” between the agency programs and the IEP. At the time, all of these groups had responsibility for Delta issues and conflicts arose when the SWRCB began holding hearings on water issues. The charge to each group was, however, slightly different and conflicts often arose when the agency directors had to make decisions. In reality, information was being filtered by deputy directors before the directors were asked to make important management decisions. In response to this conflict, Jerry Cox (CDWR program lead) and Pete Chadwick asked for “direct access” to the Four Agency Directors. Due to the high profile of emerging water projects and Delta fish and wildlife issues, the Directors agreed to become personally involved in the program, and the program structure was changed and formalized in a January 4, 1971 management memo entitled, “Management of Memorandum of Agreement re Ecological Studies in Sacramento-San Joaquin Estuary.”

This memo established a formal management structure to implement the 1970 agreement among the four participating agencies. The function of the new structure would be to assure close coordination at the working level and to provide for a rapid solution of problems at the management and policy levels. The memo noted that “Past experience with technical studies being conducted jointly by several agencies indicates that such a management structure is important to program success.” The agreement established a formal committee of the directors of the agencies to establish policy. It created an interagency management committee (later to be known as the Agency Coordinators), or Coordinators, to provide overall direction for the study program and the Interim Fish Protection Agreement. The Agency Coordinators were established as a management-level committee reporting to the Directors, and were responsible for reviewing progress of each study, recommending policy to the Directors, and solving administrative problems related to the studies. Technical management committees for each study area were established to be responsible for technical direction of studies, coordination of working level activities, and report preparation.

Under the new structure, each agency would have one representative on each committee, except that CDWR and USBR each would have two members among the Agency Coordinators, one from the planning staff and one from the operations staff. This structure would reduce or eliminate ineffective communication between planning and operations within the water agencies. Further, it was established that state and federal agencies having management responsibilities affected by study results would be invited to send observers to meetings of the Directors and the Agency Coordinators. Agencies that were not parties to the agreement but were participating in some of the studies would have representatives on the technical committees. All parties on the technical committees would have equal status. Agency Coordinators were assigned and five technical committees were established: Fisheries Committee, Fish Facilities Committee, Turbidity Committee, Algae Productivity Committee, and the Suisun Marsh Committee. The management memo also described the function of each level in the new structure, which represented a major

step in the evolution of the Four Agency Program in that it gave politically important Delta issues some autonomy within established agency structures.

Early Program Committees

The 1971 Four Agency agreement brought such a significant change from the prior activities that it was essentially the beginning of a new program that was to be maintained, albeit with some modest changes, for the ensuing 30+ years; it therefore is instructive to describe the revised Four Agency program in more detail to provide a solid understanding of its purpose. In fact, some new studies were added to the existing ecological studies in the Estuary, and many of the technical committee activities during 1971 involved planning for the future. The following is a summary of the 1971 program technical committee objectives.

Fishery Committee

Two important objectives of this committee in 1971 related to striped bass. The first was to determine the mechanisms controlling the survival of young and juvenile striped bass. The second was to measure the abundance of adult striped bass and relate that to the survival of young bass. It may seem odd today that so much attention was paid to striped bass, but in 1971 this was a premier and significant fishery that was being managed in the Estuary by CDFG, which had a strong constituency supporting its management efforts, and its goal was to manage striped bass to maintain a quality recreational fishery. In order to do that, the Fishery Committee needed to maintain a suitable environment and establish and enforce angling regulations that resulted in optimum utilization of existing populations. This work began to substantiate the need for protecting the food web in the Estuary as water development proceeded, consistent with the protection criteria for *Neomysis* established in D-1379; this was an important result provided by the Four Agency Program and had major management implications. Further, work on striped bass showed that the number of adult fish entering the fishery was correlated with water flows entering the Estuary in the spring and summer, and that the food supply (*Neomysis*) had an important effect on survival of young bass. Ultimately, this demonstrated the importance of study results to providing data for controlling flows and project development.

The new Four Agency Program agreement also augmented ongoing striped bass work. The augmentation included measurement of losses of eggs and larvae at the export pumps and evaluation and measurement of losses at selected agricultural siphons. Augmentations further included measurement of egg production and larval striped bass survival in the Sacramento River starting on May 1. Evaluation of angling regulations was also undertaken at this time; fish were tagged and population estimates were made on a yearly basis.

Salmon Component

The salmon component of the Fishery Committee was designed to coordinate salmon activities throughout the Central Valley: spawning stock surveys on each of the San Joaquin River tributaries; installation and operation of adult traps on the Stanislaus River to obtain eggs for yearly production estimates; assistance to the local irrigation districts on the Tuolumne River to rehabilitate and maintain 2.5 million square feet of spawning gravel; completion of fish screen programs on diversions, most notably the Banta-Carbona Irrigation District; and, construction of a rock barrier on the San Joaquin River near Stockton to help mitigate low dissolved oxygen problems that precluded migration of adult salmon. On the Sacramento River system, CDFG coordinated a management program to determine how best to release juveniles raised in hatcheries; a spawning stock estimate on the Yuba River and installation of screens on the Hallwood-Cordua Irrigation District diversion; completion of the fish screen on the Glenn- Colusa Diversion; and, large-scale studies on the Sacramento River system to determine the best time, size, and location to release hatchery produced fish back into the wild.

Phytoplankton Committee
(Algae Productivity Committee; to become the Water Quality Program)

The phytoplankton activities already had been underway for some time. In 1966 and 1967 CDWR, CDFG and the U.S. Geological Survey (USGS) conducted a cooperative study of dissolved oxygen dynamics in the Estuary, with the primary emphasis on the role of phytoplankton in regulating dissolved oxygen. Hydroscience, Inc. (a private consulting firm) was hired by CDWR to develop a mathematical model to predict phytoplankton productivity. Drs. Don O'Connor and Dominic di Toro, located in Westwood, New Jersey, were the primary consultants in this group who did the early mathematical modeling. The model theorized that increased light production due to decreased flows and increased nitrogen in waste loadings may cause unacceptable phytoplankton populations to grow in the Estuary and, thereby, cause eutrophication. In 1971 this work became more solidified with the stated objective of predicting changes in phytoplankton growth that would occur under various management alternatives being considered in the project planning process. A major activity of the group was to perfect the model. The cooperative nature of the new Four Agency Program was demonstrated in this effort. The USBR was responsible for carrying out field sampling and laboratory analyses, CDFG was responsible for zooplankton sampling, and CDWR worked with Hydroscience, Inc. on the modeling.

Turbidity Committee

Planning for a study to predict concentrations of inorganic suspended solids in the system began. It was necessary to look at diversion-related reductions of sediment input into the Delta and San Francisco Bay because such reductions could reduce turbidity and increase light penetration, thus causing algae blooms. The objective was to develop the capability to "predict the extent of future reductions in input of inorganic sediment into the Delta and how those reductions will affect turbidity." This planning was done in cooperation with the

USGS; intermediate objectives were developed in 1971, and a contract between USGS and CDWR was signed in 1972.

Fish Facilities Committee

One objective of the Fish Facilities committee was to improve the effectiveness of fish facilities at existing state and federal diversions. These facilities salvaged millions of fish, and even small increases in salvage efficiency would save large numbers of fish, and the expanded program wanted to identify and use the best possible operating criteria. Studies started in 1969 and evaluations were limited to the state system, but the federal Tracy system was now added to the program through the operation of the Tracy Fish Collection Facility (TFCF). A second objective was to develop a comprehensive, effective, and practical fish facility louver system for the proposed Peripheral Canal (PC), which was planned as part of the legislatively-mandated SWP. A major reason for selecting the PC in the SWP was its capability to protect fishery resources more effectively than other plans considered for the cross-Delta transport of water. Such transport was only considered possible *if* adequate fish facilities were constructed because of the vast numbers of fish that migrated past the proposed intake. The expanded program evaluated a horizontal traveling screen and the swimming ability and impingement tolerances of small fish. Four Agency Program cooperation expanded once again when USBR provided partial funding for screen development by the National Marine Fisheries Service (NMFS).

The Fish Facilities Committee prepared a comprehensive plan of work and funding that was to be completed by 1980, the scheduled completion date of the PC. The objective was to provide biological information necessary to plan, design, and operate: (1) the intake diversion structure; (2) the sediment basin; and, (3) the fish screen and fish return system for the new diversion. At this time, the Agency Directors agreed with the plan but funds were not available for fiscal years 1971–72 and 1972–73, and the group was directed to review alternative means for funding and scheduling.

Suisun Marsh Committee

This committee carried out planning programs to understand and implement water supply systems for the Marsh, and was necessary because planned freshwater diversions in the Delta were expected to change the salinity in the Marsh and, therefore, the growth of certain desirable plants that occur there. A 1970 Memorandum of Agreement among USBR, USFWS, CDWR, and CDFG provided a plan of study for the Marsh to: (1) select a water supply for marsh waterfowl habitat; (2) determine costs and benefits of the plan and define responsibility among interests; and, (3) recommend a plan of action for implementation. Initially, USBR was responsible for conducting the studies with help from CDWR, CDFG, USFWS, USGS, and the local land owners (primarily duck clubs) in the Marsh.

Program Implementation through the Early 1970s

As described above, much of the work in the Four Agency Program in 1970–71 involved administrative, structural formation, and technical program planning, implementation, and expansion. The main participants in the program were still the four state and federal agencies (CDFG, CDWR, USFWS and USBR), but others (USGS and NMFS) were becoming more involved as program activities expanded. During this period much effort was put forth implementing program studies. Important milestones and progress during the years after 1971 were as follows.

1972—Early Data Help to Understand Delta Ecology

In 1972 the Andrus Island levee failed, leading to a large amount of fresh water flooding onto the agricultural island from the Delta during the striped bass spawning season. This unplanned event demonstrated the value of interagency studies like those carried out by the Four Agency Program, and resulted in the documentation of reduced production of *Neomysis* and, therefore, reduced survival of young striped bass. In fact, the program measured the poorest survival of striped bass as yet on record during this year. In the absence of the ongoing fishery monitoring carried out by the Four Agency Program, the true impacts of such flood events would have gone undocumented.

Among other findings with management implications during the year were that: (1) 55% of all striped bass spawned in the Estuary passed the proposed (PC) intake; (2) adult striped bass abundance increased during periods of high flows from rivers; (3) a barrier placed at the Head of Old River aided migration of salmon from the San Joaquin River; and, (4) the magnitude of flow controlled adult salmon populations in the tributaries in the San Joaquin River system. These results are mentioned here because they would affect planning of management actions and additional scientific needs in subsequent years. For example, the striped bass program asked for changes in diversions to monitor outflow and diversion effects on bass populations, work proposed to be done in 1973.

Several significant agreements altered the Four Agency Program during 1972. A contract was executed with the Soil Conservation Service (SCS) to implement the Marsh management studies, and CDWR entered into an agreement with USGS for measurement of sediment inflows to the Delta. As mentioned earlier, a USFWS representative was stationed in the CDFG office in Stockton, which greatly improved coordination within the Four Agency Program. Another significant change this year was that the Fish Facilities Study received four times the amount of funds than was anticipated as per the original agreement. A total of about $1.5 million was to be spent during 1971–73 to implement a five-year plan to develop information for an operational Peripheral Canal in 1982. Major hydraulic equipment required to perform biological studies was designed, fabricated, and installed at the University of California, Davis (UCD), thus bringing a new partner to the program. Another new partner was added on August 23 when an agreement was signed

between USBR and SCS to fund Marsh management studies. Neither SCS nor UCD, however, became an official member of the Four Agency Program.

Unfortunately, in 1972 the SWRCB rejected a joint request of the Four Agency Program for funding to extend the phytoplankton model into San Pablo and San Francisco bays until verification of the model could be completed. This was disappointing, but it pointed out a strength of the program: all Four Agencies had made the request together. This was laying out a new way of doing science in the Estuary…cooperatively!

Further evidence of the success of the newly expanded Four Agency Program was the fact that it produced nine publications (Technical Reports) in 1972, on topics including dissolved oxygen, salmon, sturgeon, dispersion capability in San Francisco Bay, ecological studies, striped bass distribution and abundance, and Suisun Marsh ecological studies. The new Four Agency Program was taking root in the academic community. *[Note to Reader: A complete listing of these publications can be found in the 1972 Annual Report. Thereafter, in this history, reference to annual publications can be found in the Annual Reports for IEP that are archived in the CDFG Stockton Office Library.]*

1973—Program Strengths Become Apparent

Selected highlights from 1973 demonstrate several strengths that began to evolve would soon characterize the Four Agency Program and contribute to its long term success and utility. This was not the only year during which such events occurred, but it was an early one with products that started to shape the future success of the Program. Following are examples of Four Agency Program strengths gleaned from 1973 activities.

The Four Agency Program Emphasized Practical Work

In the early days, and indeed throughout its existence, the Four Agency Program emphasized work that had practical implications rather than pure academic interest, and produced information that was useful to its agency policy managers. For example, some parties suggested that the development projects may harm the Estuary by reducing the freshwater outflow in the system. If this were the case, managers and operators would have to alter water project operations. Even though outflow was not eliminated from consideration, experiments involving increased pumping of water suggested that impacts associated with diversions and exports were more important factors affecting survival of young striped bass. Such information helped the project managers “sort out” valued clues used to better manage the pumps.

Other practical observations came from work by the Phytoplankon Committee. The mathematical model being developed by the consultants agreed well with phytoplankton observations from the field, suggesting the model might be used to save effort in field work. The Fish Facilities activities found that fish eggs and larvae could be protected by

curtailing diversions, thus requiring flexibility in operation. Finally, the Suisun Marsh group initiated a study to assess the technical feasibility of using reclaimed wastewater for management purposes in the Marsh. Such information had an obvious value in using an unwanted resource in a positive way. The Fish Facilities work also made major headway developing practical information on the most viable fish screen concepts for the proposed PC. The Fish Facilities Program recommendations developed during 1973 were later adopted by the Directors for implementation in 1974. As a result, an “at river,” low velocity, “positive” barrier screen concept was chosen.

Program Flexibility and Prioritization

Often large programs become inflexible and unable to respond to evolving needs, opportunities, or new information, but that was not so with the Four Agency Program. A good example occurred in 1973 in the Fish Facilities Program. During 1972–73 this effort received almost 4 times the amount of funds than was anticipated in the original agreement. This money was used quickly and efficiently on many studies of value to managers that began in 1973: juvenile bass swimming performance, louver guidance, fish occurrence and distribution studies, trawl surveys, intake structure configuration models, debris clogging of perforated plates, algal growth on perforated plates, endurance and aperture study, fish response tests, and fish pump tests. This information was crucial to planning the Peripheral Canal. The Fish Facilities Program also was able to respond flexibly when studies were not going as planned. For example, a lab experiment failed when investigators could not keep young striped bass alive to determine effects of food concentrations on the young fish; as a result, the study was discontinued and money diverted to other priority efforts.

The Four Agency Program also proved adept at prioritizing activities. During 1973, when the staff of the Fishery Program had to develop the 1974 workplan, the field portions of the egg and larval surveys were stopped so that a backlog of data could be evaluated in order to develop a more robust plan. Such prioritization, in response to management or emerging needs, became common in the Four Agency Program over the years. The term “adaptive management” had not yet entered mainstream environmental resource management, but the young Four Agency Program was, in effect, already implementing some of its tenets.

Looking Beyond the Delta

The Four Agency Program was always open to learning from, and collaborating with, others. During 1973, the Fishery Program looked at evidence from other fisheries outside the Delta system that supported the fisheries/outflow hypothesis that was being developed. Data were reviewed from shrimp production in other estuaries, the Aswan High Dam sardine fishery, Quebec’s commercial catches of lobsters, oysters, and soft shell clams in the Saint Lawrence River, and striped bass in the Potomac River in Maryland.

Additionally, the chairman of the Fish Facilities Committee participated in a national workshop sponsored by the Electric Power Research Institute where he presented a paper on fish screen work in California. An official delegation of scientists from the Soviet Union visited the Four Agency fish screen research facility and was briefed by its personnel. Finally, during 1973, Drs. Krone and Amorocho and Mr. DeVries of the University of California completed a report funded by the Four Agency Program describing the concept of using a filter bed for diversions of water into the proposed PC. This work typified outreach to, and cooperation with, the academic community.

Cutting Edge Science

Four Agency Program work in 1973 also demonstrated that it led the way in some areas of science. The Marsh activities used aerial color photography and cover mapping of the Marsh area in 1973 and compared vegetation in these photos to the results of a survey conducted in 1959. This work showed a 57% reduction in salt grass production, as well as a 50% increase in alkali bulrush and a 60% increase in fat hen. This state of the art photography pointed to improved management of the Marsh for waterfowl. Other work by members of the Phytoplankton Committee led to seminal work on the concept of an “Entrapment Zone” in estuaries. Two mathematical models were being developed in 1973 to aid in the interpretation of study results and help with predicting future conditions. One was a model of phytoplankton growth; the second was to describe movement of inorganic suspended solids in the Estuary and was just being developed. A special field study coordinated with development of these models demonstrated large amounts of solids appeared to be “entrapped” in the Estuary in the general vicinity of Chipps Island. This work began a series of “Entrapment Zone” studies that received much regional and international attention, and contributed to the in-depth exploration of estuarine entrapment zones by the scientific community in estuaries around the world.

1974—Highlights

Several results from the 1974 Fisheries Committee work influenced the future of the larger Four Agency Program. Field data led to the conclusion that striped bass survival was a direct function of flows into and through the Delta, meaning alteration of flows would directly alter bass populations. This principle would guide planning, research, and regulatory efforts in the Delta into the future, and would be the basis for the paradigm used for water project development. Additionally, much was learned about life cycle dynamics in the rivers, including where bass spawned and how that related to the proposed intake for the PC. This work suggested that spawning occurred during May 10 through June 12 each year. As a result, diversions would need to be curtailed during that period. But, based on frequent monitoring of egg and larval abundance, the new information suggested that curtailment periods could sometimes be shorter; this was important to the future of management and regulation because the exact time of spawning was not predictable. The resulting regulatory flexibility based on “near real time” data was a precursor to real-time

management of water projects that used fishery data, and which would become necessary and commonplace as the endangered species acts began to limit water diversions in the early 1990s.

Another significant observation listed in the Four Agency Program annual report during 1974 was the fact that, “There is a remote possibility that the recent decline in bass survival in the Delta is due to unknown change(s) that have occurred in the Delta environment or crept into our sampling procedures.” This was an early recognition that finding absolute answers in environmental studies in the Delta was not always possible. In response, an experiment was designed for 1975 that would set pumping rates to pre-1968 levels at the onset of striped bass spawning. The fisheries work also was expanded to include a survey to measure survival rates of striped bass eggs and larvae, an activity that would endure until its termination in 1995.

During 1974, the fisheries investigations also took an important step by recognizing that there was an important striped bass fishery in the San Luis Reservoir (an off-stream holding reservoir for the SWP and CVP, located south of the Delta). This reservoir was outside of the Four Agency Program Delta study area, but had been “seeded” with young striped bass that passed through Delta fish screens since 1968 and subsequently grew to maturity. The fisheries studies began a post card survey to assess angler catch, and found angler use and catch were substantial. In fact, estimates of angler catch from this survey ranged from 100,000 to 275,000 in the four years. As a result, the 1975 work plan included an evaluation of the scales of striped bass collected from San Luis Reservoir to determine growth rates and population structure there.

Seven years (1968–1974) of monitoring data on *Neomysis* shrimp showed that the population was at its lowest level in 1974. To better understand the status and population trends of *Neomysis*, the program carried out a three-day study in the low-salinity entrapment zone and found catches of this food organism were highest between salinities of 2,000 and 6,000 micro-mhos, suggesting that these organisms were being “trapped” in the low-salinity zone. This finding contributed to an evolving entrapment zone concept and had implications for water project planning being carried out by the Water Quality Program within the larger Four Agency Program.

The Water Quality Program (formerly Phytoplankton Program) was modified in 1974 to increase sampling in the central Delta. This was largely a result of CDWR monitoring to comply with SWRCB D- 1379, which was effected in 1971 and contained new water quality requirements for the San Francisco Bay-Delta Estuary. This decision (D-1379) was also the first to provide terms and conditions for a comprehensive monitoring program to routinely determine water quality conditions and changes in environmental conditions within the Estuary. The monitoring program described in D-1379 was developed by the Stanford Research Institute through a contract with the SWRCB.

Implementation of this monitoring program had begun in 1972 as SWRCB, CDWR, and USBR met to define their individual responsibilities for various elements of that effort. In 1978, amendments to water quality standards were implemented and resulted in Water Right Decision 1485 (D-1485). These standards again were amended under the 1995 Water Quality Control Plan and Water Right Decision 1641 (D-1641), established in 1999. The SWP and CVP are currently operated to comply with monitoring and reporting requirements described in D-1641. D-1641 requires CDWR and USBR to conduct a comprehensive environmental monitoring program to determine compliance with the water quality standards, and also to submit an annual report to the SWRCB discussing data collected.

While monitoring dictated by this Decision was not formally a part of the Four Agency Program, the output was used to calibrate the mathematical model being developed to describe conditions in the central Delta and was crucial to studies of the so-called solids "entrapment zone" between San Pablo Bay and Collinsville. The conceptual model at this time was that there were 2-layered flows in the deeper channels, and tidally-averaged bottom currents that moved up-Estuary to entrap particles in the low salinity regions. Based on these new concepts, Hydroscience, Inc. improved and expanded earlier mathematical models to provide a greater understanding of 2-layered flows and their implications for water project planning in the system. Also in 1974, data analyzed by USBR scientists Jim Arthur, Doug Ball and Matt Rumholtz led to a better description of circulation and sediment transport in the entrapment zone. These new insights were immediately used by CDWR for the preparation of an environmental impact report (EIR) for the PC, and a draft EIR for the PC was issued in August of 1974.

It is important to note that the concept of the entrapment zone proved to be much more complicated than the early models suggested. Kimmerer (2004) noted, "Similarly, a lot has been learned about the Low- Salinity Zone, where freshwater and saltwater meet. Previous studies demonstrated that this was an 'entrapment zone' where particles and organisms can become concentrated. The mechanism for this entrapment was believed to be two-layer net flow in Suisun Bay, with tidally-averaged bottom currents moving up-Estuary to maintain these particles in this region. However, field, model, and theoretical studies showed that such currents are infrequent in the shallow waters of Suisun Bay. More recent studies have demonstrated how dynamic processes, driven by tidal currents but also dependent on the interplay of salinity and water depth, can retain particles and organisms in various regions of the Estuary, and how the behavior of organisms may contribute to their retention in the Low-Salinity Zone. These studies further demonstrated how salinity stratification forms and breaks down tidally, and how the length of the salinity gradient (indexed as X2), strength of the tides, and water depth influence stratification and two layered flow throughout the Estuary."

Important expansions to the Fish Facilities Program, within the Four Agency Program, also

occurred in early 1974, when the Four Agency Directors approved establishment of a Consulting Board to help with the fish screen design. This board included Drs. Loren Jensen, James Harder, Milo Bell, and Ernest Salo, and was the first time the Four Agency Program employed an independent advisory group; many more were to follow. There was a substantial expansion of the Fish Facilities Program to assess debris conditions at the Hood Test Facility located at Hood (a small town on the Sacramento River) and to study fish performance near screens. These studies were expected to be fully implemented during 1975. Indeed, early in 1974 CDWR had announced a two-year deferment of the PC to allow "full evaluation of alternatives." Part of the reason for that delay was to allow CDWR to secure federal participation in the development of an environmental impact statement (EIS) for the PC. As a result, fish screen conceptual studies were delayed to July 1977 from the original December 1975 date. Delays also occurred in some of the other activities during 1974 because of work on the EIR and EIS, and because the agencies needed to provide input to the SWRCB Delta hearing to be held in 1978.

The year 1975 marked the first instance in which the annual report referred to the Four Agency Program as the Interagency Ecological Studies Program (IESP). Also, the Phytoplankton Program was expanded and became the Water Quality Program. The IESP provided 16 publications in 1974.

1975—Expanded Work in Fish Facilities

The most notable changes in the IESP during 1975 occurred in the Fish Facilities Program. At this time, its objective was to develop biological and engineering information required to plan, design, construct, and evaluate the Delta water facility intake diversion structures and requisite fish protective facilities. During this time, the planning and development of the PC was a primary activity of the water development agencies and, therefore, greatly influenced priorities and activities of the IESP. It was a very high priority to complete this phase of the previously approved SWP. During 1975, the Four Agency Directors expanded the Fish Facilities Program to (1) expedite completion of the Hood Test Facility; (2) add the fish predation study; and, (3) add the fish screen staging and timing study. This expansion also resulted in an extension of the decision date for the facility to July 1977. As mentioned above, the Draft EIR for the PC was issued in August 1974 and, as a result, a one-year study was initiated in mid-1975 to evaluate alternative courses of action. This "Alternatives Study" was to be available in the summer of 1976. Additionally, a plan and schedule for the fish predation study was developed.

During 1975, the remaining programs within IESP emphasized normal implementation activities. There were some changes, most notably in the Fishery Program. An effort was initiated to determine salmon losses at >330 unscreened irrigation diversions on the Sacramento River between Redding and Sacramento. A benthos sampling effort was now routinely included in the D-1379 mandated water quality monitoring, and much study

continued on two layered flow with vertical mixing circulation patterns in the Estuary. Jim Arthur and Doug Ball (USBR) described the downstream flow of fresh water on top, while more salty, marine water flowed into the Estuary on the bottom (Arthur et al. 1975). They showed that this resulted in a zone of suspended materials being “entrapped” where the two movements equilibrated. Importantly, they made the point that this zone moved seaward as flow to the Estuary increased but, even more importantly, the opposite action influenced water project planning. Those authors reported that when this zone moved upstream into deeper, confined channels as a result of water project diversions, biological production was reduced, a result that had major implications for project activities. At this time, Dr. Ray Krone (a consultant for the IESP from UCD) predicted that the suspended material loads then entering the Estuary would decrease as water exports increased in the future. He further hypothesized that this decrease of suspended solids would result in decreased turbidity and major increases in phytoplankton growth and depletion of dissolved oxygen. Parenthetically, this did not come true in the following decades: while turbidity did decrease, phytoplankton production also decreased until the mid-1990s, and only recently has begun to increase in some parts of the Estuary. Similarly, newer research has shown that the original entrapment zone concept of the 1970s was much too simplistic, and tidally-averaged bottom currents moving up-Estuary are, in fact, infrequent in the shallow waters of Suisun Bay. Obviously, not all the information developed in the IESP in the early 1970s continued to be true, but it all played a role in understanding the dynamics in the Estuary as development proceeded.

1976—The First of a Two-year Drought: Uncertainty Enters the Program and Leads to Change

Two significant circumstances, one natural and one man-made, shaped the activities of the 1976 IESP activities. Nineteen seventy six was the first year of a severe, two year drought resulting in extremely low flows, the fourth-lowest Delta outflow on record, and also the first year of a two-year water rights hearing by the SWRCB. The Fishery Program noted that survival of young striped bass in 1976 continued to decline, and was the lowest since 1959. Until 1976, a 40-year stream of sport fishing records showed that the number of bass entering the fishery was proportional to the Delta outflows in spring and summer of the year when the young were hatched. Thus, IESP biologists were not surprised that, with the very low inflows during the drought, striped bass numbers were very low. Biologists were, however, surprised by the lower-than-expected biomass of phytoplankton in the Suisun region that started in the summer of 1976 and continued through 1977, the second drought year. IESP monitoring during the preceding eight years had shown that phytoplankton biomass tended to be highest during lower flow conditions with cleared water, but most of the years from 1968 to 1975 were wet years and the previously observed pattern clearly did not hold during the extreme drought of 1976–77. In addition to stimulating new research, this finding also underscored the importance of long-term monitoring intended to cover a full range of environmental conditions.

The Water Quality Program continued routine monitoring and changed only slightly with the addition of two sites. Modeling efforts that emphasized improving and expanding the ability to identify cause-and- effect relationships among water quality parameters in the Estuary were completed. A final report (O'Connor and Lung 1976) showed the greatest significance of the 2-dimensional analysis was related to its ability to contribute to the understanding of the null zone (the area where top and bottom flows are equal) and turbidity maximum (the location of greatest turbidity).At this time, IESP also entered into a contract with Hydroscience, Inc. to process and store water quality monitoring data generated by the IESP and to develop a data retrieval system. This effort resulted in ready access to data from 1968 through 1976, and was critically important since the Water Quality Program was starting to address the question of why phytoplankton biomass in the Suisun region was lower than expected during the 1976–77 drought. The Water Quality Program provided several possibilities: (1) biological effects—were more salinity tolerant species feeding on phytoplankton?; (2) toxic effects— were toxics in San Pablo Bay that previously had been shown to limit productivity now being propagated upstream?; or, (3) physical effects—were changes in 2-layered flow circulation patterns shifting the producers upstream to deep, narrow channels or changing the degree of vertical mixing that affected the plankton?

All of this uncertainty led the U.S. Environmental Protection Agency (EPA) to contract with USBR in the spring of 1976 to increase water quality monitoring and examine the effects of predicted low flow conditions on the Delta during summer months. A second investigation was aimed at studying characteristics and effects of the entrapment zone during low Delta outflow. It was found that salt intrusions came upstream 10 miles further in 1976 than 1974. Once again, the IESP demonstrated its flexibility and ability to respond to real time changes and challenges in the system.

The IESP also responded well in providing information and analytical tools to the SWRCB hearing that started in 1976. The hearing was held to (1) modify existing CVP and SWP water rights; and, (2) establish Delta water quality standards to protect beneficial uses of water within the Delta and the Suisun Marsh. During this year, a working numerical model was developed by Dr. Hugo B. Fisher (University of California, Berkeley), which allowed USBR to estimate channel hydraulics and salinities, and to predict pond salinities on individual duck clubs in the Marsh. CDFG, in cooperation with CDWR, completed an analysis of the fish and wildlife impacts associated with 14 separate Delta water alternatives: the PC was determined to be the most effective alternative for improving the Delta environment. CDFG presented operational criteria for protection of fish and wildlife in the Marsh that had been developed cooperatively by the Four Agencies. This testimony was endorsed by CDWR and implicitly by USBR and USFWS.

In December 1976 the San Francisco Bay Conservation and Development Commission (BCDC) issued a Suisun Marsh Protection Plan, the purposes of which were to: (1) set

aside a primary management area of 89,000 acres; and, (2) set aside a secondary management area of 22,500 acres to act as a buffer area. The plan also recommended that the State consider purchasing approximately 1,800 acres of Marsh, that water quality in the Marsh be maintained, and that land tax assessing practices reflect the requirements for a coordinated Marsh development effort. Notably, these recommendations were expected to be most effective if coordinated with the IESP efforts in the Marsh. A nod was thus given by a regulatory agency as to the value of the IESP.

During 1976, another example of the cooperative nature of the IESP became evident. CDFG's Anadromous Fishery Branch (AFB) was conducting another study of salmon in the upper Sacramento River. They planned to release 2.5 million tagged smolts into the river, and an agreement was reached that resulted in the IESP implementing a trawl program to collect the tagged smolts. Only portions of the AFB program related directly to the management of the Estuary were included in the interagency report. Internal agency coordination with the estuarine program became more commonplace as time passed.

During this year construction of the Hood Test Facility was completed. Most of the work was aimed at the task of understanding the mechanisms controlling flow-fish relationships. The Delta Fish Facilities Consulting Board recommended expansion and intensification of research being conducted at the Hood facility, and the Directors approved an extension of the Fish Facilities efforts. The Fish Facilities Program investigated getting six potential grant agencies to help support the studies, reiterating the program's desire for outreach and cooperation.

1977—The Drought Continues

The dominant feature influencing IESP in 1977 was the second year of the drought, which represented the most severe conditions since the "dust bowl" of the 1930s. Indices of abundance of striped bass and *Neomysis* were the lowest recorded, but the previously identified statistical relationships between Delta outflow, Delta water diversions, and abundance did not explain the low survival. Work in several portions of the Fish Facilities Program was set back one year due to the drought. For the first time since monitoring began, no phytoplankton bloom was observed in Suisun Bay, chlorophyll levels therein were the lowest on record, and experiments indicated that this was not a direct effect of increased salinity. Several technical reports on phytoplankton growth and chlorophyll were completed. The drought was causing observations that seemed inconsistent with previous knowledge and, as a result, USBR began a series of Algal Growth Potential (AGP) studies to investigate factors potentially affecting algal productivity. Among these were the location of the entrapment zone and inhibitory factors, such as low- level toxicants and benthic grazing; results of these studies were inconclusive.

Several changes occurred within the Suisun Marsh Program. First, USBR integrated it into the Solano County Water Project Feasibility Study. This was done with the consent of the

other three agencies in order to (1) elevate the importance of the study to a feasibility level effort; and, (2) coordinate the water requirements of the Marsh with those of the rest of Solano County. Further, estimates of fish and wildlife benefits derived from the Marsh were developed by the USFWS in a report that stated that the true value of a “hunter-day” was closer to $65 rather than the value of $9 as identified in a SWRCB resolution.

Another noteworthy development was that the annual IESP report format changed substantially from the prior format, which had been in use since 1972. The new format required brief descriptions of progress in relation to individual program plans made at the start of the year. Additionally, in an effort to expedite information collected from IESP surveys, results of technical analyses were virtually eliminated from the reports. The IESP provided 12 new technical publications 1977.

1978—Drought-Caused Program Changes

Changing conditions, primarily the 1976–1977 drought, caused IESP managers to reconsider and clarify goals. Water project impacts and potential impacts of the proposed Peripheral Canal were highlighted. The broad IESP goals in 1978 were to (1) identify potential impacts of diversions of water for the Central Valley Project (CVP) and State Water Project (SWP) on fish and wildlife in the Sacramento-San Joaquin Estuary; (2) provide design and operational input for Peripheral Canal planning, so the canal would meet fish and wildlife needs; and, (3) develop operational standards and facilities as necessary to prevent potential adverse effects of the CVP and SWP not associated directly with the Peripheral Canal.

These drought-driven revisions influenced the individual programs. The Fishery Program had been looking primarily at striped bass; now the study was reduced to a monitoring level program. The most important remaining question was why the survival of young striped bass was much lower than anticipated during the 1976–77 droughts, and the most probable cause seemed to be low food production in the system, with reduced production in the “entrapment zone” being particularly important. Concurrently, the Fishery Program redirected its efforts to king salmon and resident fishes. As a result, the salmon studies evolved from the recently implemented pilot study to a full scale effort, and the field activities included work on resident fishes.

The Water Quality Program was also strongly influenced by the observations made during the drought and had been examining factors controlling primary production in the Delta, with an emphasis on the “entrapment zone” area. Researchers produced mathematical models, which simulated phytoplankton production reasonably well, but did not predict the low biomass of phytoplankton in Suisun Bay during the drought, and no causative factor was identified. As a result, low production during the drought was identified as the most important effect, which contrasted with concerns about eutrophication under low flow conditions and originally had prompted the study. In April 1978, USBR scientists Jim

Arthur and Doug Ball released a report summarizing the results of their entrapment zone studies, which concluded that the location of the high-turbidity entrapment zone they observed was approximately equivalent to the extent of the estuarine low salinity zone (2–6 psu). Later studies challenged this view by showing that the turbidity maximum isn't always found in the low-salinity zone and that turbidity is strongly influenced by local topographic features (e.g., shoals near Benicia and connection of channels to the shallows of Grizzly Bay). Nevertheless, Arthur and Ball's work set in motion a series of studies and events that led to a greater appreciation of the ecological importance of the low salinity zone, and eventually culminated in the adoption of salinity standards for the western Delta and Suisun region. Arthur and Ball also reported that phytoplankton biomass varied seasonally and tended to be highest when the low-salinity-entrapment zone was located in, or near, Suisun and Honker Bays. They observed the lowest summer phytoplankton biomass when the low-salinity entrapment zone was located in the deep channels above the confluence of the Sacramento and San Joaquin rivers. To further test ideas about the relationship between the location of the low-salinity-entrapment zone and phytoplankton biomass and to study the possible mechanisms, Arthur and Ball proposed to manipulate Delta outflows in the summer of 1978 in a way that would place the tidally averaged location of the entrapment zone next to Honker Bay for at least two months. The much wetter hydrological conditions of 1978 and the high priority placed on entrapment zone studies allowed this research to take place during mid-June through October, 1978.

The Marsh Program was nearing completion of its primary assignment in 1978. It had produced a plan to protect the Marsh from excessive salinity, and grants were prepared that would enable construction of an initial salinity control facility in the fall of 1979, to be completed in 1980. Congressional approval of the initial facility also was achieved.

By 1978, the Fish Facilities Program had proceeded to the point where the general concept for the fish facility associated with the PC could be selected. It had developed criteria for a positive barrier screen and recommendations to protect bass eggs and larvae by curtailing diversions at crucial times. Some delays in completion of design tests resulted in extending development of the final design until July 1982. The Fish Facilities Program made a significant finding that would affect perception of bass predation well into the future. Losses of young-of-the-year Chinook salmon within Clifton Court Forebay and the approach channel to the Fish Protective Facility indicated that 88% of marked fish released near the radial gates (the opening to the forebay) were lost within the forebay and channel, presumably the result of predation by striped bass in this area (Schafter 1978). This huge loss grabbed the attention of water project plannersand others, and took on a life of its own. Although these studies were carried out within the diversion system, some inappropriately projected these losses caused by striped bass predation to be system-wide, and began to suggest de-emphasizing the management and protection of striped bass. This important sportfish was beginning to be perceived by some as a destructive, non-native predator of desirable native fish, which may have been the

beginning of a movement to de-emphasize striped bass as a management and planning priority and, later, to eliminate it from the system. Other predation studies were carried out using sonic tags on striped bass and Sacramento pikeminnow at the Glenn-Colusa fish screen complex and at the Delta fish protection facility. It was determined that pikeminnow were a resident predator, while striped bass were transient, or roving, predators of young salmon. These observations influenced future studies and plans in the water project.

Even though the value and desirability of managing striped bass was being questioned, fishing interests prevailed. A new objective was established in the Fishery Program to study the role of hatcheries in managing striped bass in the Estuary, with interest in determining the reliability of hatcheries and stocking programs to mitigate striped bass losses caused by water development projects and the drought. The Fishery Program carried out an extensive literature review that yielded no information on significant advancements in production techniques for this species, with the result at that time that then current hatchery techniques could not mitigate losses caused by water development. This was an important observation that would influence future work and planning in the IESP.

The undercurrent of questions about the value of non-native fish resulted in the creation of the Resident Fish Program in 1978, the object of which was to determine population parameters important to resident fishes in the Delta. An emphasis was placed on obtaining baseline information. A white catfish tagging program was started in 1978 and a largemouth bass program was scheduled to begin in 1979. Although they were small changes, these efforts paved the way to think more broadly in IESP.

Data handling was becoming more of an issue as new activities came on line and established programs generated more and more information. In 1978, the IESP added an element to process daily salinity, climate, and flow data into STORET, which was a computer-based federal storage system, and IESP entered the computer age.

IESP produced nine publications in 1978, the most notable being Arthur and Ball's "Entrapment of Suspended Materials in the San Francisco Bay-Delta Estuary." Even though some of the hydrodynamic conclusions were later challenged, this report, which was published by USBR in April 1978, received much attention. It synthesized much of the current knowledge about the relationships between estuarine hydrodynamics, water quality, phytoplankton, zooplankton, and striped bass. At the time of publication, it was considered a premier example of the state-of-the-art-science being carried out by the IESP. It is still recognized today as one of the most comprehensive and important examples of data analysis and synthesis by the IESP.

1979—Program Membership and Spatial Scope Expansion

In 1979 a significant programmatic and spatial expansion occurred in the IESP, which

eventually would lead to other agencies formally joining the four original members. During a SWRCB water rights hearing in 1978 (which would lead to Water Right Decision 1485 [D-1485]), much information from IESP was presented about conditions and needs in the Delta. Protective standards were debated and supported by new biological, hydrological, and engineering data developed in the IESP, but little mention was made of the system downstream of Suisun Marsh. By this time, Earth Day had occurred and a new-found ecological recognition, that aquatic systems are not separate entities but, instead, are part of a larger whole, was sweeping the environmental and academic communities. The mantra was “everything is connected to everything else.” Testimony, primarily from people in the San Francisco Bay area, indicated that while knowledge about water project impacts on the Delta was rapidly accumulating, nothing was being done to investigate impacts of the projects downstream of the Delta. The point was that the projects would reduce outflows to the San Francisco Bay and, thus, could negatively impact the fish, wildlife, and environmental resources elsewhere.

The SWRCB heard those concerns, and addressed them in the new Water Right Decision 1485 (D-1485) for the CVP and SWP, which was issued on August 16, 1978. The last condition listed in D-1485 (condition 10 [c]) required CDWR and USBR to carry out studies on freshwater outflow downstream in the San Francisco Bay. Specifically, investigators were to address “outflow needs in San Francisco Bay, including ecological benefits of unregulated outflows and salinity gradients established by them.” The SWRCB did not mandate that the work be done by the IESP, but stipulated that the work should be done “independently or in cooperation with other agencies or individuals.”

Prevailing wisdom was that the IESP provided the logical forum for cooperation. The SWRCB noted that the eventual purpose of the new study would be to provide information to identify any restrictions on reductions in Delta outflow necessary to protect fishery resources. The SWRCB mandated that the following questions be addressed: (1) What elements (organisms or faunal assemblages) of the San Francisco Bay biota would be affected by significant changes in inflow of freshwater from the Delta?; (2) How would total outflow reductions in conjunction with State and Federal water project operations change the hydraulics (e.g. present velocity distributions, velocity dependent mixing, and particle transport processes) and salinity gradients in the San Pablo and San Francisco bays?; (3) How would outflow-related changes in hydraulics and salinity affect fish and wildlife resources in San Francisco and San Pablo bays?; and, (4) What are recommended flow and salinity standards of other management strategies needed to maintain (or restore) fish and wildlife resources at historical levels? These broad questions would direct the IESP in a new, more broadly based ecological direction in future work in the system.

This direction from the SWRCB resulted in the establishment of the Delta Outflow/San Francisco Bay Study. Activities were restricted to developing a study plan entitled, “Study of Delta Freshwater Outflow Needs of the San Francisco Bay Ecosystem” and this plan

was approved by the Agency Directors in October and submitted to the SWRCB on October 15, 1979. Due to budget constraints and practical problems inherent in establishing a new investigation, the Directors recommended that the study be initiated on a limited basis during 1980, with full implementation in January 1981. Further, the Directors mandated that Study Element II, centered on hydrodynamic, physical, and chemical studies, be developed in more detail during 1980. As a result, the following elements were developed and included in the study plan.

Element 1: Literature Search

This element was designed to provide a framework for a thorough review of all relevant work that had been done on estuarine freshwater needs.

Element 2: Hydrodynamic/Physical/Chemical Studies

The objective of this element was to determine how Delta outflow affects flow related physical or chemical components of the Bay system.

Element 3: Outflow and Pollution Related Processes

The objective of this element was to maintain close coordination and information exchange with other SWRCB programs and related pollution-oriented studies conducted on San Francisco and San Pablo bays and on the western Delta. (Note that the Interagency Program did not want to expand into the pollution arena because they believed that was not in the purview of the SWP or CVP. These projects were involved in water flows and delivery, not pollution control. Some 20 years later IESP would reconsider and change this decision.)

Element 4: Plankton Dynamics Study

The objective of the Plankton Dynamics Study element was to determine the relationship between spatial and temporal distributions of both phytoplankton and zooplankton population parameters and Delta outflow. These organisms were known to be important as the base of the food chain. At this time, the USGS in Menlo Park had been monitoring and investigating water quality and plankton in the Bay since 1969, so the program chose to allow the USGS to carry out this element. This provided the opportunity for another member to join the program.

Element 5: Marine Species Distribution

This element was designed to determine how the spatial and seasonal distributions of important species of fish and macro-invertebrates change in relation to changes in salinity gradients in the Bay. State and Federal water project related activities were projected to alter flows which would affect salinity.

Element 6: Stratification Induced Current Transportation Study

This element was designed to document the existing relationship between landward and oceanward currents and the abundances and dispersions of selected “species of interest.” A major part of this element was to investigate the movement of larvae and small fishes into and out of the bay as affected by flow related currents.

Element 7: Shrimp Population Dynamics and Trophic Analysis

This element was meant to provide information on the relationship between shrimp population dynamics and Delta outflow. The element sampled three species of shrimp, each with different salinity preferences, and each used as food items by different species of predators. It was hypothesized that a reliable population abundance of these shrimp, coupled with trophic analyses of the shrimp associations, would provide insight into projected relationships between Delta outflow and biological population dynamics in the upper Estuary.

Building on its recent experience with the comprehensive entrapment zone studies, the IESP was now heading in a new direction that considered ecology of the entire Estuary.

An unprecedented nuisance bloom of a filamentous alga occurred in San Pablo Bay in 1979. In partial response to this and other observations, the Water Quality Program implemented certain changes that moved from data collection to data analysis, report completion, and program evaluation. Such a “stop and take notice” approach became commonplace in the IESP as time went on.

Even though IESP had been studying striped bass for almost ten years, the annual report in 1979 noted that, “…present knowledge of factors controlling striped bass abundance still is inadequate in a number of important respects, creating the need for further investigation of controlling factors.” The IESP was starting to offer explanations of the complexity and dynamic nature of the system that was being studied and rapidly developed.

A publication describing an analysis of factors affecting *Neomysis* abundance was submitted to the academic journal, *Estuaries*. The major conclusion of that report was that annual variation in abundance of *Neomysis* during summer was influenced by habitat availability and food supply. This was an acknowledgement that factors other than State and Federal project flows are important in the system, and was important in that it spurred IESP managers to think more broadly. IESP produced nine publications in 1979.

1980—A New Decade Brings More Unknowns

Nineteen-eighty marked the ten-year anniversary of the signing of the original MOU, and the IESP was expanding and maturing. One of the principal unanswered fisheries

questions continued to be, “why has the abundance of young striped bass been much lower than anticipated during and subsequent to the 1976–77 droughts?” The abundance index for 1980 was the lowest ever, except for that of 1977. This conundrum—and the lower production of food documented in the system—stimulated a major analytical effort in the Fishery Program; and, it expanded efforts to examine king salmon and resident fishes, and salmon studies switched from pilot studies to a full-scale program. Studies on largemouth bass were initiated in May 1980 as part of the resident fish study.

The Water Quality Program released a report with the results of the 1978 study investigating the importance of the location of the low-salinity entrapment zone. This study provided more evidence for a link between its location in Suisun and Honker bays and high phytoplankton biomass. A newly introduced zooplankton species (*Sinocalanus* sp.) was discovered in the Delta, but the effects of this on phytoplankton were unknown.

The Marsh Program also was at a crossroads. The original plan was completed in 1979, and CDWR moved ahead with the construction of initial salinity control facilities called for in the plan. The Roaring River unit was completed in 1979, and the remainder of the initial facilities was completed in 1980. The fish facilities work had proceeded to the point where the general concept for the facility could be selected. A positive barrier with small openings and an approach velocity of much less than 1 foot-per-second was specified, and the Marsh Program was on schedule to have enough data to permit final design of the facilities beginning in July 1982.

As a result of the actions above, the Fishery Program adjusted its objectives. The striped bass studies moved to measure survival of each year class of fish from the time eggs are laid until the year class no longer contributed to the catch. Emphasis was placed on early survival, which was that most likely being affected by water development and management.

Salmon studies were attempting to determine the minimum acceptable flow rates necessary for adequate survival of young salmon downstream from the proposed PC intake at Hood. The Fish Facilities Program clarified its objectives as: (1) Evaluate existing fish facilities; (2) Develop biological design criteria; (3) Work on fish return facilities; (4) Carry out predation studies; (5) Fish screen clogging, cleaning and corrosion studies; and, (6) Biological engineering technology reviews.

The Suisun Marsh Program also revised and listed its objectives as: (1) Utilization of waste water for duck pond operations and salinity control; (2) Channel Salinity Data Collection Program; (3) Identification of impacts of water development in the Central Valley on salinity levels in the marsh; (4) Determination of alkali bulrush and fat hen seed production; (5) Long term marsh vegetation surveys; and, (6) Development of a marsh management manual.

During 1980, the new San Francisco Bay Study received the official name, “Delta Outflow/San Francisco Bay Study” chosen to clarify that this effort was about Delta outflow effects in the Bay, not just about the ecology and natural history of the Bay. The study’s objectives now were to: (1) Determine how outflow changes resulting from state and federal water projects could alter hydrodynamic and salinity gradients in the Estuary; (2) Identify those elements of the biota most vulnerable to outflow related changes; and, (3) Determine how those biotic elements are likely to react to projected changes.

Also during 1980, the Water Quality Program spent its efforts characterizing the spatial-temporal variations of phytoplankton populations in the western Delta, Suisun Bay, and Central Bay with one another and physical water quality parameters. The new Delta Outflow/San Francisco Bay Study hydrodynamic program was still being finalized, and a workshop was scheduled for early 1981 to finish the plan: controversy centered on the magnitude of the effort needed to meet objectives.

Coordination became a byword in the new Delta Outflow/San Francisco Bay Study. The field sampling schedule mirrored the field schedule for the water quality monitoring conducted by the USGS-Menlo Park and carried out under the direction of Jim Cloern, in an effort to achieve maximum overlap in the field so that fishery, phytoplankton, and zooplankton data could be coupled. The Study also coordinated with the SWRCB on pollution-oriented studies. The SWRCB was developing an “Aquatic Habitat Program” in the Bay to investigate pollution issues, which was to be carried out by consultants. Delta Outflow/San Francisco Bay Study personnel sat on all the planning and technical committees for this effort to ensure overall program cohesion and coordination. And, finally, an agreement was struck with the CDFG Planning Branch to have the Biometrics Unit in Menlo Park handle all data entry, storage, retrieval, and programming needs for the NCSS NOMAD database management system. As time passed, such coordinated efforts expanded in the overall IESP.

1981—Data Handling Expanded

The movement toward computerized data storage and handling was a significant driver of IESP activities during 1981. The Water Quality Program, and specifically the USBR, took the lead in this effort, and Element 2 of the 1981 workplan called for development and initiation of a common data storage system and a common sampling site identification program for water quality and other parameters. Even though these were developed for water quality data, the concept would grow until all data from all activities were computerized in a common database. The initial effort in the spring of 1981 had the stated purpose of developing “a common data storage and retrieval system for the 4-Agencies and possibly other agencies in the EPA-STORET system.” At that time it was decided that all the Delta Outflow/San Francisco Bay

Study biological and water quality data would also be stored in a uniform format and be

readily accessible. That study was selected because it was new and did not have a large, pre-existing database; however, this effort was not without problems.

Beginning in 1968, the USBR had utilized the STORET system, but CDWR had collected data since 1975 and had entered only a portion of the data into STORET. CDFG data were not in the STORET system but, instead, were in two different storage systems. Further, all the sample sites in each of these systems were identified differently. Standardizing data and information from these varied activities was a difficult task. A two-step approach was set to accomplish the goal. First common names for all sample sites were developed and agreed upon; after this, all the data were entered in the STORET system. One of the substantial problems involved entering biological data into a system originally developed for physical (water quality) parameters. To assist, EPA and a private contractor were asked to identify steps necessary to store biological data. Interestingly, this problem has persisted to the present day and proved to be the bane of several additional efforts that followed this initial attempt to reconcile the difficulty.

Element 3 of the 1981 workplan called for the IESP to prepare a tape of water quality data from the information collected because of mandates contained in Decision-1379 and Decision-1485. DWR contracted with Ecological Analysts (a private consulting firm) to construct an integrated file of data generated from these efforts. Data were transferred from CDWR's WDIS computerized storage system to STORET, and then merged with the biological information that was stored on specialized in-house systems. All was then merged into a single file, and that file was put into a Statistical Analysis System (SAS) format to facilitate in-depth analyses. All of this seemed like a lot of effort to develop common data storage systems and, in retrospect, the desired value may not have been accomplished. Nevertheless, the important thing was that a movement toward consistent handling of IESP data had begun. Over time, this development would make the IESP a great source of information for use by the agency, environmental, academic, and private communities.

During 1981, the Water Quality Program took other significant actions. CDWR contracted with Hydroqual, Inc. (an offshoot of Hydroscience, Inc.) to develop a multilayer phytoplankton model of the western Delta and the Suisun Bay. The Water Quality Program also began review of the existing Decision-1485 monitoring activities to determine if they could be reduced in scope to allow fiscal and personnel resources to be used in other studies. An important observation made by the Water Quality Program in 1981 was that water hyacinth increased to major nuisance levels in the Delta; this would have water quality implications for the Delta in the future.

In 1981, the USBR applied to the SWRCB for a discharge permit for the San Luis Drain, which had been proposed to collect agricultural return flows from the west-side farming areas in the San Joaquin Valley and discharge those flows into the Delta. This was the last

piece of the CVP project that provided water for agricultural use in that area. Before making a decision, the SWRCB asked for additional information about the project, and USBR proposed to develop the plans in 1982 for a 4-year study.

Another potentially significant project proposed in 1981 was one to determine the technical feasibility of reducing salinity intrusion into the Delta by maintaining the Entrapment Zone in Suisun Bay, and destratifying the vertical salinity gradient at Chipps Island. Initial tests using a destratification device in the U.S. Corps of Engineers (USCOE) Physical Model were proposed for implementation during 1982– 83 to determine the feasibility of such a concept. The theory was that if the Entrapment Zone could be kept in Suisun Bay and environs, biological production in that area could be kept high while freshwater flows could be reduced.

The Delta Outflow/San Francisco Bay study spent significant effort in study plan implementation and in further development of its hydrodynamic element. A special, 4-person committee made up of CDWR, CDFG, USFWS and USBR staff was created to redraft the hydrodynamics workplan. The Delta Outflow/San Francisco Bay Study maintained close coordination and information exchange with SWRCB activities and related pollution-oriented studies. Study personnel were active on the Executive Committee, the Policy Task Force, and the Technical Advisory Committee of the SWRCB's San Francisco Bay and Delta Aquatic Habitat Program. Dr. Alex Horne and Dr. Hugo Fisher, both from UC Berkeley, were co- principal investigators and served as the Delta Outflow/San Francisco Bay Study science advisors. Alex Horne developed a study plan for pollution studies in the Bay. This relationship with the academic community further demonstrated the intent of the IESP to seek input from all stakeholders.

The Delta Outflow/San Francisco Bay Study also carried out a special episodic study in 1981. The intent was to obtain information about fish distributions during at least one uncontrolled outflow event during the year. The study reorganized sampling activities during February, so sites could be intensively surveyed before and after the only high outflow event of the year to determine its effects on the fish distributions. The IESP produced 10 publications in 1981.

1982—Voters Influence IESP Activities

In June of 1982, California voters greatly influenced the direction of the IESP. Proposition 9, which would have authorized the construction of the PC along with other facilities and various operational constraints, was defeated. That construction was to have been the final part of the legislatively authorized SWP, and was fully supported by all agencies involved in the IESP. Interestingly, an alliance was formed that influenced public opinion through an expensive public relations program and led to defeat of the proposition. Large agricultural interests in the San Joaquin Valley joined with the environmental community in northern California and campaigned that the canal was too expensive. In reality, the

agricultural interests were concerned about the constraints placed on operation of the canal, and the environmental community was concerned about perceived environmental impacts associated with more water being diverted from the system. The environmental community saw an opportunity to stop the diversion of more water, but missed the point that the water diversions would continue in a way that was possibly even more damaging: water would still be diverted directly from the Delta, rather than from a more remote upstream area. As a result of these events, CDWR phased-out planning for the canal facilities listed in Proposition 9, and emphasis was shifted to an evaluation of ongoing operational impacts and development of information for general use in future planning.

The IESP Fish Facilities Program was especially affected by these changes. Consensus was reached between staff and the Fish Facilities Consulting Board as to the concept of the first stage of the PC, but defeat of Proposition 9 caused major activities to be terminated, and continuing efforts to be directed toward evaluating and improving existing facilities. One such effort involved the John E. Skinner Fish Protection Facility. That project was completed in 1971, and was named in 1979 after CDFG Biologist John E. Skinner who worked for CDFG for 25 years and led CDFG Delta fish programs before he died, tragically, in a fire.

The remaining Fish Facilities Program elements to be emphasized included: (1) Evaluations of existing facilities; (2) Predation studies; (3) Biological studies support; and, (4) Engineering studies at the existing and proposed facilities. In addition to these efforts, considerable effort was expended preparing a report that summarized results of the entire Fish Facilities Program. The decision was made to complete the report without a formal recommendation but, instead, to indicate consensus of the Fish Facilities Technical Committee and the Consulting Board. The Fish Facilities Program now emphasized work at the Roaring River Slough intake in the Suisun Marsh, and modification of the Hood facility for a new long- term fish response test facility.

The Fish Facilities Program also evaluated the need for screening agricultural diversions in the Delta. The initial report concluded there were approximately 2,000 small diversions in the Delta and screening would be expensive, and appropriate screen designs were not then available.

Another significant effort shaped the activities of staff in the Fisheries Study Program during 1982. A major, multi-agency effort was begun to determine the cause of the observed striped bass decline, and was based on the re-evaluation of existing data. The SWRCB played a major role in this event, and appointed a panel of 15 biologists and engineers to assess the situation. The panel included 5 members of the IESP and other experts from around the nation. These individuals provided significant expertise in reviewing and helping the Fishery Program during the coming years. The panel identified entrainment losses in diversions and toxic substances as plausible contributing factors, in

addition to those that previously had been identified. The panel did not reach a definitive conclusion, but advocated management actions to alleviate the four suspected causes of the decline. They are: (1) Inadequate food supply for the young bass; (2) Entrainment losses in diversions; (3) Toxic substances; and (4) Lack of striped bass eggs.

In 1982, USBR negotiated a contract with Drs. Josselyn (San Francisco State University) and West (UC Berkley) to expand the San Luis Drain macroalgae studies that were ongoing under a Water Resources Grant to UCD. USBR also contracted with Hydroqual, Inc. to conduct an evaluation of potential drain discharge impacts on phytoplankton, dissolved oxygen, and conservative constituents using the newly developed steady-state multilayered, two-dimensional phytoplankton model. This “state-of-the-art” model became a predictive model. The USBR also conducted several other drain-related studies on pesticides and boron, toxic metals in the water column, and toxic metals in sediment. They completed bioassays using receiving water organisms, and evaluated the potential of using the USCOE physical model to study destratification at Chipps Island. As time moved on, USBR included all of the drain information in the annual reports of the IESP, even though those efforts were not part of the interagency study; their thought was that the results could help the overall understanding of issues in the Delta.

While the San Luis Drain was never completed, another new drain came online in 1982: the Sacramento Regional Wastewater Treatment Plant began to serve as the primary wastewater treatment plant for the city and county of Sacramento. Previously, 22 separate treatment plants operated in the Sacramento region and discharged into various local waterways, including the Sacramento and American rivers. Starting in the mid-1970s, a system of interceptor pipelines began bringing sewage from various locations in the greater Sacramento region to the new treatment plant in Elk Grove. All secondarily treated sewage from the new central plant was then discharged into the Sacramento River near the town of Freeport. Discharge from that plant grew along with the population in the Sacramento region, but did not receive much attention from the IESP until about twenty years later.

With the exception of salmon trawling studies, most of the Delta Outflow/San Francisco Bay Study was implemented fully in 1981. The hydrodynamic studies were approved for implementation in 1982. The literature review was completed and progress was made on coordination with the San Francisco Bay- Delta Aquatic Habitat Program. Lower trophic level studies, a part of the program carried out by USGS, focused on South San Francisco Bay, and researchers reported that phytoplankton biomass in San Francisco Bay is seasonally maximal during the spring and the timing of maximum chlorophyll concentrations coincide with a 3–4 week “window of weak tidal currents and high rates of inflow of fresh water.” These results started to lay groundwork showing the roles of freshwater flow on the biology downstream in the Bay portion of the system, as required in the study mandated by Decision-1485. Significantly, the Delta Outflow/San Francisco Bay

Study Bay Technical Committee was expanded to include the Bay Conservation and Development Commission (BCDC) and the NMFS. This Technical Committee then became the largest and most diverse committee in the IESP, reflecting the new direction to consider a broader scope.

In 1982, a river-kilometer index system (RKI) was developed to include all water quality monitoring sites. This was the first successful attempt to derive a common location system for sampling sites prior to development of LORAN and Global Positioning Systems. The RKI was needed for STORET but, unlike STORET, the station naming system is still used today. The EPA STORET Users Group was contacted and agreed to make major modifications in STORET software to accommodate IESP biological data. USBR also contracted with Ecological Analysts to develop computer files for all CDFG biological data.

New species also appeared in the system this year. The previously introduced species, *Limnoithona sinensis*, a small Asian copepod, was first identified in the system. Another newly described copepod species, *Oithona davisae*, was also found and named after Sally Davis, the DFG laboratory assistant who discovered it during ongoing sampling efforts. A manuscript was written on the accidental introduction of *Sinocalanus doerrii* to the Estuary (Orsi et al. 1983). Such accidental introductions would soon play a significant role in changing the estuarine environment.

1983—Movement Away From Peripheral Canal Studies

By 1983, the IESP changed the second broad program goal from “Provide design and operational input for Peripheral Canal planning so the canal will meet fish and wildlife needs,” to “Provide design and operational input for Delta water facilities planning so the facilities will meet fish and wildlife needs.” This change reflected the defeat of Proposition 9 in 1982. As a result, the program shifted attention to evaluating non-peripheral canal alternatives for diverting water from the Delta during 1983. Nevertheless, water diversions were to continue, just not through a canal as all of the agencies previously had recommended.

The Water Quality Program assembled an Interagency Phytoplankton Task Force to continue examining factors controlling algal growth in the upper Estuary. An emphasis was placed on the drought and post- drought decline in algal production, and a new report was scheduled to be released in 1984.

The Suisun Marsh Program was at this time involved in completing the overall plan, evaluating the use of waste water supplies for the Marsh, monitoring and evaluating operations and basic soil-water channel relationships, and preparing necessary environmental documentation and negotiating agreements among the various parties. While carrying out the studies that had been redirected because of the defeat of Proposition 9, the Fish Facilities Program de-activated and secured the Hood Test Facility

site.

During 1983, uncertainty continued to plague the Fishery Program regarding the reasons for the striped bass decline over the years since the drought of 1976–77. The Fishery Program reported lack of a clear- cut explanation for the decline in numbers of both young and adult bass, and the continued low number of bass. This was perplexing because recent, apparently optimum conditions of Delta outflow and diversions, had resulted in more effort being spent on striped bass than would have been thought necessary in the early 1970s. Uncertainty regarding this decline continues to this day.

The Delta Outflow/San Francisco Bay Study released a literature review and report in 1983, and began the salmon sampling at the Golden Gate Bridge in San Francisco Bay. The objective was to relate outflow in the vicinity of the bridge to movement by salmon smolts. A new research vessel for the study, the MR/V Longfin, was delivered and trawl comparisons with older research vessels were completed. The USBR and USGS proposed significant changes in the hydrodynamic element of the Delta Outflow/San Francisco Bay Program. Even at the end of 1983, however, there was still no specific proposal available for review.

Work continued on data storage. In the summer of 1983, USBR hired a temporary employee to transfer earlier USFWS beach seine data from field sheets to keypunch format. No headway was made, however, on the transfer of CDFG data to STORET, a result of contract problems with the consultant.

1984—The Expansion of IESP

In 1984 the face of IESP changed in several ways. First, there were the six agencies represented by the Program Coordinators. Besides the four original agencies, the group included representatives from USGS and the SWRCB. This involvement stemmed primarily from interest in the new activities associated with the Delta Outflow/San Francisco Bay Study. Further, a new technical committee was added to the program: the Data Management Committee reflected the recent emphasis on data handling, storage, and analysis. The new committee worked with the Environmental Protection Agency to develop an “enhanced” STORET system to handle interagency databases.

Also this year, the format of the annual report was changed, and it was now compiled by Dr. Randall (Randy) Brown (CDWR). The new format incorporated important findings as well as program accomplishments. Dr. Brown’s involvement and scientific influence resulted in a significant change in the IESP that would play out over time, yielding a greatly strengthened and effective program. Primarily, Randy represented CDWR in IESP and assumed a senior scientist role on the Coordinators. He facilitated enhancement of the IESP’s scientific credibility, and moved it from a program focused mainly on water project related studies to one with a broader ecological approach.

Dr. Brown's influence is demonstrated in the 1984 Annual Report, which he compiled. He wrote a section summarizing the physical system and what we had learned about it. The following three paragraphs from his report are included here because they give insight into the broadening of the horizons of the IESP that would occur under his influence. The program was no longer only a water project driven effort.

> *"The Estuary is a focal point for water development in California, because water is transferred from Northern California and moves through the Delta. Diversion of water from the Delta by the California Department of Water Resources and the U.S. Bureau of Reclamation is by authority of water right permits granted by the State Water Resources Control Board. These permits are reviewed periodically to ensure that water diversions are not adversely affecting the Estuary. The next review session is scheduled to begin in 1986; data from the interagency study and others will be used to determine if changes are needed in operating criteria or water quality standards.*
>
> *The Interagency Ecological Study Program is designed to evaluate impacts of the State and Federal water projects on the Estuary. Other human activities and natural events also affect the system. The effects of changes in volume and quality of municipal and industrial wastes, irrigation return flows, dredging, bay filling, flooding of Delta islands, and major climatic events such as El Nino must be considered when trying to assess the impacts of diversions on the estuarine health.*
>
> *Studies by various entities outside the interagency program increase understanding of estuarine processes and help sort out cause and effect relationships. The results of some of these related studies are included in this report to provide a more complete understanding of the issues."*

The insightful recognition of "other human activities and natural events" affecting the system and the verbalization that, "various entities outside the interagency program increase understanding of estuarine processes…" would set the course for a new and more inclusive IESP that would gain credibility among the public and academic community.

1985–1986—Summarization and Preparation for SWRCB Hearings

In 1985 and 1986 comprehensive reports were being developed for all major IESP elements in order to summarize knowledge of each element and to serve as exhibits for a SWRCB water rights hearing to be held in 1987. In fact, the fifteenth annual report combined information from both 1985 and 1986, and was the first time multiple years were combined. This was done to save staff time, which could then be expended on preparation of the comprehensive reports. The fifteenth annual report was to contain summaries of all the individual technical reports developed during 1985–1986.

During this time, the IESP became officially known as the “Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary." It was still commonly known as IESP, but the addition of the phrase, “for the Sacramento-San Joaquin Estuary” sent the message that the scope was larger than it had been. The IESP was now interested in the whole system, not just parts of it. It had become more inclusive, and reflected the expansion of “ecological” thinking.

Another significant activity during 1985–86 was the creation of a task group to aid state and federal agencies in analysis of factors contributing to the decline of striped bass in the system. The cause of this decline, which began during the drought of 1976–77, had not yet been explained. The task force members included: Don Kelley (bass biology), Jerry Turner (early life stages), Jeanette Whipple (environmental contaminants), Lou Botsford (population modeling), Joe Loesch (east coast striped bass population dynamics) and Paul Smith (field sampling strategies for juvenile fish). In addition to searching for causes for the decline, this group was asked to review the Fishery Program and make recommendations. The resulting report included much technical information and was submitted to the SWRCB during the water right hearing scheduled to occur during 1987. Similar to previous endeavors, this report was inconclusive regarding the causes of the decline in striped bass.

An additional noteworthy activity during 1985–86 occurred in the Data Management Program. As described earlier, EPA had established a national storage and retrieval system for water quality data known as STORET and, in 1981, USBR had begun to work with EPA to modify STORET to accommodate other types of data. Using CDFG and USFWS data in a pilot project, EPA/STORET developed “enhanced STORET.” This system was put on line in May of 1985.

One of the problems with using "enhanced STORET" in the IESP was that compromises had to be negotiated between each study program to ensure data compatibility. In order to accomplish this, 65 new media codes, 550 new species codes, and 40 new parameters were requested from STORET. Considerable IESP resources were expended in this effort to make the data available for all parties participating in the 1987 water right hearings. The following information provides an example of the effort involved. Each program had the following data residing in STORET at the end of this exercise.

Delta Outflow Study

Data from 1980–1983, 64 stations, 206,000 samples, and 626, 000 observations.

Neomysis/Zooplankton Study

Data from 1970–1981, 86 stations, 236,000 samples, and 546,000 observations.

Midwater Trawl Study

Data from 1967–1983, 156 stations, 43,000 samples, and 546,000 observations.

Townet Survey

Data from 1959–1983, 35 stations, 71,000 samples, and 23,000 observations.

Striped Bass Egg and Larvae Survey

Data from 1966–1977, 54 stations, 75,000 samples, and 90,000 observations.

Salmon Study

Data from 1976–1984, 39 stations, 148,000 samples, and 441,000 observations.

In order to allow staff to access and retrieve these biological data, the group had to write a "Users Guide." This guide and data storage provided a capability that previously had not existed for CDFG and USFWS data. As a result, IESP-generated data became more accessible.

1987–1989—A Time for Review and Change

Most staff time during 1987 and 1988 was spent on the SWRCB water right hearing. That hearing continued for months while data, management recommendations, and requirements were debated by lawyers, engineers, biologists, water agency managers, environmentalists, and consultants representing many perspectives. During this time IESP data were prominently presented and discussed, but not always by IESP personnel. The process became adversarial, and each agency generally presented its own perspectives on the data. There was no "IESP" presentation, but information developed by that program still provided the "backbone" of knowledge about the system.

The year 1988 also saw the IESP take steps to enhance communication, integrate studies, facilitate work, and increase efficiency within the Fisheries and Water Quality programs. At that time, the Food Chain Group was organized within IESP, and the group was charged to integrate studies on phytoplankton, zooplankton, and larval striped bass in order to answer the questions: (1) What has caused the changes in production at all levels of the food chain within the Estuary?; and, (2) Has the increased mortality of young striped bass been caused by a change in food supply?

Meetings of the new group were inclusive and open to everyone, not just IESP staff. The meetings usually were attended by at least 10 scientists, included day-long discussions of data, hypotheses, and analyses of programs. Members of the group submitted drafts of 43 working papers that were reviewed at the meetings. In 1989, the group discussed and took actions on zooplankton, the entrapment zone, striped bass egg and larval surveys, larval striped bass stomach analyses, feeding studies, and water quality changes, as well as the newly introduced Asian overbite clam, *Potamocorbula amurensis*, a brackish water

mollusk first observed in Suisun and Grizzly bays in the spring of 1987. It was thought this species was introduced in late summer of 1986 near Carquinez Strait. Populations of this clam would greatly expand in the system and influence trophic dynamics for years to come. Another significant change occurred in the system in 1987 when the introduced calanoid copepod, *Pseudodiaptomus forbesi*, was first observed. This species was of substantial concern because it was not as good a fish food source as the previously abundant calanoid copepod species, *Eurytemora affinis*, or even the earlier invader, *Sinocalanus. P. forbesi* largely replaced both *E. affinis* and *Sinocalanus* in the low salinity zone.

Three changes of note occurred in the IESP during 1989. First, the Suisun Marsh Program moved from a planning mode to a management mode. As a result, it was removed from the IESP, even though its monitoring activities were still reported in that group's annual report. Secondly, the IESP image was further evolving, as demonstrated by a change in format in the Annual Report format. During 1989, the report was not organized by study element as it had been in the past. Instead, the report began with a discussion of physical topics and then moved to phytoplankton and the Marsh, and then through larval fish and the fisheries programs. The stated purpose of this change in organization was to encourage the reader to think of IESP as an integrated study of an entire estuarine system. This intent was also reflected in program staff thinking and the stated intent to study the system as a whole and not just as a series of unrelated parts. In other words, IESP became interested in looking at the whole ecosystem, a change that had its beginnings in 1984 as a result of the new emphasis described in Dr. Brown's annual report. Thirdly, the Directors asked that the IESP hold a workshop in 1990, and established an organizing committee to find a site and develop an agenda. That workshop was to become known as the Asilomar Workshop because it was held at the Asilomar State Conference Center in Pacific Grove.

In line with increased program sophistication, USGS and DWR began measuring hydrodynamic parameters as part of the Delta Outflow/San Francisco Bay Study and established continuous monitoring at several stations in the system. The USGS began studies of gravitational circulation and used state-of- the-art, upward-looking Acoustic Doppler Current Profiler techniques, which measured water speed and direction. At this time, the IESP made major strides into modern sampling techniques.

The importance of IESP-generated data and the willingness of that program to expand were noted in 1989. The Electric Power Research Institute sponsored a $12 million research program on fish population dynamics to study compensatory mechanisms (COMPMECH). A major part of this effort was fish population modeling, which was carried out at the Oak Ridge National Laboratory. Striped bass was a key species in that effort, and it planned to use much of the information generated by IESP. This national effort required coordination between Oak Ridge National Lab, CDFG, and other IESP members.

Also, during this time, CDFG was conducting adult striped bass health monitoring, which was part of the Regional Effects Monitoring Element of the Aquatic Habitat Institute Monitoring Program. Striped bass continued to be a prominent part of IESP activities in the system, and a report put out at this time on all the analysis going on with striped bass concluded that, “past entrainment losses of young bass are the root cause of the problem and reduced egg production by the depleted adults … probably caused lower annual production of young fish.” However, there was not consensus with the conclusions of this report among the fisheries community. By this time, the striped bass program had been reviewed extensively by the Striped Bass Task Force, which generally agreed that population monitoring should continue and the bass program should be expanded to help quantify mortality mechanisms and to develop solutions to the problem.

The IESP salmon program was coordinated with CDFG’s Region 4 salmon activities, which were designed to evaluate factors influencing smolt survival in San Joaquin River tributaries to the Delta. The results of these efforts were presented at the SWRCB water right hearing. These, and other salmon program data, later would be used in the SWRCB Delta hearings, and in the “Article VII” (a section from the 4 pumps mitigation agreement between CDWR and CDFG) negotiations. The intent was to reach agreement between the two agencies for mitigation of fish losses attributable to the operation of SWP facilities in the Delta.

The Schubel Freshwater Inflow-San Francisco Bay Workshop (“If we don’t change direction, we are apt to end up where we are headed.” — an old Chinese proverb)

The Delta Outflow/San Francisco Study began analysis of the data collected between 1980 and 1988 in order to complete a 1991 Fish Bulletin describing early program findings. The workload on staff to prepare this work necessitated that field sampling in 1989 be restricted to the period January through August, instead of year-round. As part of this first major review of the relatively new study, IESP invited a panel of twelve estuarine scientists to spend 2.5 days (July12–14, 1988) at the Tiburon Environmental Center to review ongoing monitoring and research programs. Even though the initial request was to review only the Delta Outflow/San Francisco Bay Study, the review expanded to include all the programs under the auspices of the IESP. This expansion occurred partially because the panel was informed that the results of the ongoing IESP had recently been presented at the SWRCB Board hearing, and that both the SWRCB and those involved with the program had been dissatisfied with the arguments that they were able to make at that presentation: those arguments were centered on the effects that changes in freshwater inputs to the Bay would have on the estuarine portion of the Bay. As a result, the IESP managers in attendance at the panel review agreed to the change in direction and expansion of the panel’s charge.

The panel was comprised of prestigious members of the estuarine research community

and, therefore, it is important to mention them here. The panel members were Dr. J. R. Schubel (Office of the Provost, State University of New York); Dr. David A. Armstrong (School of Fisheries, University of Washington); Dr. Neal Armstrong (Department of Civil Engineering, University of Texas at Austin); Dr. Alan F. Blumberg (HydroQual, Inc., Mahwah, New Jersey); Dr. Donald Boesch (Louisiana University); Dr. William Boicourt (Horn Point Environmental Laboratory); Dr. L. Eugene Cronin (Chesapeake Biological Laboratory, Retired); Dr. Ford A. Cross (NOAH-NMFS, Beaufort, North Carolina); Dr. Robert Huggett (Virginia Institute of Marine Science, College of William and Mary); Dr. Maurice P. Lynch (Virginia

Institute of Marine Science, College of William and Mary); Dr. Scott Nixon (Department of Oceanography, University of Rhode Island); Mr. Charles A. Simenstad (Wetland Ecosystems Team Fish Research Institute, University of Washington); and, Dr. Carl Walters (Institute of Resource Ecology , University of British Columbia). In addition to this panel, 34 local program and non-program researchers knowledgeable about the local system participated. In retrospect, this event may be considered one of the most through reviews in the history of the IESP.

The findings and recommendations from the workshop were targeted to answer the following questions: (1) Will the present and proposed research, monitoring, and modeling programs provide the level of understanding needed to make reliable forecasts of how changes in the allocation of freshwater inputs to the Bay would affect the estuarine portion of the Bay and its biota?; (2) If not, what modifications would be required?; and, (3) What new knowledge is needed?

At the beginning of the workshop the panel highlighted the importance of distinguishing between “doing the right things” and “doing things right.” The panel made it clear that its role was to attempt to determine whether or not existing scientific and technical programs, particularly the monitoring efforts, were doing the right things — the things that would, if continued for the next 10 years, provide the basis for predicting what the effects of different freshwater allocations would have on the estuarine portion of the bay and its living resources.

The panel’s final report listed general observations, general recommendations, and findings and recommendations for each of four major program areas. Given the eventual influence of this panel’s recommendations and the universality of the group’s wisdom, it is appropriate to list the general observations and the recommendations.

The panel's observations were that: (1) The present San Francisco Bay Interagency Program suffered from the lack of a sound conceptual framework; (2) A concerted and coordinated effort also needed to be made to identify the full range of potential beneficial uses and users of the San Francisco Bay estuarine system, to put some value on each of

these uses, and to document the information needed to assess how these uses might be impacted by alterations in the freshwater input; (3) Because of the diffuse nature of the "program," which cuts across agency bounds, it is difficult for any individual or collection of individuals to exert effective leadership; (4) In the absence of major fundamental and structural changes, the State would not be in a significantly better position for the next set of hearings before the SWRCB, approximately a decade from the present time, than what it currently was; (5) The program should sponsor special, intensive studies during those periods—prolonged dry to wet periods—when the probability of impacts of water diversion on the environment and the biota would be greatest; (6) If substantial increases in the diversion of freshwater are to occur in the future, the processes and facilities by which the diversions are to be implemented, and the timing of the diversions, will require careful evaluation to minimize the probability of adverse impacts on the San Francisco Bay ecosystem because timing and the places and modes of withdrawal are critically important; (7) The National Estuary Program study of San Francisco Bay was in its formative stages, and special attention was needed to ensure that the EAP study would complement the ongoing efforts; (8) If environmental monitoring programs were to be successful, they must be sustained, and stability of funding and consistency of commitment would be essential; (9) Data should be transformed into information on a regular and timely schedule and should be used to test the hypotheses or answer the questions on a recurring basis—at least once per year; and, (10) Water is a precious resource and one that will increase in value with the effects of the forecast of climate change anticipated to affect California and much of the United States; thus, a special effort should be made not simply to evaluate the trade-offs of different allocation processes, but to conserve the resource.

The panel's general recommendations were that: (1) Strong conceptual leadership should be added to the IESP to ensure adequate program synthesis and scientific vision directed to the critical management questions; (2) The involved agencies should also explore alternate organizational models to improve interagency cooperation in execution of a well-integrated studies plan; (3) Efforts be undertaken to increase involvement of university faculty and students in the Ecological Studies Program; (4) A focused effort be continued to: [a] to identify the specific effects of flow on water quality and changes on the "desirable uses" of the Estuary; [b] clarify the means by which such efforts would be achieved in the Estuary; [c] seek potential numerical and seasonal standards to be applied at Chipps Island and other sites to enhance of minimize adverse impact on estuarine resources; and [d] test, by research and analysis, each potentially useful standard to refine both the useful standards and their justification; and, (5) Mechanisms for synthesis be developed and implemented.

Specific findings and recommendations for the four major IESP program areas discussed by the panel are not listed here, but interested readers are referred to the original document developed by the panel (Schubel 1988). As time passed the Coordinators

reviewed the panel's recommendations and made many significant changes in response; those changes will be described in sections of this report that follow.

Another significant addition to IESP occurred in June of 1989, when Dr. Randy Brown published Volume 1, No. 1 of the *IESP Newsletter*; subsequent editions would be published quarterly. The goal of the *Newsletter* was, "to provide staff of the cooperating agencies and others with periodic updates of programs and findings from the Interagency Program and related studies in the Bay-Delta system." Readers of the *Newsletter* were encouraged to submit brief articles or ideas for articles. This new publication became a valuable tool to communicate program information rapidly, and signified a professional upgrade for the IESP even though the articles were never meant to be peer reviewed. The *Newsletter* was read by program staff and managers alike, and publication continues. The *Newsletter* is available at the IEP Web site.

1990—Program Evolution and Outside Perspectives

In 1990, IESP evolved in several significant ways. First of all, the United States Corps of Engineers (USCOE) officially joined the program and signed the MOU. This occurred primarily in response to expanded engineering and hydrodynamics work carried out in the Delta Outflow/San Francisco Bay Study that was associated with USCOE's dredging activities, and a desire to coordinate with IESP on the Baldwin Ship Channel activities, which were under the direction of USCOE. Further, the SWRCB mandated that the Water Quality Compliance Monitoring Program be incorporated by CDWR into the IESP in 1990, and this typified the desire of agencies to incorporate similar work into the IESP.

A more substantial program change was the decision by the Agency Directors to establish a Study Manager position. That new position was to assist in carrying out IESP activities, and to supervise and coordinate technical aspects of program management. This was a major step in becoming a truly cooperative program. Dr. Perry L. Herrgesell (CDFG) was chosen for this position, the duties of which were to (1) Supervise DFG technical staff; (2) Oversee technical staff of other programs; (3) Develop and implement a public relations/communications program to make data and findings available; (4) Work with the Coordinators to develop meeting agendas and follow-up; (5) Work with technical committee chairs to establish and oversee technical advisory panels; (6) Coordinate annual development of workplans and budgets for individual study programs; and, (7) Coordinate preparation of annual reports and technical workshops.

Prior to 1990, the IESP held an annual workshop for staff to review Program activities and discuss findings and results in an informal atmosphere. These meetings had occurred at various locations including Sacramento, Davis, and Vallejo and were limited mostly to select staff. The 1990 workshop was held at Asilomar Conference Center in Pacific Grove, and marked an "opening up" of IESP to outside participants (e.g., water users and consultants) and a formal and more disciplined agenda. The Conference Center provided

a casual atmosphere that encouraged staff interactions at the site and during meals; 115 people attended this first workshop. The collegial atmosphere allowed interaction between programs and scientific disciplines. Engineers, biologists, secretaries, field personnel, and boat operators were invited and this led to a feeling of a more unified and cohesive program and all participants had a clearer understanding of where their work fit into the larger scheme of things. An emphasis was placed on well- prepared presentations, and the workshop became more like a scientific conference. This change in workshops resulted in a new more inclusive face for the IESP.

An important session during the 1990 workshop was one titled, “Outside Perspectives of Interagency Activities” that solicited review and criticism from people outside the IESP. The group of speakers recommended that: (1) Staff must make technical findings routinely available; (2) Staff should evaluate the desirability of consensus building and enhanced advocacy roles; (3) Staff should work together and stop interagency “bickering”; (4) Staff must be willing to make decisions and recommendations based on their information; (5) The IESP needs intense and open annual technical review by outside reviewers; (6) staff must develop schedules for reporting findings; (7) The IESP should provide studies that result in more water for biological resources and not as much study of facilities; (8) Agencies must be willing to compromise; and, (9) The IESP move away from the emphasis on striped bass and salmon and more toward delta smelt, etc.

In response to comments received from these participants, the Coordinators and Directors implemented some program changes during 1990. During the October meeting the Program Directors approved a revised set of IESP goals. In part, this effort was in response to the 1988 Schubel Freshwater Inflow-San Francisco Bay Workshop Panel’s recommendation to provide a sound conceptual framework for the program. The revised program goals were to: (1) Provide for the collection and analysis of data needed to understand factors controlling the distribution and abundance of selected fish and wildlife resources in the Sacramento-San Joaquin Estuary and make data readily available to other agencies and the public; (2) Comply with permit terms requiring ecological monitoring in the Estuary; (3) Identify impacts of human activities on fish and wildlife resources; (4) Interpret information produced by the program and from other sources and, to the extent possible, recommend measures to avoid or offset adverse impacts of water project operation and other human activities on these resources and seek consensus for such recommendations, but to report differing recommendations when consensus is not achieved; and, (5) Provide an organizational structure and program resources to assist in planning, coordination, and integration of estuarine studies by other units of cooperating agencies or by other non-IESP agencies.

Goal number 4 was of significant importance because it mandated recommendations on measures to avoid or offset adverse impacts of the projects. Until then, such recommendations were always made by individual agencies. Now, there was recognition

of the desirability for “unified” recommendations, but also recognition that a consensus may not be reached. This verbalization of the value of such recommendations was a big step for the multi-agency IESP with many separate agency goals.

Another significant attempt at IESP improvement resulted in the Directors agreeing to meet on a biannual basis to receive technical briefings on aspects of program activities; prior to this they met only annually. The agenda for those meetings was not to include decisions or budget items, but would only focus on technical updates and findings from the study programs. This information would allow the Directors to make more informed policy decisions. As a result, the IESP became more relevant to decision makers.

As more information was generated by the IESP, it became apparent that there was little involvement by the academic community in local estuarine science. On the east coast, there were many research programs in Chesapeake Bay that were associated with local universities. The same was true for estuaries in the south. In California, particularly in the San Francisco Bay system, there were major universities (UC Berkeley, UC Davis, Stanford, San Francisco State, and others) that were located “on the shores” of the Bay, yet they were not involved in study or research in the system. The 1988 Schubel Panel pointed this out specifically, and made a recommendation to address that issue. In an attempt to foster more research on various aspects of the Estuary by local universities, and to respond to the panel recommendation, the IESP and the San Francisco Estuary Project established a grant program called the University Academic Research Involvement Program (UARIP), which would support graduate students and post-doctoral fellows. The intent was to provide “seed money” so that professors and their graduate students would be drawn to work in the Estuary. IESP allotted $75,000 and SFEP allocated $75,000 for the first year.

During 1990, 20 proposals were submitted and reviewed by a group of academics, coordinated by Dr. Tom Powel (UCD). Other review panel members included Scott Nixon (University of Rhode Island), Bill Boicourt (University of Maryland), Carl Walters (University of British Columbia), Sam Luoma (USGS, Menlo Park), Paul Sawbatier (UCD), and John Lech (Medical College of Wisconsin). From the group of 20 proposals, funds were awarded by IESP to four researchers: Dr. R. Tjeerdema (Bioconcentration in striped bass), Dr. J. Harney (Habitat use by harbor seals), Dr. J. Largier (Water exchange through the Golden Gate), and Mr. W. Bennett (Interaction of starvation and predation on striped bass). As a result, several world-class university researchers developed lasting programs and relationships within the system and with IESP, and the IESP was exposed to academicians around the country.

During 1990, IESP received exposure to the outside world in several ways. The USBR sponsored an Israeli scientist to tour the Bay-Delta and describe the use of echo-sounding equipment to assess fish populations in field applications. Also, Dr. Brown visited the

Soviet Union to discuss mutual experiences regarding the impacts of water development on fishery resources.

During 1990 the IESP established a scientific review panel for the Delta Outflow San Francisco Bay Study. The panel met twice a year to review program workplans and determine if the program was “doing the right things” and if things were “being done right.” The six panel members were: Dr. Jerry Schubel (State University of New York, Stonybrook), Dr Donald J. O’Conner (HydroQual, Inc.), Dr. Tim Hollibaugh (San Francisco State, Tiburon Center), Dr. Alec McCall (National Marine Fisheries Service, Tiburon) and Dr. Carl Walters (University of British Columbia). That panel typified the desire of the IESP to receive helpful review and be recognized as a reputable research and monitoring program.

In April of 1990 work began on a proposal for CDFG to assume responsibility for fish sampling and transportation at the Skinner Fish Facility. This was necessary to improve data quality and to carry out the anticipated doubling of the workload that was planned when new holding tanks at the facility were to go into operation in 1992. In reality, biologists from CDFG were more appropriately trained for the job when compared to the engineers in CDWR, who were currently assigned to that task. The work was more biological than engineering.

Finally, a very significant event took place in 1990 and proved to have a major influence on IESP direction and on the future of water projects in the Estuary. A small fish, the delta smelt, was endemic to the Estuary. In 1990 USBR contracted with Dr. Johnston Wang to develop a taxonomic key for identification of early life stages of this estuarine fish. During this time, various IESP surveys noted that the population of the smelt had declined substantially since the 1980s. In 1989, Dr. Peter Moyle (UCD) petitioned the California Fish and Game Commission to list the delta smelt as endangered under the state endangered species law. That petition triggered a CDFG status review, which confirmed the decline but was unable to determine the cause. CDFG recommended listing the smelt as “Threatened.” The Commission did not agree and directed CDFG to do studies, with funding to be provided by CDWR before they would consider listing. Smelt investigations were planned and implemented in 1990; actual field work began in January of 1991. Eventually, this fish would be listed, an action that would have a major impact on diverting water from the Delta. Concurrently, CDFG began new studies, using mark- recapture, radio tagging, and juvenile captures, to better define spawning areas for sturgeon in the Sacramento River. The future would also hold a listing of green sturgeon.

1991—New Membership and Development of X2

Increased agency membership expanded the IESP in 1991 and early 1992. At the October 1991 Director's meeting, the Directors recommended that the EPA be invited to formally join the IESP. This recommendation was based on EPA’s interest in the SWRCB’s Water

Quality process in the Bay and Delta, and its involvement in the San Francisco Estuarine Project. EPA signed the agreement in early 1992 and became the 8th member of the IESP.

EPA's involvement would become important, as that agency promulgated a water quality standard (X2) after the state failed to adopt a draft water right decision following a prolonged hearing. The EPA involvement began in August through the sponsorship of the San Francisco Estuary Project, which included a 3-day workshop of about 30 estuarine scientists, engineers, and policy makers in an effort to determine if an entrapment zone standard should be adopted to protect San Francisco Bay. IESP staff participated by "invitation only." Again, Dr. Jerry Schubel (State University of New York, Stony Brook) facilitated the workshop. During the ongoing state water right hearings, the Environmental Defense Fund argued that the entrapment zone should be positioned near Suisun Bay to maximize its benefit to some estuarine biota. Such a criterion would come at a cost to the water project's yield because downstream flows would be needed to maintain it in the desired position.

Discussions among scientists at the workshop quickly indicated there was too much uncertainty regarding the entrapment zone, how to monitor and predict its position, and the nature of expected benefits to justify setting a standard designed to locate the zone in any specific area at that time. With guidance from Dr. Schubel, the discussion moved to the potential benefits of a bottom salinity standard at various locations from Carquinez Strait to the western Delta. There was considerable discussion regarding the desirability of using salinity as a surrogate for flows, but too little was known about salinity requirements of fish and invertebrates in the system. As a result, Dr. Schubel recommended, and the majority agreed, that a small technical team be established and attempt to better quantify the benefits and bring the results back to the larger group in December.

The technical team carried out analyses of existing data with the intent of investigating the validity of using salinity instead of outflows for standard setting, and two significant technical reports were prepared. One report, by Wim Kimmerer (BioSystems Analysis, Inc.) and Stephen Monosmith (Department of Civil Engineering, Stanford University), was titled "An estimate of the historical position of 2 ppt salinity in the San Francisco Bay Estuary" and another by Alan D. Jassby (Division of Environmental Studies, University of California, Davis) was titled, "Isohaline position as a habitat indicator for estuarine resources: San Francisco Estuary." These papers established the validity of a criterion based on salinity rather than flows. Almost all of the data used in these analyses were collected by IESP, particularly the Delta Outflow Study. The larger group then met and reviewed the technical input, and completed a report on their work.

That report, published in 1993, made 11 important recommendations, that: (1) Estuarine standards should be developed to be used in conjunction with flow standards and one set of standards should be based upon an index of the physical response of the Estuary to

fluctuations in the input of fresh water; (2) Salinity should be used as an index for the development of some estuarine standards; (3) Standards should be developed using an index that establishes an upstream limit of the position of the 2% near-bottom isohaline, averaged over different periods of the year; (4) The downstream position of the 2% isohaline should be unconstrained; (5) The potential importance of variations in salinity on different time scales to the structure and dynamics of estuarine ecosystems should be considered in developing salinity standards; (6) The salinity distribution should be monitored continuously at a series of at least six stations; (7) *At this time,* the most appropriate basis for setting salinity standards for the portion of the Estuary on which this report concentrated is the position of the near bottom 2% isohaline *alone*, unless it can be shown either that another variable is the controlling variable or that incorporation of additional variables improves the predictive capability; (8) Salinity standards should be keyed to the existing city, county, regional, state, and federal water diversion and distribution system; (9) Salinity and flow-response matrices should be developed for different biologically important periods of the year; (10) Goals should be expressed in terms of desired conditions for some future time; and, (11) A range of environmental or ecosystem restoration and biological goals should be selected, and analyses should be made to determine the distribution of the 2% near-bottom isohaline throughout the year consistent with those goals.

This report and its recommendations would have a great impact on the water projects diverting water from the system. The issue became “political” because EPA now had a basis to promulgate water quality standards for the State of California. Pursuant to the Clean Water Act, EPA reviews a state’s water quality standards to determine whether the state has adopted criteria (water quality objectives) that protect the designated beneficial uses. Those reviews have generally considered chemical, biological, and physical parameters, such as salinity and temperature. Objectives for flow and operations are not subject to EPA approval. The EPA approved in part and disapproved in part the provisions of the 1991 Bay-Delta Plan, finding that it did not contain sufficient criteria to protect the designated uses. EPA also specifically disapproved the absence of salinity standards, among other things, to protect the Estuarine Habitat and other fish and wildlife uses in the Suisun, San Pablo, and San Francisco bays and Suisun Marsh.

In the summer of 1992, the SWRCB held hearings for the purpose of establishing interim measures to protect beneficial uses in the Estuary. This became significant because, in December of 1993, the SWRCB released a draft Water Right Decision (D-1630) that was to provide interim (5 years) and long- term protection to Bay-Delta environmental resources. The SWRCB objectives were to provide measures that would stabilize or enhance public trust resources in the Estuary. The draft decision would affect IESP in many ways, because it would require IESP to develop reverse flow values to guide project operation, carry out real time fish monitoring, and define the meaning of “significant” numbers of fish. It would also provide for a new monitoring program that water user groups

would be required to help fund. In short, this draft plan was considered to be pro-environmental and highly protective of the aquatic resources in the Estuary.

Critics of the draft of D-1630 persuaded the governor of California to not allow the SWRCB to adopt the decision. Since the State did not have a plan that was considered to be protective of the resources, EPA intervened and, using the 2% salinity recommendation (X2) from the technical experts, promulgated federal water quality criteria for the Bay-Delta based on salinity rather than flows. The State's inability to establish standards was, however, superseded by the federal government. This caused consternation in the water community and also among some of the IESP staff that had participated in the X2 workshops. Dr. Schubel mentioned in his "Personal Observation" to the final report that, "Each conclusion and recommendation in this report was reviewed and voted upon in the final workshop. In no case did the final number of dissenting votes exceed three and in only a few cases did the number exceed two. In spite of this endorsement, a number of participants subsequently requested that their names be removed from the cover of the report. I have honored those requests." The two names were IESP representatives from the CDWR and USBR. IESP data had been used in a political arena, and state authority over standards enforcement had been superseded.

1991—Other Activities

Concurrent with program expansion, the Program Coordinators determined that a better mechanism was needed to describe IESP elements to the Directors during their annual program reviews. They asked staff and the Study Manager to develop "Fact Sheets" for each program element. These fact sheets, along with the standardized and updated workplans, were finalized in late 1991 for the 1992 Directors meeting.

During late 1990, hydrodynamics became a separate element and technical committee. The scope was expanded, from the more narrow emphasis on the Delta Outflow/San Francisco Bay Study, to include the Delta. However, the group still had the broad purpose to "determine the magnitude, duration, and location of biologically significant variations in hydrodynamics, salinity, suspended solids, and pollutant transport within the bay, which result from changes in delta outflow." Much discussion centered on how much engineering work was needed in order to sufficiently describe bay hydrodynamics. A workshop was held, and it was concluded that only "biologically relevant" work should be done, because such work would result in understandings that could be used to manage resources. The Committee was charged to reorganize and develop a 3-year workplan for 1991–93. The new Committee asked each other technical committee to provide a list of unanswered technical questions that were important to their studies. The group then ranked the questions, and plans were put in place to answer them.

Outreach also became a significant issue in 1991. IESP held a Public Forum (Constituent Forum) at Contra Costa Water District on March 28, during which the Program was

reviewed by program staff and input was received from the public. An underlying goal was to encourage development of a constituency for the IESP. One significant message from the public was that IESP should do some things to further enhance its positive image. In response, the Study Manager and the Coordinators developed a Public Outreach Plan for implementation during 1992. Activities, to be carried out under the direction of the Study Manager, were to: (1) Increase and broaden notification of the Public Forum; (2) Publish articles in CDFG's *Outdoor California* and other popular magazines; (3) Annually distribute an Interagency Program "State of the Estuary" news release; (4) Increase interaction with water users, environmental groups, and academia; (5) Develop and use Interagency Program stationary; and, (6) Sponsor selected conferences or scientific meetings.

The upcoming (1992) SWRCB water rights hearing played a role in affecting activities of IESP during 1991. Program staff developed a new proposed water quality and biological monitoring program for the San Francisco Estuary to be submitted to the Board during their 1992 hearing. The plan presented revised baseline monitoring and a 1-year pilot study upstream of the Delta and into San Francisco Bay. At the same time, CDFG scientists explored factors affecting adult striped bass abundance, and developed a statistical regression and model indicating that outflow and exports from the Delta during early life stages were the primary factors explaining adult striped bass abundance. This method provided a quantitative approach for evaluating impacts of alternative outflow and water export standards on striped bass in the Estuary. The Salmon Program updated and further refined the knowledge of factors influencing salmon in the Estuary. This information was also to be used to develop recommendations to the SWRCB on how project impacts could be reduced.

Late in 1991, the UARIP was merged with the San Francisco Estuarine Project's Gaps in Knowledge Program. The Gaps in Knowledge Program was started to fund research by agencies and universities that addressed management questions of significance in the Estuary, a similar objective of the UARIP. The merger allowed a larger program (funds available for 1992 totaled $500,000) and provided a stronger review process for related proposals of the Gaps in Knowledge Program. Six proposals were received for potential funding; those selected for funding centered on investigations of the (1) Longitudinal analysis of attitudes of policy participants regarding the San Francisco Bay-Delta, 1984–1991 (Paul Sabatier, UCD); (2) Prehistoric salinity record in the San Francisco Estuary (James C. Ingle, Stanford University); and, (3) Hydrodynamic influence on the survival of wetlands in San Francisco Bay (Rodney J. Sobey, University of California, Berkeley).

Workers from three local universities were now participating in research in the Estuary, and the IESP goal of engaging the academic community was being met. Over the years the concept of IESP providing support of special studies, like the UARIP, became significant. These efforts provided "seed money" to start work that was later funded by others. The delta smelt culture work by Joan Lindburg (UCD) was a prime example. This

effort developed the technology allowing the culture of delta smelt and allowed a number of experiments and bioassays to be conducted without impacting wild populations by providing larval and juvenile fish for lab studies that, otherwise, would not have been available.

During early 1991 the San Francisco Estuarine Project (SFEP) sponsored an effort to develop a regional monitoring strategy for the Estuary. The Federal Clean Water Act required a mechanism to track success of management activities as part of the final comprehensive management plan. A workgroup was formed to ensure the regional monitoring strategy was developed with adequate input from IESP. Three IESP staff participated on the workgroup. SFEP contracted with Tetra Tech, Inc., The Aquatic Habitat Institute, and EcoAnalysis (a consulting firm) to help develop the regional monitoring strategy. The plan was to focus on dredging, pollutants, flows, biological resources, and land use.

Declining abundance of estuarine species continued to influence IESP activities. In 1990 the Cal Neva Chapter of the American Fisheries Society petitioned the USFWS to list delta smelt as an endangered species under the Federal Endangered Species Act (ESA). In September of 1991, USFWS proposed listing the species as threatened. Work continued on the delta smelt study in IESP and full implementation of IESP's earlier planned smelt studies was scheduled for 1992.

The IESP also emphasized work to reduce losses of fish to the diversion facilities during 1991. USBR undertook a major study to improve salvage at the Tracy Fish Collection Facility. As part of that work, USBR began surveys to determine fish species composition in its south of Delta canals with an emphasis on native fishes. The USBR effort also carried out new approaches aimed at removing predators from their holding facilities. Concurrently, CDWR's Division of Planning renewed an effort to develop fish protective facilities for a proposed diversion on the Sacramento River. This effort was a continuation of work for the PC that had been done in 1982, before the statewide referendum halted work on the project. In 1992, this work was not directed at a specific size or type of diversion. Instead, draft workplans for phased development of a demonstration fish protective facility near the town of Hood was developed by the Fish Facilities Technical Committee and the CDWR Division of Planning. At the same time, CDFG began to assume responsibility for fish salvage, hauling, and salvage sampling at the Skinner Fish Facility.

Important work also was carried out on zooplankton in 1991. Two papers were published in scientific journals. One, in collaboration with UCD centered on feeding of striped bass and copepods, and the other on *Pseudodiaptomus forbesi* and *P. marinus*, the most recent copepod immigrants to the California Sacramento-San Joaquin Estuary. The second paper, completed in collaboration with the Smithsonian Institution, described

introductions from ballast water. An important observation was that since its introduction in 1989, *P. forbesi* had replaced *Eurytemora* (a preferred native food item for young bass) in the entrapment zone in the summer and fall.

During 1991, CDWR started genetics work in order to determine races of Chinook salmon. It was important to ascertain which races were being impacted by Project operations, and how they related to biological opinions mandated by the Endangered Species Act.

The Coordinators revised activity schedules so that gaps in funding stemming from the difference between federal and state fiscal years would be eliminated. Activity schedules were changed so that they were now scheduled on a calendar basis, rather than a fiscal year, and one of the Directors meetings was scheduled to occur in December so the Directors could approve the upcoming year's activities.

In 1991 CDFG announced that, effective July 1, the Stockton IESP office was elevated from a Branch to a Division. It was now known as the Bay-Delta and Special Water Projects Division.

1992–1993—Another Time for Introspection

The years 1992 and 1993 were periods of significant introspection, program review, and program revision. Since 1982, four additional state and federal agencies had joined IESP, the budget had increased dramatically, and new study elements were added while old ones continued. But, most importantly, the political, planning, sociological, and environmental climates had changed dramatically. During this time, project planning faltered (due to lack of specific direction since defeat of the Peripheral Canal referendum), regulatory and environmental compliance requirements had dictated program directions (i.e., implementation of the Central Valley Project Improvement Act- PL-102-575), and, most importantly, biological resources in the Estuary had continued to decline. The continuing decline in biological resources stimulated implementation of the ESA, as well as development of additional federal legislation intended to reverse those declines.

Initiation of a joint state and federal large-scale Bay-Delta problems solution finding process (which ultimately led to the July 1994 CALFED “Framework Agreement” and the December 1994 “Water Accord”) greatly influenced Program directions and mandates. The ongoing and contentious SWRCB Bay-Delta water right process (which resulted in a draft Water Right Decision 1630 that was never adopted), also contributed to the confusing and highly charged climate associated with planning and management. In short, problems in the Estuary had become more acute and satisfactory solutions had become more elusive. All this pointed to the need for a review of the IESP that would ensure the Program would remain a relevant force in the development and protection of estuarine water supplies and biological resources.

In order to carry out this review, the IESP Coordinators commissioned an *ad hoc* Review Team to develop recommendations necessary to ensure that the Program remained effective and relevant to current planning and resource conditions. The *ad hoc* group consisted of Dr. Perry L. Herrgesell (Study Manager), Mr. Leo Winternitz (CDWR), Mr. Jim Arthur (USBR), Mr. Pat Coulston (CDFG), and Dr. Marty Kjelson (USFWS) and became known as the "Kitchen Cabinet" because it met in Herrgesell's kitchen to carry out their work uninterrupted by normal office distractions. The group developed a 3-phase plan to complete the review, which was guided by a self-generated list of assumptions relevant to the objective of IESP. Phase I included review of existing information, development of a new conceptual program, development of a strategy to be followed to complete an "Implementation Plan," and preparation of a report, to be reviewed by the Coordinators, by June 9, 1993. Phase II included development of the implementation plan. This effort included broader staff involvement in order to flesh out details necessary to make the recommendations easier to implement. Phase III was implementation of the revised program, which was scheduled for January 1994.

The initial task of the Kitchen Cabinet was to develop a group of assumptions that would guide their review process. These 16 assumptions were significant and not only provided the basis for the review, but also would guide the program until the present day, and are listed here in their entirety. (1) The IESP is 22 years old, and indications are that it needs an infusion of new life. Old programs have continued without careful revision, and new programs have many times been added on to existing programs (sometimes without deference to duplication). It is time to take a close look at all IESP efforts and determine if these efforts are still relevant in the environmental, political, and planning arena of the 1990s. (2) The initial review of the programs needs to be simple, yet rigorous and without bias or favoritism. (3) The review process should be completed by the fall of 1993 so that program modifications can be described in the 1994 workplans and implemented in early 1994. (4) It is recognized that this process may result in major program reorganization within some agencies and even between agencies. (5) As a result of this critical review of the various programs, significant conclusions or findings may emerge, dictating new program directions or agency policy. (6) To the extent possible, revised efforts should not require major additional funding. (7) The "Kitchen Cabinet" will have freedom to consult with all Coordinators, project leaders, and staff members during the review process. (8) During the review process, the "Kitchen Cabinet" should be cognizant of agency missions, but these missions should be superseded by objectives and missions of the IESP. (It is implicit that IESP should advance the missions of all member agencies). (9) An overriding principle should be that water project related activities and impacts receive highest priority in study review or formulation. (10) Generally, IESP programs are either compliance monitoring or special studies. At least the following questions should be considered when reviewing these types of programs. [a] Is the work relevant? [b] How FREQUENT are efforts needed? [c] What SPATIAL COVERAGE is needed? [d] Is it possible to

INCORPORATE these efforts with other efforts? [e] Is the HYPOTHESIS of special studies, clear and concise? and, [f] Can it be done? (11) To the extent possible, program elements should aim to improve fisheries in the short and long term, as well. Actions should be emphasized that would improve the fishery, not just study it. (12) When special studies are proposed, a testable hypothesis should be developed that could either be accepted or rejected. (13) A list of key management plans or projects should be developed, and this list should guide program element development. (14) An outcome of the IESP Program Review will be the delineation of certain “facts” that should be recognized and/or accepted as findings of the IESP. (15) A criterion to evaluate a program element should be how well it evaluates management or mitigation actions. (16) The program should not do monitoring just for the sake of monitoring. There should be a clear purpose.

After the assumptions were developed and approved by the Coordinators, the Review Team began reviewing existing elements of the program. That rigorous review centered on the Program Element Fact Sheet and workplan for each of the 31 existing program elements within IESP. Concurrent with the element review process, the Review Team developed a description of the key management issues that were currently, or would be in the future, influencing IESP. Among these key management issues were (1) The Endangered Species Act — Winter-run Chinook salmon and delta smelt were listed, longfin smelt and splittail had been proposed, and others would follow. (2) Water Right Decision 1630 (D-1630, December 1992 DRAFT) — When the review took place, the majority of IESP activities were being conducted under D-1485. The draft decision called for compliance monitoring, real time monitoring activities and assessment of the success of implementing D-1630. IESP was called out in the draft to carry out this work. (3) The CVP Improvement Act — This Act was meant to implement specific management actions to improve fish and wildlife in the Central Valley and fisheries on the Trinity River and included a variety of resource, planning, monitoring assessment, and investigations that were relevant to IESP. (4) The San Francisco Estuary Project — Growing public concern for the health of the Bay and Delta led the EPA to establish the San Francisco Estuary Project (SFEP). This five-year cooperative effort was to promote more effective management and restoration of the Estuary. This effort was jointly sponsored by the State of California and this required the input from the IESP agencies. (5) The Bay-Delta Oversight Council — The Governor of California had recently created the Bay-Delta Oversight Council (BDOC) to assist and advise the state administration in designing its comprehensive program to resolve the many problems then affecting the Estuary. The mission of the group was to design a long-term solution to the conflicts in the Delta. The group was made up of 22 members representing environmental, water, and agricultural interests. The BDOC reported to a Water Policy Council chaired by the Resources Agency Secretary. John Amodio was the Executive Director. Six, 8-person technical advisory committees were established. By executive order, all state agencies and departments

were to cooperate with BDOC, so IESP would have to make pertinent information available to BDOC. (6) Agency Regulatory Issues— Some of the member agencies had units that were responsible for carrying out activities associated with regulatory and permitting authorities. For example, the USCOE had permitting authority under the Clean Water Act (Section 404). Other IESP agencies had California Environmental Quality Act (CEQA), California Endangered Species Act (CESA), Federal Endangered Species Act (FESA), and National Environmental Policy Act (NEPA) responsibilities.

While the list of issues is not comprehensive, it at least provided the Kitchen Cabinet with information to guide the review process so that management needs would be properly addressed. As can be seen, the biological, social, political, and planning environment in the Estuary was becoming very complex during 1992–1993.

During the review process, the Review Team interviewed the project leaders and staff of the 31 IESP study elements. Additionally, the team met with representatives from member agency planning units, the water user community, and consultants working in the system. Responses from the process were recorded and reviewed collectively by team members after the fact-finding phase of the review, and were used to guide development of recommendations for program or element revisions. Significant IESP items or issues that emerged from the review were that: (1) There was a need for IESP's mission to be clarified— its focus became less clear in 1982 when the PC was defeated; (2) IESP could be more responsive to management needs of its member agencies and those who fund the work; (3) Data and data analysis (reports) need to be available in a more timely manner and communication, both internal and external, could be improved; (4) There was a need for better communication and coordination with agency permitting units in the regulatory agencies; (5) IESP activities must be more anticipatory in nature; and, (6) IESP could benefit from improved technical, budgetary, and management accountability, as well as improved staff morale.

The *ad hoc* group completed its program review and development of recommendations in mid-1993 and submitted them to the Directors, who approved them in concept in March of 1994. Full implementation of the recommendations took place over the next several years. The program revision that resulted from the review included 33 specific "programmatic solutions" and a suite of "structural solutions." A complete listing of the solutions is contained in the Review Team's report (Herrgesell et al. 1993), which is commonly referred to as the "Red Book" due to the color of the binding on the report. Included among the programmatic solutions offered by the Review Team was the adoption of the mission statement to, "Provide information on the factors that affect ecological resources in the Sacramento-San Joaquin Estuary that allows for more efficient management of the Estuary."

The IESP Program Coordinators also reviewed and retained the Program's previously

adopted goals, which were to: (1) Provide for the collection and analysis of data needed to understand factors controlling the distribution and abundance of selected fish and wildlife resources in the Sacramento-San Joaquin Estuary and make the data readily available to the other agencies and the public; (2) Comply with permit terms requiring ecological monitoring in the Estuary; (3) Identify impacts of human activities on fish and wildlife resources; (4) Interpret information produced by the Program and from other sources and, to the extent possible, recommend measures to avoid or offset adverse impacts of water project operation and other human activities on these resources, and seek consensus for such recommendations, but to report differing recommendations when consensus is not achieved; and, (5) Provide an organizational structure and resources to assist in planning, coordinating, and integrating estuarine studies by other units of member agencies or by agencies that are not members.

The Kitchen Cabinet also recommended systematic outreach to agency managers and stakeholders in regard to their information needs, because reaching out to those stakeholders and providing them better access to IESP activity planning and products were among the objectives identified during the review. The original intent was to form a group to provide managers a forum in the Bay-Delta water project planning and environmental regulation units of member agencies to make their information needs known to the IESP and to review and comment on program activities. The group, known as the Management Level Advisory Group (MLAG) was established in 1994, its membership was expanded to include non- agency representatives, including those from environmental, fishing, and water contractor groups, and the MLAG allowed good communication from these groups to the Coordinators.

The Kitchen Cabinet also recognized a need for smaller, more focused technical work teams. As a result, a new team, the Management Team, was created to provide strong oversight of the now $10 million annually spent in monitoring and special studies. Additionally, the IESP replaced the standing technical committees with more focused Project Work Teams (PWTs), the membership of which included agency technical staff and stakeholder technical representatives, to provide a meaningful interagency forum for planning and implementing, and producing products in each subject area. The PWTs could be permanent or ephemeral, and could be responsible for one program element or for many.

The Kitchen Cabinet also recommended more specific allocation of staff time and resources for data analysis and reporting during program element planning, creating computer links between member agencies, and working more closely, through workshops and technical team involvement, with agency regulatory staff to improve the quality of mandated monitoring.

Besides the structural changes discussed above (Management Level Advisory Group,

Management Team, and PWTs), the structural revision of the IESP maintained the Directors and the Coordinators. The revision also established a new Program Manager Position in CDFG. This position was to oversee the whole program and lead the Management Team.

Finally, the 1993 “Redbook” provided a detailed discussion of the structural solutions and functional descriptions of the revised groups in the IESP. It included descriptions of the new IESP Work Components (Estuarine Management Component, Monitoring Component, and the Special Studies Component). Further, it had a long section listing the IESP element observations, recommendations, and justifications that were gathered during the initial program review, as well as a listing of comments from managers and water user groups and problems with IESP from the perspective of Element Project Leaders. The reader is referred to the Red Book for more information on these issues.

In 1993, the program underwent a significant and interesting name change, from the Interagency Ecological Study Program to the Interagency Ecological Program (IEP). This change was made by the Directors, at the insistence of one agency director who did not want to give the impression that the program existed only to carry out studies. This was a big “philosophical” change in that there developed a perception among some that IEP could no longer conduct original research but, instead, only practical management-related work. The name change and new direction would affect the program for years to come.

1992–1993—Other Program Updates

During 1992, the name of the University Academic Research Involvement Program was changed to the Research Enhancement Program to reflect a broader interest and IESP support in areas outside the university environment, primarily in areas related to management issues (see name change discussion, above). In 1992, the budget was $460,000, and $414,000 was awarded to 6 scientists chosen from 49 who submitted proposals. More than 200 scientists participated in the peer-evaluation process. In December 1992, the Coordinators approved the appointment of a Technical Information Specialist. Olof Hansen (EPA) was appointed to the position, which was defined as a senior-level technical expert to support the IEP in data management.

In April of 1993 the Coordinators discussed the conversion of the Aquatic Habitat Institute (AHI) (which had been established by the SWRCB to carry out pollution work in the Bay) to the San Francisco Estuary Institute (SFEI). The Federal Estuarine Project’s Comprehensive Conservation Management Plan (CCMP) designated SFEI as the implementing entity of the CCMP, and IEP needed to be associated with these activities. As a result, the IEP drafted a MOU that would develop an alliance between the AHI SFEI and IEP. Also at about this time, The Bay-Delta Oversight Council (BDOC) was becoming a force in Delta water issues. As a result, the Coordinators included a recommendation on how IEP would relate to BDOC during the Director meeting that year.

The influence of endangered species continued to be felt. The federal listing of delta smelt as threatened took place in March of 1993 and went into effect on April 5, 1993. The California Fish and Game Commission was also expected to make a listing decision in 1993. The delta smelt project was fully implemented in January of 1992, when abundance measures were near record-low values. The listing of winter-run Chinook salmon under the ESA prompted a major augmentation of the salmon sampling program being carried out by the USFWS, which was funded by CDWR and USBR, but was under the direction of the NMFS as a result of its endangered species Biological Opinion.

At the same time, introduced species continued to make their presence felt. The native *Neomysis* population reached record lows during the summer and fall of 1992, while a new species of mysid shrimp, apparently from the Far East, invaded the Estuary. The IEP Newsletter reported that a new genus and species of mysid shrimp was discovered in the Estuary, while the Fishery Program reported that chameleon gobies (*Tridentiger trigoncephalus*) had recently become very abundant in the Estuary. Not only was the IEP changing, the biological make-up of the Estuary was changing as well.

During 1993, IEP partnered with the Delta Mendota Water Authority and completed the field portion of an evaluation of the effectiveness of an acoustic barrier for preventing juvenile Chinook salmon outmigrants from entering Georgiana Slough from the Sacramento River. Chuck Hanson was the Authority's consultant, and provided a final report in August of that year. Additionally, the Coordinators became concerned about the use of the word "mandated" in program fact sheets, and replaced the word with appropriate phrases that allowed footnotes and descriptive explanations that would be more meaningful.

In August of 1993, IEP agreed to coordinate a USGS toxics study with the IEP hydrodynamic/entrapment zone studies. This was the first time that IEP expanded to include issues related to toxicity. Two USGS staff persons (Larry Smith and Kathy Kuivila) were assigned to co-chair a PWT to develop a study plan to be considered for implementation in 1994.

On July 31, 1993 Pete Chadwick retired. Chadwick had been an influential force in water issues and the IEP for many years, and was known within CDFG as "the go to person" regarding Delta issues.

1994—New Project Work Teams and Outside Influences

By 1994, most of the new organizational changes resulting from the program review were in place. The 1994 IEP Quarterly Report noted that it was the first quarterly report under the new IEP structure. In March 1994 the Directors approved the new PWTs. The new teams (and their responsibilities) were the: (1) Estuarine Monitoring Team (fish egg and larvae survey, Fall midwater trawl, adult striped bass, Bay Protection and Toxic Cleanup

Program [BPTCP], San Francisco Bay-Delta Outflow Study sampling, sturgeon, and the *Neomysis*/zooplankton project); (2) Salmon Survival/Migration Evaluation Team; (3) Resident Special Status Species Team (Delta smelt and striped bass egg and larval study, purse seining, delta smelt – Wakasagi investigation, special townet sampling, Clifton Court Forebay, net evaluation studies, longfin smelt, and Sacramento splittail); (4) Estuarine Ecology Team; (5) Suisun Bay Team; (6) San Francisco Bay Outflow Team; (7) Delta Fish Facilities Development Team; (8) Clifton Court Forebay Predator/predation Control Team; (9) Delta Ag/municipal Diversion Evaluation Team; and, (10) South Delta Temporary Barriers Project Evaluation Team.

During fall of 1994 a significant step was taken in the IEP. The program established a standing Science Advisory Group (SAG). The Management Team invited Dr. Sam Luoma to work with them to develop a charter for the group, which was to be advisory in nature and with the goal of helping the IEP managers guide the evolution of the program in a scientifically optimal manner. The group was formed to provide specific recommendations on program issues or to suggest mechanisms whereby the best recommendations could be obtained. In early 1995 a charter for the Science Advisory Group of the Interagency Ecological Program was adopted. The mandate of the SAG stated the SAG, "shall offer technical and scientific advice to IEP about the knowledge necessary to understand the dynamics of the aquatic resources of San Francisco Bay-Delta and effects on those resources of water projects and other activity or disturbances of concern (e.g. toxics, exotic species, eutrophication, land use change) … SAG shall also be an agent for facilitating communication between IEP and relevant aspects of the scientific community including other agencies and other Interagency or Interdisciplinary groups." The charter also noted that the SAG, "shall work in collaboration with IEP management in selecting the subjects of its activities." It would report to the Coordinators on matters relating to strategic issues, and would offer technical advice to the Management Team and project leaders. The charter listed the activities of the SAG as: (1) Detailed evaluations; (2) Peer review; (3) Advice on specific technical questions; and, (4) Involvement in the annual IEP planning process. In the charter, the SAG agreed to center many of its activities around the annual IEP workshop and to produce written reports for the IEP that detailed the SAG's recommendations.

The early members of the SAG included Drs. Samuel Luoma and James Cloern (USGS), Edward Houde (Chesapeake Biological Lab), Alan Jassby and James Quinn (Division of Environmental Studies-UCD), Carole McIvor (National Biological Survey), and Stephen Monismith (Department of Civil Engineering- Stanford University). During the following years this group conducted several in-depth reviews (Bay Study, DWR's Environmental Monitoring Program [formerly the Water Quality Program], delta smelt) and their recommendations resulted in a number of dramatic changes. Although their recommendations were not always implemented, they were highly valued by the IEP. A list of the SAG program reviews is available at the IEP Web site.

During 1994, the Delta Outflow/San Francisco Bay Study completed a draft of a major report that described the basic life histories, and summaries of 1980–1992 abundance, distribution, salinity, and temperature data for 28 species of fish, shrimp and crabs. The report was over 400 pages long.

In May of 1994, Pat Coulston (CDFG) took over as the IEP Study Manager and the new IEP Management Advisory Committee (MAC) was developed. This group consisted of 20 members from non-IEP agencies and other groups who used IEP data but that were not actively involved in the IEP. Among those groups were state and federal water contractors, environmental organizations, fishing groups, and DWR and USBR planning and project operation groups. The purpose of the newly organized MAC was to ensure that the IEP was developing answers to important management questions that were needed by decision makers, and not just doing “science for the sake of science.”

In some respects, the IEP became a victim of its own success as the value of its work was widely recognized. The Program became more involved in the Governor’s Bay-Delta Oversight Council (BDOC), and Perry Herrgesell and Randy Brown were appointed as technical advisory members of its Aquatic Resources Committee. In addition to those appointments to BDOC, other staff within the IEP was redirected to work on implementation of ESA, CVPIA, and BDOC, and other efforts. There was a struggle to balance the protection and use of the Estuary, and this put a sharp focus on IEP activities and demands on individuals working in the IEP. Levels of stress were high among staff during this time. As a result, Pat Coulston wrote an article for staff of the program titled, “Working effectively in today’s interagency ecological program-guidelines from the program coordinators- August 8, 1994.” That document provided guidance to overloaded staff and addressed ways to elevate issues within the "New IEP," communication, cooperative efforts, contract responsibilities, involvement in agency disputes (peer review, inappropriate efforts to influence agency policy, and acknowledgment of agency missions), data ownership and use, and working relationships.

In the summer of 1994 the state and federal agencies responsible for the management and protection of the Estuary’s resources signed a “Framework Agreement” providing for improved coordination and communication, and a process for developing long term solutions to the Estuary’s problems. In the agreement, the IEP was identified as one of the primary sources of technical information.

During October 1994, the California Urban Water Agency (CUWA) wanted to be represented by an agency Coordinator, but it was decided CUWA would, instead, be represented in the Management Level Advisory Group. Additionally, the National Biological Service (NBS) made a request to become a member of IEP. Although the NBS proposed “in kind” support to the program, the details of their incorporation were never developed and, consequently, NBS never became a member of the IEP.

In late 1994, Patrick Wright, the Coordinator representing EPA, updated the Coordinators on the new CALFED Bay-Delta Program, which was intended to replace the BDOC as a forum to develop long-term fixes for the Bay-Delta. He announced a public workshop to be held on September 7–9 that would introduce the new process. As the CALFED program developed over the years, it became one of the largest Delta programs ever.

December 15, 1994 marked the historic Bay-Delta Water Accord and the signing of its associated “Principles of Agreement.” The Accord established or led to many specific Bay-Delta management, protection, and restoration actions and processes, which directly influenced the ecological information needs of the IEP’s member agencies and, therefore, the monitoring, special study, and research activities of the IEP.

The new programs mentioned above caused the Directors to ask staff to work on a revised program to meet current needs.

1995—Another Internal Review

The “deal” reached between parties with respect to solving problems in the Delta and the “Principles of Agreement” of that deal created a significant change in management of the Bay-Delta and the biological resources that depend on it. The deal involved water quality standards, endangered species protection, and other measures to improve Bay-Delta environmental resources. Written material describing the deal included numerous references to monitoring. The SWRCB's draft Water Quality Control Plan for the San Francisco Bay Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) that was then out also emphasized the need for monitoring to determine compliance. To expedite development of a revised monitoring program, the IEP Coordinators and staff met on January 11 with the Urban/Agricultural Policy staff, the Estuarine Institute, Environmental groups, and others to outline a process leading to development of a new program. California Urban Water Agency (CUWA) members again discussed involvement in the IEP, noting that IEP needed to be receptive to new ideas. Consultants to the Metropolitan Water District of Southern California presented an article in the Newsletter outlining their position on the potential new program. They noted that an ecosystem-based decision-making process was needed, and that to meet that challenge a comprehensive monitoring and assessment program was necessary. That monitoring and assessment program was proposed to address broad geographic coverage, compliance monitoring, an operations support group, effectiveness of standards, long-term trends in aquatic resources, ecological relationships, and monitoring of non-flow projects. Much discussion occurred, but such a comprehensive program never materialized in full. The Program Manager was assigned to work with CUWA representatives to define that organization's involvement, and the IEP Management Team prepared a report entitled, “Preliminary recommendations for the proposed revision of the monitoring, special study and research activities of the Interagency Ecological Program (IEP) for the Sacramento-San Joaquin Estuary.”

One significant change, however, in monitoring did occur in 1995. A “Real-Time Monitoring Program" began in May in response to the need for near “real time” information on listed fish species. The objective of that new program was to use real- time monitoring of fish densities and distributions to modify pumping. The purposes of the new program were to: (1) Conduct monitoring consistently over a long period of time and get reliable data out for use within 24-48 hours; and, (2) Assess the feasibility for protecting Chinook salmon, delta smelt, and other fish species from the SWP and CVP operations in the South Delta.

The Real Time Monitoring Program was to be implemented in two phases. Phase I was to occur from May 1 through May 21 and would sample salmon and 20-mm delta smelt; phase II sampled for splittail from May 22 through June 30. This effort required a combination of new technology, dedicated equipment, lots of boots on the ground, and increased coordination to make it a reality. Fax machines, cell phones, personal computers, and the World Wide Web were used extensively. Fishery data were collected daily at 12 sites by 15 boats and 45 people. The data then were interpreted and made available on a Web site in 24–48 hours. Posting of information in “near-real” time allowed policy makers to make decisions about pumping rates and times on a daily basis so that the take of large groups of fish could be avoided.

Design and implementation of the new program were coordinated with the Agricultural/California Urban Water Agency. The State Water Contractors would provide some sample nets and back up boats. It was agreed by all parties that the new effort should not “adversely affect the continuity of IEP’s long-term monitoring program databases.” The new program worked better than some expected and would continue for years to come, although there was always a question of whether such sampling had any significant impact on understanding fish populations and issues.

The IEP workshop kept growing and expanding in the 1990s. In the late 1970s, the old Four Agency Program held annual meetings in Modesto and Stockton with attendance by some 30–50 people. In the mid-1980s, the IESP held annual workshops at the Maritime Academy, and which were attended by about 100 people. More than 340 people attended the 1995 IEP workshop held at Asilomar. In addition, top staff from the eight agencies comprising the modern program, representatives of 6 institutions of higher education, 28 consulting firms, 11 water agencies, and 8 other groups (environmental organizations, and local and state government) also attended the workshop. The Bay-Delta Modeling Forum, a recently organized group dedicated to review and development of hydrodynamic, biological, and other models, held two sessions and its annual meeting concurrently with the workshop.

During 1995, the NMFS Tiburon Laboratory was “reprogramming” and placing greater emphasis on salmon issues in the Delta. IEP personnel met with the laboratory director to discuss integration with IEP, and NMFS would later become a full member of the IEP.

The Academic Research Enhancement Program awarded $100,000 to university researchers during 1995. Three proposals were selected from the 12 submitted. Those research topics included digestive performance of bivalves, fingerprinting natural waters of the Delta, and sources and reactivity of organic matter.

In 1995 the IEP again became introspective, and performed an evaluation with the goal of developing a revised program to present to the Directors. Dr. Randy Brown (CDWR Coordinator) wrote a 16-page memo with his thoughts about the Program; he listed at least 9 concerns, and called for “fundamental changes.” In his memo, Brown called for: (1) More timely and thorough program proposals; (2) More peer review; (3) More timely dissemination of verified data and interpretational reports; (4) Better documentation of quality assurance and quality control procedures; and, (5) Establishment of a contaminants work team. Partially in response to these concerns, and because of the extensive planning efforts put into revision and expansion of monitoring program called for in the “Principles of Agreement” in 1994, the Program Directors on October 17 approved a significant revision to IEP. The revisions assumed a level budget (a sign of the times) while also listing studies or elements that should be funded if additional money were made available.

The FY 96 budget for IEP was $12,041,500 and included as base monitoring programs the midwater trawl survey (CDFG), Chinook salmon monitoring (USFWS), Bay fish and invertebrate surveys (CDFG), water quality monitoring surveys pursuant to D-1485 (CDWR), hydrodynamic monitoring (USGS), Suisun Marsh fish monitoring (CDWR, CDFG), numbers of fish salvaged at the SWP and CVP intakes (CDFG), and special studies including, most notably, an expanded version of the real-time monitoring, a salmon study at Knights Landing, as well as several others (CDFG).

The Directors also made some significant decisions about program structure, including direction to: (1) Retain the Management Level Advisory Group and improve the way it is used; (2) Retain the Science Advisory Group and improve the way it is used; (3) Work with staff to develop a more effective means of keeping track of the budget; (4) Develop, publish, and use quality assurance and quality control, study design, and peer review processes to enhance the quality of the program data; (5) Establish a data users’ project work team to help make data more readily available to staff and others; (6) Establish a contaminants project work team; (7) Integrate representatives of the stakeholders into the project work teams; and, (8) Coordinate the IEP with other monitoring activities ongoing in the system. The Coordinators also authorized staff to develop a brochure and letterhead to help provide useful and easy ways to introduce personnel and institutions to the IEP. At this time much interest was being shown in the program.

An important step forward occurred in 1995 when the IEP went online. The IEP program file server used the World Wide Web to provide Bay-Delta information to researchers. The

new system used hypertext to provide a bibliography of current and historical documents, lists of IEP personnel, and background material on the organization and how it was structured. It was planned that most of the data would be available to all users by the end of November.

As part of Program efforts to adapt to changing priorities, increase efficiency, and organize data, the Coordinators, management group members, and water contractor representatives met with the Science Advisory Group (SAG) for a two-day workshop on July 27 and 28. The purpose of that workshop was to review the Long-Term Trend Monitoring Program. At the conclusion of the workshop, the SAG presented a report discussing six recommendations for Long-Term Trend Monitoring. More importantly, however, the SAG commented that, although many complex ecological questions remained unresolved, the Bay-Delta ecosystem is “one of the best understood and most comprehensively studied estuarine ecosystems in the United States and that this is a result of Interagency Program monitoring and special studies.” The Group also recognized that IEP data are the basis for the public's growing awareness of Bay-Delta resources, that IEP had been critically important in detecting exotic species and understanding their effects, and that IEP was the basis for environmental standards to protect the ecosystem. These were encouraging comments and suggested that many IEP goals were being met.

1996—Expansion of Scope

In 1996 the SWRCB approved implementation of a revised compliance and monitoring and special studies program that was recommended by IEP. In December, Chinese mitten crabs were first collected by the Delta Outflow/San Francisco Bay Study; this was the first collection since their accidental introduction. In an effort to respond to the lay public's need to understand the “health of the Estuary,” the winter Newsletter provided information on the “status and trends” of selected species. The Newsletter reported on water supply, X2, phytoplankton, pollution, delta smelt, bay species, salmon, bass, and fish salvage at the facilities.

During this year, IEP continued to demonstrate its inclusive thinking while working on the effects of water projects on the ecosystem. The spring Newsletter included an article by Nat Bingham entitled, “Human management and development of the Sacramento-San Joaquin Delta: a historical perspective.” That article discussed the prehistoric Delta, Native Americans, Spanish colonization, demise of tribes, riparian deforestation, gold mining, flood control, toxins, and water development, among other subjects. Five other articles in that issue demonstrated that the Program was expanding its scope to address more than just water projects.

Efforts continued in 1996 to carry out the principle of the State-Federal Accord on Bay-Delta Standards “to the maximum extent possible…use real time monitoring to make decisions regarding operational flexibility.” Efforts were put into effect that would further

develop IEP and use the data to implement adaptive management to modify water project operations when appropriate. An integral part of the Real-Time Monitoring Program was an active feedback loop that adjusted sampling effort based on collection of the special status species: delta smelt, splittail, and winter-run size Chinook salmon.

The Real-Time Monitoring Program was implemented as follows. Operation of the field and data reporting aspects of the program and preparation of daily summary reports were conducted by the Data Review Team (DiRT). A subgroup, the Data Summary Team (DuST) monitored results of the field collections and salvage counts. Based on this information, DuST prepared recommendations to minimize the impact of water project operations on fish, and adjusted sampling as necessary. DuST's recommendations were provided to the CALFED Operations Group for review and use in making decisions about alterations in water project operations. The Operations Group consisted of representatives from federal and state water and resource agencies, with input from agency stakeholders including water contractors, private water agencies, sport fishing groups, and environmental groups. Data from the field became available for use in policy discussions within one to two days. As a result, the Real-Time Monitoring Program became a show piece for data collection and use by policy makers in the highly complex and political world of water management.

An interesting story regarding the use of data by policy makers involved CDWR's Deputy Director, Bob Potter, who served during the time when it was not a given that policy makers had access to computers for daily use. Bob supposedly told other policy makers that they needed to get a computer and follow the Data Assessment Team (DAT) data on a daily basis. Everyone who knew Bob realized this was a major change for him and that it demonstrated the value of the DAT activities.

During 1996 the Research Enhancement Program had 15 ongoing contractual studies funded in an amount totaling $802,000. All but three studies were completed and the program received final reports from nine of the projects. Approximately 20 peer-reviewed papers stemmed from this work, and provide additional examples of the success of the IEP.

As with all large programs, misunderstandings occur from time to time. During the mid-1990s misunderstandings arose in discussions of Bay-Delta environmental issues about what constitutes science, how ecosystems function and, in particular, how to deal with uncertainty in scientific findings. Two members of the Estuarine Ecology Team wrote an essay describing their views on these matters, and how science can support effective management and policy making (Kimmerer and Bennet 1996). Importantly, they evaluated the ability of the IEP to provide valid scientific input to policy-makers and concluded, "that Interagency Program is doing a credible job of providing scientific input for policy decisions, although there will always be room for improvement." The authors provided

several suggestions to IEP to help improve the way science is used to support policy, including those to: (1) Encourage peer review and publication; (2) Seek outside collaboration and review; (3) Conduct experiments; (4) Conduct investigations into fundamental questions (5) Recognize inherent uncertainties and limitations; (6) Recognize the complexity of the ecosystem; and, (7) Recognize the limitations inherent in “expert opinion.” The authors concluded by noting that it was difficult to evaluate the ability of IEP to deal with items 5–7 and that they saw several problems in the way the IEP responds to them, but also saw several encouraging signs. They noted that the main problem was that many scientists in IEP seem to have formed opinions about the workings of the system that do not respond to new information, but they also saw that there was a willingness of the IEP to encourage alternative views. All in all, this was positive feedback for IEP, which was now almost 25 years old.

Internal and external feedback during the mid-1990s included some criticisms regarding the need for more quality assurance/quality control procedures. In early 1996, the IEP formed a Quality Assurance/ Quality Control (QA/QC) working group to develop a QA/QC system for selecting and implementing program elements within IEP. The group was charged with examining the QA/QC system guidelines for IEP member agencies, and to develop a system that incorporated the basic elements of each agency’s guidelines. As it turned out, most of the agencies based their QA/QC system on EPA guidelines, so the system they developed closely followed the EPA system.

The system developed by the workgroup had two components: (1) A Quality Assurance Project Plan (QAPP), which described the technical activities needed to assure a good quality product; and, (2) A Quality Assurance Management Plan (QAMP), which was to assure that the QAPP activities were completed. The QAPP was equivalent to a project proposal or a detailed study plan. The QAMP described the organizational process, procedures, and responsibilities for assuring the QAPP was completed by all efforts in IEP. The QAMP included three phases: (1) General program planning; (2) Detailed project plan; and, (3) Implementation. The QAPP process was used by the Management Team to maintain control over proposals and workplans, and allowed managers to ask what staff was proposing to do, how they planned to use the data, what their take of endangered species would be, how and when data would be analyzed, and what products would be produced. A side benefit of the program was that it applied not so subtle pressure on program staff to analyze and write up monitoring data. This has been quite successful over the years since the QAPP was adopted in 1996.

In late October the IEP Directors met to consider monitoring and special study elements that were recommended by the Coordinators for 1997. After considerable discussion about the work and the disproportionate shares of funding between the state and federal agencies, agreement was reached. The 1997 program included several core, but routine, monitoring elements meant to provide long-term measures of the abundance and

distribution of an ecologically diverse group of estuarine species. Among these core elements were Bay salinity monitoring, estuarine/marine fish and shrimp survey; Delta resident shoreline fish sampling, CVP/SWP fish salvage reporting, adult sturgeon tagging, adult striped bass tagging, summer tow-net surveys, Delta flow measurements, D-1485 water quality compliance monitoring, real time monitoring, and downstream zooplankton monitoring.

About half of IEP fiscal resources were approved for investigations generally intended to answer particular “how,” “how to,” or “why” questions about the Estuary. These efforts included work on Chinook salmon, delta smelt and splittail, estuarine ecology (net fluxes in the western Delta and ecosystem performance), Yolo Bypass, contaminant effects, Georgiana Slough acoustical barrier, and introduced species. The introduced species component was significant because, during the nine-year period from 1986 to 1995, 43 introduced exotic species were recorded in the Bay. The Coordinators assigned questions dealing with impacts of introduced species to the Estuarine Ecology Team for discussion. The IEP was also represented on the Western Panel Work Group formed under the auspices of the recently amended National Invasive Species Act, and approved a pilot monitoring program for implementation in 1997 to follow introduced juvenile mitten crabs.

1997—More Program Introspection

A long time IEP participant from USBR retired in March of 1997. Jim Arthur, who had been instrumental in significant studies on the entrapment zone in the system, left the IEP after many years involvement.

Program introspection continued during 1997. At the end of the 1997 Asilomar Workshop, the Coordinators participated in a two hour, “open, facilitated critique of the Program.” Dr. Jim Cloern (USGS, Menlo Park Office and Chair of the Science Advisory Group) facilitated the session. Among questions posed during the session were those about Project Work Teams, goals and missions and needed changes, relationships with the CALFED, CVPIA and the Anadromous Fish Restoration Program (AFRP), reporting data, and communication with the Directors. As a result of this session, the Coordinators committed to hold a retreat during July 30–31 to examine structure and function of IEP, and to consider the need for changes. They also pledged to report back at the 1998 workshop regarding their revisions.

In preparation for the 1998 workshop, the Coordinators would meet with about 20 key stakeholders and agency representatives to obtain their views on the Program. They committed to discuss significant changes with the Management Level Advisory Group before going to the Directors. The goal of that effort was to develop a yearly plan to best meet information needs of the resource managers. Coincidentally, the summer edition of the IEP Newsletter for the first time included a section called, “Noteworthy for Managers.” The intent of that section was to describe significant management activities in IEP and

around the Estuary that directly or indirectly would shape the Program's future. The first appearance of this section addressed Spring Chinook Candidacy, NMFS Consideration of Listing Central Valley Steelhead, CVPIA, CALFED Bay-Delta Program, UC Davis EPA/National Science Foundation Grant, and the Coordinator's retreat.

As planned, the Coordinators met on July 30–31 to discuss questions about program scope and future directions. They also considered IEP's role in the CALFED. Five Action Items were generated: (1) Enhance the role of the Management Team and increase the effectiveness of the Project Work Teams—The Coordinators agreed that the Management Team needed to take on more responsibility in truly managing the program. As a result, they charged the team to: [a] hold more frequent meetings and provide summaries within three days and to review the composition of the Team and recommend changes; [b] conduct a thorough review of all PWTs; [c] prepare and distribute written guidelines for the roles and responsibilities of PWTs; [d] delegate Management Team tasks more evenly; and, [e] develop agendas for the Coordinators meetings that are policy oriented. (2) Make better use of scientific and Management advisory groups. (3) Enhance communication with people who use IEP data. (4) Continue discussions with CALFED management regarding the role of IEP. And, (5) Make strategic (long-term) planning an integral program component.

An additional significant agreement at the workshop was that the IEP should not be limited to the Bay- Delta or its existing technical components. The Coordinators recognized that this holistic, ecosystem approach could require expansion into the watershed and include additional technical disciplines. They also noted that would be challenging, given staff's existing workload.

1998—Comprehensive Monitoring

The need for improved and expanded monitoring was always a point of contention in the Estuary. Over the years, several efforts to develop comprehensive programs were attempted, but most were not implemented. During 1998, another attempt emerged when CALFED spent considerable effort directed towards developing a monitoring and research component for their activities. At a November 24, 1997, CALFED Policy Group meeting, IEP and SFEI proposed that they take a joint lead in working with CALFED and others to develop a comprehensive monitoring and research program. IEP assumed responsibility for a two phase program. Phase 1 consisted of a three-month effort to prepare and recommend the scope of the program. Phase 2 included development of a detailed program with the scope to be approved by the Policy Group. At the same time, the Secretary of Interior directed the USGS to prepare an ecosystem monitoring report, and by December 19 a small group of scientists had completed a draft. On December 20 the Policy Group met to consider the IEP/SFEI and USGS proposed programs. The Policy Group reaffirmed its approval of the IEP/SFEI proposal, and directed USGS to work with

IEP to prepare a scope of work. A Steering committee was set up.

On May 1, 1998, the CALFED Policy group approved a $1.8 million proposal by the IEP, SFEI and USGS to develop a comprehensive monitoring, assessment, and research program (CMARP) for the CALFED. An agency and stakeholder steering committee was established, and tasks were assigned to: (1) Refine goals, objectives and needs; (2) Develop a conceptual framework; (3) Develop a monitoring program design; (4) Develop a focused research design; and, (5) Develop institutional structures.

A workshop was held on June 17, and 40 people from programs outside California (Puget Sound, Chesapeake Bay, and south Florida) attended. By the fall of 1998, draft monitoring plans had been submitted to the Comprehensive Monitoring and Research Program (CMARP) Steering Committee, and staff and the Committee began the process of fitting plans into a single, cohesive plan. Following the workshop the Steering Committee finished writing the plan, which was to be available for public review from late November to mid-December. Informational public forums on the process were scheduled, and plans were made for a final program to be ready in January of 1999.

In the winter of 1998, a Bay-Delta email reflector was set up to help disseminate Bay-Delta announcements and information. International access continued on the IEP World Wide Web site. In 1998, the site received over 65,000 hits from 69 different countries. Among these included hits from government entities, commercial interests, networks, educational entities, non-profit organizations and the military.

A few years prior to 1998, IEP had established a Contaminant Effects Project Work Team. During 1998, CALFED allocated several million dollars to contaminant-related projects. One and a half million dollars was to be used to develop a study plan to evaluate effects of pesticide use on priority fish species, and another $1.5 million was intended for specific pesticide-related projects. This was a significant expansion for IEP beyond the “flows only” work they had been doing. During this time, IEP work also expanded geographically. In the spring of 1997, IEP and the Romberg Tiburon Center began a pilot study of zooplankton in the lower Estuary, the purpose of which was to extend IEP monitoring downstream of Suisun Bay. One requirement was that the new program would fit into an existing monitoring program; this demonstrated that IEP sampling methods were adequate, albeit with a few modifications, to meet needs.

During February 1998, Pat Coulson left the Program. On April 1, 1998, Chuck Armor was appointed as IEP Program Manager.

On March 11, 1998, IEP and the Bay-Delta Modeling Forum sponsored a workshop to discuss issues related to the X2 standards and the relationship between X2 and various measures of abundance and survival of fish and invertebrates. The SWRCB had adopted the X2 standard in the 1995 Water Quality Control Plan for the San Francisco

Bay/Sacramento-San Joaquin Delta Estuary (1995 Bay-Delta Plan) after the Bay-Delta Accord was signed in 1994. A provision of the Accord was that there would be a triennial review of the standard, but until this workshop, that had not occurred.

The Management Team conducted the review of the existing PWTs that had been identified during the 1997 Coordinator workshop. This review resulted in the dissolution of two PWTs, rearrangement of three others, and the addition of three more. The three new teams were the Water Quality PWT, the Hydrodynamics PWT, and the Shallow-water Habitat PWT. The Shallow-water Habitat PWT is noteworthy because its need was clearly demonstrated at an earlier CALFED workshop on shallow-water habitat. Numerous studies were underway to gather needed information because CALFED had determined that restoration of shallow-water habitat was a “cornerstone” of their Ecosystem Restoration Program. The mission of the new PWT was to develop and communicate a comprehensive understanding of shallow-water habitat ecology in the Estuary to meet the needs of IEP and its member agencies. During this time another group was formed by the Coordinators. They created a Fish Facilities Coordination Group that would report to them. Additionally, USBR was carrying out state of the art studies on fish screening and development at their laboratory in Denver. Dr. Charlie Liston, who headed up the work, carried out several studies that helped improve operation of the federal fish facilities at Tracy. The Program Manager was assigned to oversee the review of the Fish Facilities Coordination Group proposals.

During 1998 the Endangered Species Act continued to affect IEP activities. Since the IEP sampled salmon and steelhead populations, it was necessary to apply to NMFS for a Biological Opinion on the effects of these activities. Later, IEP would apply to USFWS for an opinion for the take of delta smelt.

As time passed and CALFED became a greater force, IEP recognized the need for better coordination with CALFED activities. Over the next several years, much effort would be expended to define the relationship with CALFED. As a result, the Coordinators agreed to schedule a separate Directors meeting 2–3 hours before the CALFED Policy meeting, during which a report to the Policy Group about current topics affecting both IEP and CALFED, like the CMARP activities, would be presented. Since most of the Directors sat on both groups this was an efficient use of their time and schedules.

During December the IEP also improved internal planning. All principal investigators were required to complete a workplan each year. Each element would be required to have a review team consisting of two Management Team members knowledgeable in the subject area of the proposed work. Each program element would have at least one annual review by a review team. The review team would need to sign off on all written products. These changes “tightened up” IEP activities to assure consistency of products and for quality assurance and control.

During these times, IEP continued to evolve while at the same time maintaining collection of essential environmental data. During 1998, eight events were especially noteworthy: (1) The Asilomar workshop was a success, with 300 attendees including stakeholders and invited speakers; the meeting was held in concert with the California Water Quality Modeling Forum; (2) The Coordinators met for the 2-day workshop and implemented many beneficial changes; (3) For the first time, Director approval of the program budget occurred as part of the regularly scheduled meeting of the CALFED policy group. This was done to emphasize the fact that IEP was an integral part of CALFED; (4) CDFG committed to an aggressive publishing policy for their Stockton IEP staff. They planned to publish 20 articles and have 20 more in various stages of preparation during the year; (5) The Coordinators approved the use of an IEP letterhead with the intent of furthering outreach of the program; (6) The Program developed a long range planning/funding matrix to track funding by years for project elements in response to a Management Level Advisory Group (MLAG) request; (7) The Program established a Mitten Crab PWT in response to the accidental introduction and proliferation of this species in the Estuary. The coordinators asked that the first product of this effort be a mitten crab brochure; and, (8) The Coordinators approved a boat operations evaluation and training policy to ensure that people who operate boats in the IEP would be knowledgeable and trained adequately, thereby enhancing safety. It also became a requirement that all boat operators complete either the Department of Interior's certification class or the Boat Operators Evaluation.

1999—Program Element Determination

When the Directors approved the 1999 workplan and its associated budget, it was the culmination of a 10-month process that was newly implemented by IEP. The new process for determining work elements used 7 separate steps to develop the plan. In order of implementation, the steps are: (1) The Management Team revises the long-term Planning Considerations document, which provides a broad sense of what work should be done; (2) The Management Team sends the Planning Considerations document to the Principal Investigators; (3) Based on the Planning Considerations, the Principal Investigators prepare pre- proposals and submit them to the PWTs for review; (4) The PWTs send prioritized lists of projects to the Management Team; (5) Following Management Team review and prioritization, the projects next are sent to the Coordinators, who provide conceptual direction and return them to the MT for revision; (6) The conceptual workplan is reviewed by MLAG and then finalized by the Coordinators; and, (7) the Coordinators then present the workplan to the Directors for approval.

Several general themes were followed in the new process for determining workplan elements. First, all data were to be submitted for storage on the IEP server within six months of collection. Second, all products were to be identified in pre-proposals and were to identify the type of scientific paper to be produced and a date for the draft to be completed. Third, all elements were to be assigned a review team that would be

responsible for first level review of all products produced by each element. Using this new development process, 65 separate monitoring and special study elements were approved for implementation during 1999.

Another change in IEP occurred in 1999. The IEP Fish Facilities Program was revised by establishing a parallel group to the Management Team and the PWTs. This new group was called the Fish Facilities Coordination and Review Team. This group was charged with overseeing all of the fish facilities work and reporting their observations to the Coordinators.

Over a period of several years, the presence of delta smelt started to impact the water diversion facilities, and data collected by IEP played a major role in water project operations and decisions. In May and June of 1999, the State and Federal export facility operations were modified in response to concerns about the distribution and high salvage of delta smelt at the CVP and SWP. The USFWS Biological Opinion included thresholds that, when reached, called for reduced pumping rates and, therefore, impacted water deliveries. For example, when the running average for smelt salvage was at a certain level, a “yellow light” was reached, which essentially meant, caution. When a higher level was reached, a “red light” was triggered and diversion reductions had to be considered. A “yellow light” was exceeded by May 16 and a “red light” by May 18. By the end of May the exports had been decreased, and by the end of June exports were more than 400,000 acre feet less than what would have occurred in the absence of concerns with respect to smelt. All of the data used to make these reductions were collected by IEP, and the practicality of the work of IEP was demonstrated in this process.

IEP also had an additional role in implementing the Biological Opinions of the USFWS. In 1998, the USFWS placed the Vernalis Adaptive Management Program (VAMP) sampling effort, carried out by a private consultant, under an IEP permit for take of delta smelt, which were under the formal protection of the Endangered Species Act. Previously, IEP had obtained a permit to cover the take of smelt during sampling operations. The aforementioned consultant asked IEP for coverage in 1999, but the USFWS was unwilling to increase the take for the IEP. As a result, smelt taken in scientific studies reduced the amount of water that could be exported. Other IEP-associated activities were similar in that smelt were being taken under the IEP permit. These included CDFG’s Region 4 salmon sampling, the UCD Suisun Marsh sampling, the delta smelt culture facility, CALFED Category III projects, and the CMARP activities. Since these programs could reduce IEP’s authorized take, the Directors decided that IEP's permit should not have to cover all of those associated programs and asked the USFWS to reconsider their previous decision to authorize them to take smelt under IEP's permit. The USFWS considered the request, but decided to not move them from under the IEP umbrella. As a result, IEP decided to monitor the take project by project, and to limit “IEP associated” (like those mentioned above) projects when established limits were reached. This required

substantial work on the part of the Program Manager, and included the need to brief CALFED's Operations Group on potential ESA take issues. It was also decided that CDFG would pursue a separate take permit for their internal sampling programs. Finally, during November, USFWS and IEP discussed take issues. USFWS decided not to include CALFED associated projects on the IEP permit, that VAMP would be separate from IEP, and that UCD would need their own permit after they switched over to CALFED funding.

The CALFED-related Category III Program requested assistance from IEP staff to review Category III monitoring proposals and to serve on technical review panels. IEP Coordinators determined that staff did not have time to provide this assistance, and CALFED was asked to provide funding for such proposed increase in workloads.

The USBR took a soon-to-become significant step in 1999. They proposed funding a statistician that would be dedicated only to IEP work. As time passed this became reality, and a position was established in the USFWS office in Stockton and filled by Dr. Ken Newman.

The CMARP activities, which began in 1998, resulted in staff completing in March 1999 a document entitled, “Recommendations for the implementation and continued refinement of a comprehensive monitoring, assessment and research program.” That document became an appendix to the CALFED EIR/EIS, and was a summary of 50 technical appendices produced by CMARP work teams. The effort took one year, but as time would tell, CALFED would never implement the program; this was another failed effort to develop and implement a comprehensive monitoring program.

A major technical report (Number 63) was completed and published by November. That document, entitled, “Report on the 1980–1995 fish, shrimp, and crab sampling in the San Francisco Estuary, California” was the first major product of the Delta Outflow/San Francisco Bay Study. It described the abundance and distribution of 38 fishes, 4 *Cancer spp.* crabs, and 6 caridean shrimp. During the year, a team of IEP scientists established a network of peer review colleagues for IEP, which was modeled after a similar program in Florida.

When Randy Brown retired, a need arose to obtain a replacement that would be responsible for publishing the Newsletter. The Management Team decided to have several of its members assume the role of “managing co-editors.” In addition, several other members began soliciting articles.

In April, SFEI and IEP signed a new MOU intended to develop more comprehensive estuarine monitoring. The work was to be cooperative, but a problem arose when money was to be transferred. The state could not give the money to SFEI without using a competitive bidding process. The MOU was, therefore, not implemented.

Toward the end of the year, Dr. Jeff Mount and Dr. Peter Moyle (UCD) made a presentation to IEP on their proposed Consumnes River Consortium. This would begin the development of a Bay-Delta Consortium proposal.

In December of 1999, Perry Herrgesell was promoted to Chief of CDFG's recently established Central Valley Bay-Delta Branch; and he stepped down as chair of the IEP Coordinators. Alan Barracco (CDFG) became the new chair.

2000—Linking to CALFED

By the turn of the century, the IEP contained 68 separate monitoring and special study elements. The same review process that was developed and used in 1999 was used to develop the 2000 program. This year, 87 proposals were processed and reviewed. The approved program included 18 monitoring projects, 32 ongoing projects, 3 fish facility elements, and 15 new, special study elements. About $16.179 million was spent on monitoring, $6.73 million for special studies, and $1.0 million for management-related activities. By now, IEP had made substantial progress in developing and implementing a relational database that would house data from IEP, CAMP, AFRP, Category III, and Fish Salvage at the CVP and SWP in the Hydrologic Engineering Center Data Storage System. IEP had provided a customized data- editing program for principal investigators to upload information into the system; the system also had a GIS (Geographic Information System) feature. In combination, this system allowed information on delta smelt to be available to managers within a few days after data had been collected.

During 2000, more discussions began about standardized terms for use in IEP publications. Many folks weighed in, and the Coordinators discussed the issue and agreed to adopt the term, "San Francisco Estuary" and that it would include the San Francisco Bay and the Sacramento-San Joaquin Delta in its definition. Also, it was decided that in January 2001, the full name for the IEP would be "The Interagency Ecological Program for the San Francisco Estuary." The IEP also agreed to use the Standard International (SI) units when reporting measurements for IEP. The IEP became more standardized, both nationally and internationally, by using conventional scientific and engineering nomenclature.

IEP continued to be linked to the ongoing CALFED process. Barbara McDonnell was appointed as CDWR's representative on the Coordinators and, as Chief of CDWR's Environmental Services Office, this linkage was verbalized in describing her role. In the Newsletter, she stated that she, "…will strive to further the role of ESO in the scientific endeavors of IEP— particularly in its certain role of importance within the overall CALFED Science Program." The Coordinators, as a whole, also endorsed her desire, and directed staff to continue to be involved in the CALFED/CMARP process. Further, the Coordinators viewed this as a high priority that should be accomplished "via redirection, and/or suspending or re- evaluating existing elements or element products." At this time, a

Science Oversight Team (SOT) was established to oversee science in CALFED and IEP, and was later assigned the task of developing scientifically based questions for CALFED to investigate. The Program Manager was also asked to serve as a liaison to the CALFED Science Program. The coordination with, and the respective roles of IEP and CALFED science, was not clear and much activity to clarify the roles of both programs continued. These efforts diverted substantial staff effort and time away from IEP's traditional activities.

The CALFED Management Group reviewed and approved a plan by which IEP and the CALFED Science Program would be integrated in a manner that would ensure close communication and coordination. This plan included having one of the senior staff from the IEP Management Team (Program Manager) serve as a member of the CALFED Science Program Management Team. Additionally, the CALFED Chief Scientist would review products and accomplishments of IEP on an annual basis, and recommend changes for future programs to better focus IEP elements on issues important to CALFED.

One specific issue focused on approval for IEP programs from the CALFED Management Group. The agreed upon method involved the following steps: (1) Secure approval of IEP Directors; (2) The Program Manager would prepare a cover memo and a review to the CALFED Management Group; (3) A briefing would be scheduled at noon before the group officially met to discuss IEP programs; and, (4) The Program Manager would address the CALFED Management Group and ask the IEP Directors present to approve the IEP annual budget in the presence of the larger group with the intent to make CALFED aware of the IEP programs but to not have complete authority over it.

Part of the directive to be involved with CALFED science centered on IEP involvement in the first ever CALFED Science Conference, held October 3–5 at the Sacramento Convention Center. Participation and attendance at this event demonstrated the popularity of CALFED/IEP science. The conference was attended by 825 registered participants, and there were 125 oral presentations and 100 poster presentations. Feedback from one participant summarized the event thusly, "…overall the highest proportion of high-quality talks and posters I have seen at any conference." Additionally, a 50-page summary report of the event was written and made available in hard copies and on the World Wide Web. The web-posting included abstracts of oral and poster sessions. All of this was quite an endorsement for IEP/CALFED science.

Part of the general reputation for good science stemmed from the IEP Newsletter as an outlet for a wide variety of scientific papers and reports. The Newsletter filled a niche in estuarine science by providing a variety of articles, not just flow-related information as early IEP documents had done. IEP had evolved. Four Newsletter volumes in 2000 had published 28 papers on topics from Chinese mitten crabs to tidal marshes, from hydrodynamics to primary food resources, and from mortality of largemouth bass to smelt and pesticides. IEP science was noticed and became more respected by the broader

academic community, although the Newsletter was considered “grey literature.”

Late in the year, the Management Team recommended to the Coordinators that a Post-doctoral Program be established in IEP. Participants would be selected through a Request for Proposal (RFP) process, and two interested academic sponsors would be selected. The Coordinators approved the proposal and the plan was implemented. Later, IEP asked CALFED to fund the post-doctoral program through the Sea Grant program and, in 2002, the CALFED Science Program contracted with Sea Grant for $2 million to administer the post-doctoral program. Two proposals were chosen by IEP: one on longfin smelt in the Estuary with Dr. Peter Moyle as the Principal Investigator, and the other was an analysis of long-term monitoring data with Dr. Wim Kimmerer as the Principal Investigator. The post-doctoral researchers received 20–26 month contracts.

The Management Team also began some discussions about the role of non-native predators in the decline of native species in the Delta. Some members argued that more effort should be expended to understand that role, which was a departure from previous program emphases.

Correspondence from the USCOE to the IEP Management Team in 2000 described two upcoming USCOE programs. One was the Sacramento River Bank Protection Project, and the other a 14-acre restoration in a Napa Marsh. The USCOE requested the assistance of IEP in reviewing proposals for completion of thesis projects.

2001—Collaboration and the Science Consortium

During the winter of 2001, a small planning group of scientists met every 4–6 weeks to discuss science coordination in the Bay-Delta and the merits of some infrastructure changes. The motivation for this was the need for additional IEP space in the Stockton and Sacramento offices, and CALFED’s need for science coordination to support adaptively managed restoration projects. CALFED asked Perry Herrgesell (CDFG) and Randy Brown (CDWR) to develop a proposal to acquire a Delta site to house what was initially called the “CALFED Science Center.” As discussions evolved, that charge morphed into exploring ways to achieve better coordination with scientists at new facilities in the Delta and at UCD. The planning group, which was driven largely by IEP, settled on a tentative “Consortium” title, and reached out to others doing science in the Delta, including the Delta Science Center at Big Break and the Natural Heritage Institute. As time went on, the membership in the “Consortium” expanded to include the Romberg Tiburon Center, San Francisco Estuarine Institute, Point Reyes Bird Observatory, CALFED, USGS, UCD, CDWR, USFWS, and two stakeholders, The Natural Heritage Institute and the Metropolitan Water District of Southern California. Initial activities centered around development of plans for a new facility in the Delta (mainly for field elements) and a facility on the UCD campus (mainly for office related activities). The Planning Group worked on staff assignments for each location, and developed core principles for the Consortium.

Some IEP representatives met with the mayor of Rio Vista to discuss property to be turned over to the city from the Federal government; it was hoped that site would be the location of the new field facility. Others met with UCD to discuss a facility near the UC Campus. UC Davis assigned a vice-chancellor to assist with a proposal to build in the “Enterprise Zone.” The IEP facility would be part of this zone. The plan was to have an external contractor set up the facility, a consultant to develop a site plan and calculate costs for the Davis and Rio Vista sites, and for the Management Team to develop a personnel placement plan for both facilities. At this time, the name was questionable, but the prospect for improved scientific coordination through co-location at a field site and a University site was promising. Much work on the concept would continue over the following years. CALFED would support the fledgling effort with about $1 million, and an MOU with primary participating agencies was soon to be signed.

Collaboration was blossoming in IEP during this time in ways in addition to development of the Consortium. A strong emphasis was being placed on publication and collaborative science. During 2001, five IEP-affiliated scientists collaborated to report the results of the Yolo Bypass Study initiated in 1997 as an IEP project. Funding for the work came from CALFED, and staff assistance came from IEP. The title of the collaborative work was, “Floodplain rearing of juvenile Chinook salmon—evidence of enhanced growth and survival” and was published in the Canadian Journal of Fisheries and Aquatic Sciences. Authors included T. Sommer, M. Nobriga, B. Harrell, W. Batham and W. Kimmerer. This work also demonstrated further evolution in IEP: the paper was on the ecology of the Yolo Bypass and not directly on water project-related topics, as had been the case earlier in the history of IEP. IEP continued to expand.

As IEP activities expanded, the roles of IEP staff sometimes became “blurred.” The work being done by IEP staff was being used to implement Endangered Species Act requirements, and management of water projects, two examples of which follow. First, the 1995 delta smelt Biological Opinion required that a delta smelt working group be established to “resolve biological and technical issues raised by this opinion and to develop recommendations for consideration by the Management Group.” Participants included people from all agencies, yet it was called an IEP group. The group developed a “Delta Smelt Decision Tree” to be used to inform interested parties and policy makers of the process used to make recommendations to protect smelt. The Decision Tree was a written description of the types of information, questions, and thought processes the working group used to determine if recommendations for operational changes were warranted. The information used in the decision-tree process included life stage, timing, data of interest, assessment of condition, tools for change, biological questions using available data, questions concerning operations, assessment of concern, and recommendations. The Decision Tree became an important tool to be used by managers, yet some perceived it as a straying from the role of IEP staff. It was viewed as a management tool, rather than a scientific activity. The key was that all the data came from

IEP work, and scientific data were being used in an applied manner.

The second example of a blurred role for IEP staff was the Environmental Water Account (EWA). The EWA was called for in the aforementioned biological opinion and was designed to balance two sometimes conflicting objectives: (1) To protect endangered fish; and, (2) To avoid interruptions of water deliveries by the SWP and the CVP. The account was built on the premise that water can be obtained and banked until needed for actions to protect fish. The water would be acquired either by purchasing existing water rights, or by relaxing water quality standards when project pumping capacity was available. The first year the EWA operated mostly in the Delta, and 2001 was the first year of a proposed 4-year evaluation of the EWA; IEP staff was called on to participate in the evaluation. Again, scientific staff was asked to become advocates for agency positions…an uncomfortable position for IEP staff. However, and importantly, all data used in this important evaluation were provided by the IEP.

Additional IEP involvement in endangered species issues occurred on August 30, 2001 when the IEP Resident Fish Project Work Team hosted a thematic meeting on green sturgeon. This meeting was prompted by a petition to list green sturgeon and recognition that little was known about that fish. As a result, the group prepared a white paper on the sturgeon and set up an IEP-sponsored e-mail list server that could be used to communicate sturgeon information among interested stakeholders.

After seven years, the IEP Real Time Monitoring (RTM) Program actively continued, and the 2001 field season was the most varied. During 2001, RTM Program released data through its web page, carried out Kodiak trawling at Mossdale to monitor salmon and splittail, used light trapping in the Delta for larval delta smelt, and did three gear evaluations. The RTM Program was successful and received much praise from the policy makers in the management agencies because the data became so useful in implementing biological opinions and managing water projects. The RTM Program was one of the first times that biologists and engineers sat down and worked together constructively.

During 2001, the name of the Mitten Crab PWT was changed to the Nuisance Introduced Species PWT because other species were now being considered by the group. Additionally, efforts at defining IEP- CALFED integration continued during the year. Sam Luoma, the CALFED Chief Scientist, developed a review of IEP strengths, weaknesses, and solutions/opportunities from his perspective. He listed strengths as the Delta Cross Channel work, the EWA analyses, multi-year planning, emphasis on written products, post-doctoral programs, filling Bay Study staff positions, and water quality staff review. Weaknesses he recognized were needs to outreach to partners, turn studies into papers, strengthen processes to get complete papers, and a need to review the Delta Smelt Real Time Monitoring Program. Suggestions for solutions and opportunities to solve the problems were to use a scientist position to act as lead over the science and mentor

writers, and for IEP to reach out to multiple partners to fill data gaps.

The Management Team began developing the concept of using “forums” to assist management in IEP during 2001. The Team reviewed each PWT's performance and relevance. Two questions were asked of each PWT: (1) Are we getting what we want from the PWT?; and, (2) Are the PWTs otherwise functioning in the manner desired? For some PWTs the answers was “yes” and for others, “no.” As a result, something needed to change and the Management Team adopted a new IEP paradigm designed to correct underlying problems. They proposed to establish 2 permanent “forums.” One forum would deal with research, and the other with monitoring. The forums were to meet a few times each year with the entire Management Team and were to subsume the bureaucratic functions assigned to the PWTs. The PWTs would persist, but they would become the *ad hoc* issue or project-oriented bodies described in the IEP Redbook. The forums were meant to be permanent bodies and were not intended to change the roles of the PWTs. The Management Team noted that this effort was a high priority and requested time from members of the PWTs to do the work. The Management Team also asked the CALFED Science Program for money to hire a consultant to lead the effort. Discussions continued throughout the year, and a document was prepared describing the proposal. It was eventually approved and added to the IEP Red Book.

The end of 2001 was the beginning of a modest reduction in resources available for the IEP. A post 9/11 hiring freeze, which would certainly impact the future of IEP, was implemented by the Governor. The Coordinators provided guidance to staff regarding program elements or products that could be forgone. The times of abundant funding for the CALFED program were ending. Financial resources were becoming scarce.

2002—The Beginning of the Post “Big Dollar” Period

During 2002, introduced species continued to influence IEP work. The Newsletter highlighted work on an introduced shrimp (*Expalaemon modestus*), a zooplankter (*Daphnia lumholtzi*), and the Chinese mitten crab. Those articles demonstrated that introduced species were a substantial and, in many ways, dominant component of the aquatic flora and fauna of the Estuary. In some ways they became a form of “biological pollution.” The Newsletter put out a call for, “Managers and scientists to consider the influence of introduced species as we develop plans and expectations for habitat restoration.” CALFED was emphasizing shallow water habitat restoration as a means to improve conditions in the Estuary during these years.

In partial response to listed species concerns, the Coordinators established a delta smelt workgroup within IEP. Previously, this work had been part of the fisheries element. The new workgroup was to be led by a USFWS biologist; previously, CDFG had been the lead on smelt efforts. Now, funds were redirected from CDFG to USFWS. Part of the reason for the redirection had to do with a perception of lack of technical expertise following Dale

Sweetnam's departure from CDFG, but really was more a result of the inability of CDFG to fill vacancies in the smelt program during the State's freeze on hiring.

Work continued on the Bay-Delta Science Consortium and an advisory committee comprised of personnel from most of the IEP member agencies as well as local universities and non-profit organizations was established. In December, 13 agencies and organizations submitted their signed copies of the MOU to this committee. The overall goal of the Consortium had become to, "enhance cooperation and collaboration among researchers working in the Bay-Delta." CALFED provided $1 million/year to increase collaboration and cooperation. The Consortium determined to sponsor an online technical journal, while IEP and USGS continued to pursue moving staff to the proposed facilities at Rio Vista and UCD.

Database and Website managers from the Consortium began a series of meetings to share digital information, and the Consortium advisory committee considered hiring a consultant who would act as an interim Executive Director. Considerable enthusiasm existed around the proposed Consortium and the potential move of staff to a field station and a university site. A staff person was hired to put together a Science Consortium Website. DWR architects toured the Rio Vista site and talked with staff about needs. UCD proceeded with their environmental documentation process. A development company, Carr America, was proceeding with planning the Rio Vista development. There was a lot of optimism about the Consortium and joint habitation of agency staff by early 2005, but as will be discussed later, the concept was not to come to fruition.

The coordination of joint IEP and CALFED projects continued to provide challenges. As a result, a process for joint review was developed by IEP and CALFED Science Program staff. The joint review process involved the following steps: (1) Project reviewed by the appropriate sponsoring IEP team; (2) Management Team reviews and approves the project; (3) The sponsoring Team meets with the Management Team to work out any differences; (4) The proposals are forwarded to the Coordinators for review, but NOT approval; (5) IEP requests CALFED Science input and peer review; (6) Principal investigator revises proposals as suggested by reviewers; and, (7) Coordinators make final review and give approval. As a result, there was no formal approval by the CALFED Science program, only review and input. IEP maintained sole authority over program approval through this process.

During 2002, IEP data on surfperch were released, and this led to the development and adoption by the California Fish and Game Commission of more restrictive angling regulations for surfperch. The IEP- directed study showed a severe decline in abundance of some surfperch, and was instrumental in better protection of these Bay-oriented species.

IEP papers and reports became more widely available after Cambridge Scientific Abstracts requested to abstract program reports and the Newsletter. The request was approved by the Coordinators. At the same time, the IEP Newsletter Editor was no longer available and the program decided not to hire a new one. In the future, the Newsletter would be led by an editorial board comprised of Management Team members.

On April 25, 2002 a long time IEP participant from USFWS, Dr. Martin Kjelson, retired from federal service. Also, during early 2002, Chuck Armor (Program Manager) accepted the Operations Manager position at the CDFG Stockton office. That change left the IEP Program Manager position vacant.

Over the years, IEP was an example of the robustness that allowed agencies to accommodate both monitoring and research during difficult funding times. During such periods, agencies were tightening their budgets and there were severe hiring limitations. To the casual observer of the IEP program, it probably appeared to be “business as usual” in the spring of 2002. After all, the critically important, time- sensitive tasks such as the near-real time collection and reporting of 20-mm Survey data were largely successful at meeting the information needs of the agency decision makers. Virtually all of the routine monitoring was completed, adding to highly robust datasets on the status, trends, and functions of the largest Estuary on the west coast of North America. An editorial in the Newsletter noted an old golfing axiom, that it is sometimes “better to be lucky than good.” In the case of the 2002 spring-summer field season, the IEP was *BOTH* lucky and good!

By early winter of 2001–2002, the effects of changed economic conditions, particularly State agency hiring constraints, were starting to be felt. Project supervisors reported to managers that it was highly likely that resources would fall short of needs during the critical period of March through July, and everyone worked to try and make the best of it. So, how was IEP “lucky” and how was it “good” in 2002? It is instructional to spend some time considering these points, since they really show the “robustness” of the IEP, and provide an example for future program organizers to consider.

How was IEP lucky? The “take” of delta smelt and winter-run Chinook at the SWP and CVP intakes never reached critical levels, which obviated the need for supplemental 20-mm survey runs and allowed staff to both complete sample processing and fill in where needed in field sampling; the relative absence of filamentous algal blooms in 2002 reduced effort required to process 20-mm survey samples; and, although there were many troublesome program-related vacancies within the agencies, IEP’s complement of skilled vessel operators was at near-full strength during the spring-summer field season.

How was IEP good? The IEP Agency Coordinators quickly identified program priorities so that staff could focus their project planning and implementation efforts; project supervisors and staff carefully identified planned activities that could be deferred until after the critical

field season; staff and supervisors willingly participated in an unprecedented level of cross-project and cross-agency integration to ensure efficient use of resources; at critical times, dedicated vessel operators willingly worked many long days and weeks, in particular to facilitate salmon trawling at Mossdale and the San Joaquin River; in several cases, program staff willingly stepped back temporarily into critical field and lab activities from which they had previously promoted or transferred; and, IEP agencies worked collaboratively to arrange fund transfers that allowed federal agencies to fill in critical holes with supplemental hires.

It is difficult to overstate the robustness of IEP's multi-agency approach to accomplishing environmental monitoring and research objectives. As in biological systems, a more diverse program is more resilient and able to withstand perturbations. The ability to integrate and swap resources during lean economic times allowed work to go forward that would very likely be suspended, or even cancelled, in a single- agency, state-only, or federal-only program.

The "openness" of IEP programs was also demonstrated in 2002 when the IEP began a review of its Environmental Monitoring Program (EMP-formerly called the Water Quality Program). The stated goal of that effort was to "recommend a balanced, scientifically sound, implementable environmental monitoring program designed to fulfill water right permit conditions and address the needs of current and potential users identified during the review." The process employed a multi-tiered approach involving a core group of agency scientists, invited technical experts working in four subject area teams, stakeholder representatives, and the IEP Science Advisory Group (SAG). A draft report was prepared and presented at an IEP Workshop and at the National Water Quality Monitoring Council Conference held in Madison, Wisconsin. The staff addressed the SAG issues and submitted the draft report to the Management Team and Coordinators for their approval. Resources for the new work came from reallocations within the old EMP and through more collaboration and continued funding obtained from outside IEP agencies. The new program was eventually approved by the SWRCB and implemented.

During 2002, IEP also continued to sponsor student research, although its goals did not explicitly include academic work. It continued to provide funding, samples, and data for many local graduate students doing graduate work, or post-graduate research, in the system. IEP could not claim credit for all the data or support that students received, but it is obvious from the list of personnel involved, that IEP's effect on university science was far-reaching. In 2002, IEP's work affected 7 universities, 2 states, and 40 students. During this time, 6 IEP-affiliated scientists published papers in 3 international journals and in the open literature. IEP's products were being seen internationally.

Dr. Brock Bernstein was hired to facilitate development of a process IEP could use to develop and update a strategic plan. The desire was to link the IEP plan with the CALFED

long-range plan. The process, however, did not produce a viable product.

IEP continued its effort to build alliances with the academic community. In June of 2002, the Coordinators supported the establishment of an endowed chair at UCD for coldwater fishes. IEP sent a letter of support over the signature of the chair of the Coordinators.

Another Fish Facilities Program change occurred in 2002. The Central Valley Fish Facilities Coordination Team was disbanded, and the Central Valley Fish Facilities Review Team assumed a role, similar to that of the IEP Management Team, for facility related issues in the Program. This group reported directly to the Coordinators.

The request for funding support for a DFG regional salmon project prompted IEP to make a policy decision with regarding work in tributaries. Until then, most work was being done in the Estuary. After much discussion within and between the Management Team and Coordinators, a decision was made that the IEP focus should remain in the Estuary, UNLESS more money became available to support this additional work.

During 2002, IEP did more work on planning directives. Beginning this year, a small number of especially pertinent issues were planned to be supported for as long as necessary to resolve each of them. The issues were to be related to “overarching questions” and would be chosen because they were: (1) Central to IEP’s mission and interests of stakeholders and CALFED; (2) Timely; and, (3) Would usually require the coordinated and sustained effort of a multidisciplinary team of investigators to resolve. The first three overarching questions for 2002 were: (1) Are we monitoring the right things to reliably detect and quantify long-term ecosystem change, and how will we use monitoring the results?; (2) What factors limit the abundance and distribution and reproduction success of delta smelt?; and, (3) what factors limit the abundance and distribution and reproduction success of migrating salmon?

2003—CALFED Use of IEP Information and Staff

By 2003 the IEP had expanded considerably. The total program budget for 2003 was about $14.359 million. About $6.5 million went to estuarine monitoring, $6.7 million to special studies, and $1.1 million to program management and infrastructure.

During 2003, IEP continued to be the major source of data for management activities in the Estuary. Information from various activities in IEP was used in two CALFED-related activities during the year. First, CALFED held a science program workshop on Water Operations and Environmental Protection in the Delta. The goal was to have a balanced discussion among policy makers, stakeholders, and scientists to be aimed at characterizing the scientific issues underlying the uses, conservation, and management strategies affecting the Estuary and associated watersheds. The objectives were to explain the state of scientific understanding and to consider how the CALFED program

depends on and uses the knowledge. The findings were that there was strong governmental support for CALFED and its Record of Decision; the X2 outflow standard was very robust and relevant; the Delta Cross Channel had been the subject of intense study and the findings would be used in CALFED; the EWA was seen as a way to reduce or avoid conflict between water operations and resources; and, folks should bring science to bear on knowledge, particularly with respect to delta smelt. All data for that workshop came from IEP.

Another CALFED use of IEP data was in the Delta Regional Ecosystem Restoration Implementation Program (DRERIP). That was the first of four plans for implementing the California Bay-Delta Program's Ecosystem Restoration Program (ERP) element. The plan was to articulate the scientific rationale and level of certainty associated with ERP actions for the Delta, thereby establishing a more rigorous foundation for planning. DRERIP was a collaborative effort that involved IEP members, and IEP provided baseline data.

Efforts continued to better integrate IEP and CALFED programs. Programs such as the Handling, Hauling, and Trucking Program for delta smelt, and the Delta Cross Channel studies budgets, were approved jointly. Other efforts continued to better mesh CALFED Science with IEP as long as CALFED was continued.

In the summer of 2003, several efforts began to create a sophisticated, user-friendly interface to extract data from the many databases managed by IEP. Up until then, the Bay-Delta and Tributaries (BDAT) database merged data from dozens of smaller databases maintained by various agencies and groups. Once databases were merged, it was made available on the internet. Subsequently, it was recognized that some of the database system needed to be replaced. A new system was developed with features that included a large number of data summaries so users could see the extent of data available. A query process, intended to be simple and flexible, also was designed.

During 2003, enhanced funding from CALFED ushered in many new initiatives related to monitoring, research, and management in the Estuary. But, IEP recognized that in addition to doing new things, it was also important to "do things better." For example, ongoing activities should evolve to take advantage of new technology and what had been learned from past efforts. The Newsletter reported on at least five IEP efforts that were updated. In 2003, the Summer Townet Survey began a fixed-date sampling effort and included a standard number of individual surveys; this initiated a new era of greater utility of survey results, without orphaning the information gathered since 1959. Additionally, the USFWS added a robust "species identification quality control component" to their Delta Juvenile Fish Monitoring Program, and Russ Gartz (CDFG) updated his effort to examine the feasibility of deriving biomass and condition indices from some of the major fisheries monitoring programs. Finally, CDWR addressed the very important topic of maintaining continuity of methods and data comparability as long-term monitoring programs evolved.

Another CDWR effort improved the methods of enumerating adult salmonids ascending Central Valley streams. IEP continued to do things better as time passed.

During 2003, publication of results became a priority. IEP began an effort to develop a bibliography of journal articles and books that were the result of work funded by IEP. The list was meant to include peer- reviewed papers that would record IEP's progress over the years, and would act as a reference list for the major scientific issues and findings in the Estuary. Included papers were to meet one of the following criteria: IEP funding; reliance on IEP samples; use of a substantial amount of IEP data; be an "official" IEP program; published as part of an IEP-sponsored volume; co-authored by an IEP staff member; or, if the work preceded the formal formation of IEP, should have focused on the evaluation of potential water project impacts or collection of pre-project data.

As stated earlier, publication of technical papers had become an important aspect of IEP. Twenty articles had been published in Volume 15 of the Newsletter in 2002. The Spring 2003 Newsletter published only species status and trend reports, and several contributed papers. Additionally, the Coordinators felt that improvement could be made in staff presentations and poster preparation at Asilomar. Two Coordinators teamed up to write some guidance on how to make presentations more effective, and provided it to staff. Internal improvement continued to be a priority.

In March a presentation was made to the UCD Facility Enterprise Zone Development Board regarding the proposed move to UCD as part of the Consortium. The Development Board felt the Consortium would be a good fit with the University, but was unsure whether it should occupy more than 25% of the available acreage. A decision was put off for one month, after which time the proposal to locate the proposed Consortium at UCD was approved. After this, UCD was ready to negotiate a lease. CDWR and CDFG now needed to agree on a Form 10 (form outlining needs and administrative details).

Tightening of budgets in state and federal governments continued. This resulted in a 3% across-the-board cut in the IEP budget to balance the program with a $9 million level of funding. This reduction started a discussion about what to do if IEP could not fund the special studies in the future, which would mean serious cutbacks to outside participants. The anticipated problem became a reality, and there was no money for special studies in 2005. State budget cuts were even projected to affect the Asilomar meetings, and staff was asked to examine other options for 2004. It was decided that the Coordinators would meet for a full day in July in an effort to resolve long-term funding issues and strategies. The Coordinators spent the meeting discussing: (1) Vision and mission- Science vs. monitoring; (2) IEP's mission vs. individual agency's missions; (3) The need to maintain monitoring program review and progress on data analyses and interpretations; and, (4) Multi-year strategies and IEP's relationship to CALFED/CBDA.

During that session the Coordinators agreed that IEP's mission should be to provide a scientific basis for management of the San Francisco Estuary by CALFED's member agencies through continued monitoring and science. The Coordinators concluded that IEP did not wish to be an "umbrella" for all science in the Estuary, and that it did not want to get involved in areas outside of the biological or hydrological disciplines. With respect to the IEP relationship with CALFED, they concluded that IEP should provide science-based options for guidance and action to CALFED. With respect to a multi-year strategy, the Coordinators noted a problem in that IEP staff had been redirected to work on other activities that take time away from data analysis and interpretation. To resolve this issue, they concluded that budgets should be redirected, accountability should be tightened, more funding should be sought, and agency participation in activities should be streamlined (e.g., one IEP member per outside group, rather than one from each IEP member agency). The Coordinators asked the Management Team to rectify the budget to reflect the time scientists spend on activities not described in the work plan and to provide guidance for accountability. Even in light of this budget tightening and adjustment, lack of discretionary funds necessitated cancellation of the 2004 reservations at the Asilomar Conference Grounds. The 2005 workshop was to be held locally, in Lodi, that year.

In August a ceremony was held at Rio Vista to officially transfer the future Consortium site from the U.S. Army to the City of Rio Vista. The plan to move was still on track. Documentation required by the State was signed, and developers were ready to start the EIR process for the UCD facility. Also in August, the first IEP-funded study on Yolo Bypass was released (Sommer et al. 2003). It included three significant findings: (1) Yolo Bypass is ecologically important to many native species; (2) Flood plains respond to restoration efforts; and, (3) Flood plains have major passage problems. These results would pave the way for substantial efforts in 2010 to restore the bypass as part of the Bay-Delta Conservation Plan (BDCP).

In an attempt to remain relevant to agency management needs, the IEP Program Manager attended the Water Operations Management Team (WOMT) meeting to see which of its needs could be met by IEP. This effort was well received, and good feedback was provided.

In an effort toward further internal improvement, the Management Team and the Coordinators developed a process to develop "priority questions" to be answered by the IEP. The process included the following steps: (1) Coordinators would solicit questions from IEP clients (e.g., WOMT, MLAG, PWTs); (2) Coordinators would provide internal filtering of questions and priorities and become advocates for questions sent to them; (3) The Management Team would review the list and break down complex questions into answerable questions and provide the revised list to the Coordinators; (4) The Coordinators would then review the list, make needed changes, and send it back to the Management Team; and, (5) The Management Team would solicit proposals to address

questions.

In addition to this guidance, the Program's Mission Statement was revised. It now read, "The mission of IEP is in collaboration with others to provide ecological information and scientific leadership for use in management of the San Francisco Estuary."

2004—IEP and CALFED Relationships — Continued!

The uncertainty of the relationship between IEP and CALFED continued to be a topic of major interest, and much time was expended trying to formalize that relationship. After the CALFED Record of Decision was signed, IEP became a "Category A" activity under the CALFED framework and, thus, was technically under the purview of the CALFED Management Team. Consequently, the IEP Directors no longer met once a year to discuss IEP issues without the other CALFED Directors being present. Instead, IEP became one item on a broader agenda of items discussed at the CALFED Management Team meetings. But, in August of 2004, the Directors met separately again, primarily because of funding shortfalls. They needed to discuss ways of achieving a balanced budget with an operations monitoring component that included the "Real Time" fish monitoring; that component provided data to various CALFED management and regulatory groups. The Directors also needed to discuss how IEP related to the California Bay-Delta Authority (CBDA); they noted that IEP's strength was long-term monitoring studies, combined with limited research, data analyses, and reporting. CBDA, which evolved from CALFED, was funding more research, data analysis and reporting than was IEP. The IEP had created staff expertise on the Estuary, and CBDA was drawing on those experts to do further investigative work. IEP was mainly concentrating efforts in the Estuary, in particular on how water projects were affecting the Estuary, while CBDA was looking at a system-wide restoration effort. At the time, IEP Coordinators were sitting on the CBDA Management panels so coordination among the groups was occurring, but there was no one formal group to coordinate activities. The Directors concluded that increasing CBDA demands for additional data, accelerated time frames for data reporting, and increasing program costs combined with agency budget cuts, were hinderinsg IEP's ability to accomplish its mission and goals. The Directors determined that if there was no change, the Program would not be able to provide basic data and information needs.

The IEP Directors discussed the implications of doing all the requested special studies. If those activities were done, USFWS would lose $300,000 to $600,000 of funding, while CDFG would lose $200,000 in matching funds. The Directors recognized that IEP was dangerously close to a situation where it would be able to monitor only what had been mandated, and to present data without converting it into useful information for management purposes. The IEP was at a crossroads. Historically, its focus had been the effects of the CVP and SWP on the Estuary only. Now, IEP was being asked to provide data for a much broader arena of issues like the Ecosystem Restoration of the CALFED

and CVPIA programs, but with little additional funding. The question for the Directors became, “Should the program focus on the traditional expectations or expand to meet other needs?”

Throughout this uncertainty, the Directors recognized the long-term funding shortages for the program and committed to find long-term solutions. However, coordination between IEP, CBDA, and others was not obvious. The Coordinators wanted staff to identify relationships with these groups clearly to be sure there was not duplication of effort. They asked for a full science program review by both IEP and CALFED staff, and sought ways to integrate IEP activities with the broader CALFED Science umbrella without compromising IEP’s core mission, goals, or objectives. As a result, the Coordinators began another review of IEP goals and objectives. Several Coordinators provided suggestions, as did the Management Team.

Work continued on developing the physical location of the proposed Consortium. The State Water Contractors inspected the Rio Vista site, and expressed interest in participating in the project while the Agency Directors considered the decision to make a physical move.

The use of data from IEP in regulatory and management arenas continued to be important in the Estuary. The Environmental Water Account (EWA) was a premier user of data generated by IEP, particularly with delta smelt and other listed species. The Vernalis Adaptive Management Plan pursuant to the San Joaquin River Agreement (SJRA) was designed to protect fall-run salmon from reduced spring flows. The “Post Vamp Shoulder” was intended to improve habitat and afford delta smelt larvae an opportunity to move north and west toward rearing areas in Suisun Bay. No water was allowed to be exported during the Post Vamp Shoulder. Recommendations about Post Vamp were made following interagency discussion of IEP data at the staff level. Those staff level groups included the Interagency Team, the Data Assessment Team (DAT) and the Delta Smelt Workgroup. The DAT used IEP smelt data from the Real Time Monitoring Program, and formulated recommendations that were submitted to the Water Operations Management Team (WOMT) for discussion and decision. IEP data from previous years included abundance information from the Fall Mid Water Trawl Index, abundance of juvenile delta smelt in the South Delta, incidental take limits, and length of spawning season.

In the winter of 2004 another IEP program was approved for implementation. Much activity occurred with respect to coordination of this program with CBDA, and it was one of the first projects that went through the coordination and approval process involving the two entities. The Collection, Handling, Transport and Release (CHTR) Program for delta smelt was begun. The Program was meant to assess the effects of the terminal phase of the fish salvage process at the Skinner Facility. That Program ultimately yielded several techniques to increase survival and that could be used successfully to handle the delicate

delta smelt.

During 2004 the Ecosystem Restoration Program (ERP) of the CBDA was interested in developing a monitoring component. As it rolled out, IEP considered the feasibility of submitting a proposal to do this monitoring for ERP. The idea was reviewed by the Agency Coordination Team (ACT) of CBDA, and they were supportive of the idea but they did not have the authority to mandate the work. The ACT suggested that IEP sign an MOU that would authorize expanded monitoring; this work would be called IEP+. Much discussion and planning was carried out, but not much headway was made in developing the new program. In December the ACT re-confirmed its desire that IEP start developing IEP+. A group of aquatic biologists formed a subcommittee to develop the conceptual model for an IEP+ and proposed to present it to the Directors.

While discussing the 2005-year budget, it became obvious there would be a $1.3 million shortfall that year. Discussions were held to consider if the CBDA Science Program could fund some of the shortfall. The Science Program wanted to see a “balance of monitoring, research and analysis, and review” if they were to participate. Specifically, they were interested in funding the research portions of IEP for something less than $1 million. These events precipitated a serious discussion among the Directors about the relationship between IEP and other groups, particularly CALFED (CBDA). The Directors were unclear about how existing monitoring and research in the Estuary related to each other; they wanted a proposal that outlined how all the work could be amalgamated to avoid duplication and to streamline coordination. Several Coordinators worked on a draft description of the potential relationship between IEP and CBDA. Finally, in September, CBDA agreed to fund $900,000 of the 2005 program, with the condition that CBDA staff wanted to conduct a full program review. The Directors did not agree, and merely asked for a scope of work rather than a CBDA review of the IEP. CBDA provided the $900,000 and during the next year, IEP workplans were also prepared in CBDA format so that CBDA science staff could review them.

In the spring of 2004, IEP staff began a review of IEP fish monitoring program elements. Given the importance and prominence of these elements, the Management Team requested a review to help with managing the monitoring. This effort was tied to the ongoing development of the strategic plan. Five organizations completed 16 element reviews, and a report was prepared that summarized questions asked of each element and the responses received. The elements were then categorized according to a hard or soft mandate. Eleven of the 16 elements fell within these two categories. The report noted that generally, the evolution of IEP fish monitoring program elements occurred in stages spanning almost five decades (Honey et. al. 2004). This evolution tracked the shifting concerns for selected fish species and the programmatic responses of IEP.

During the 1950s and through the 1960s there were two geographically broad surveys that

were implemented to sample distribution and abundance of age 0 striped bass and pelagic fish communities in the Delta. Also in the 1960s, more narrowly targeted surveys were added to monitor the abundance of white sturgeon and striped bass. IEP fish monitoring program elements continued to focus on sport fish in the 1960s. Significantly, in the 1990s several native fishes were listed as threatened and those actions resulted in a shift of importance for those species in the monitoring programs. The report listed sampling methods and gear for each survey, and reviewed them based on nine criteria. The final report listed six strengths and weaknesses for each of the elements, and recommendations for improvement for each were provided in the report. The reader is directed to the original report for more detail.

The Annual Workshop was held in Lodi. Attendance was down by one-half compared to previous years.

Publication continued to be an emphasis of IEP. The Newsletter published a list of 22 articles that had been previously published in the "Early Life History of fishes in the San Francisco Estuary and Watershed." This report was facilitated by IEP. Additionally, 10 peer-reviewed articles were published in journals in 2004.

2005—The Year of The Pelagic Organism Decline (POD)

In 2005 a major discovery was gleaned from IEP data on pelagic fishes in the system. The Spring issue of the IEP Newsletter reviewed the zooplankton and fish abundance trend information from the previous several years. Articles in the Newsletter showed that 2005 was the third in a series of low annual indices, and this information reinforced concerns about fishery declines in the Estuary despite the restoration efforts supported by CALFED. CALFED had spent around $700 million on restoration projects in the Delta, and IEP data showed that pelagic fishery resources had declined precipitously. This information would shake the scientific and political communities all the way to Washington, DC. A chronological discussion of the emergence of this issue, commonly referred to as the Pelagic Organism Decline (POD), follows.

January 12 (approximately). CDFG and CDWR biologists identified species that had undergone substantial declines.

January 14. CDWR biologists circulate a draft white paper internally to IEP managers presenting information on the apparent problem and outlines of three broad explanatory hypotheses. The paper noted that the 2004 adult delta smelt index was the lowest in the 38-year record, while the 2002-2003 delta smelt indices were the 6th and 10th lowest. During 2002–2004 the striped bass indices were the 2nd, 3rd and 1st lowest on record, respectively. Threadfin shad indices were the 6th, 7th and 5th lowest on record, and longfin smelt were the 12th, 4th and 3rd lowest on record. The biologists did not know the cause, but knew that all the affected fish species spawn at different times of the year and

rear in different parts of the Estuary. Thus, the mechanism(s) causing the observations must operate through much of the year and most of the upper Estuary, or those mechanisms operate when all species have young-of-the-year in the pelagic environment (summer). The paper listed three possible causes; toxic effects, food web effects, and export effects. The biologists preparing the report suggested several potential actions while acknowledging that there were substantial gaps in knowledge. They recommended more sampling; studies on toxicity, feeding success and origin; data analysis; and, modeling. They also asked IEP managers to convene a dedicated meeting of the Estuarine Ecology Team (EET). The biologists also prepared a set of speaking points for inquiries from the press and public reflecting the increased level of concern about the status of biological resources in the Estuary.

January 21. The IEP Management Team held a one-hour discussion of the white paper and what should be done about it. The whitepaper was circulated widely outside IEP after the meeting.

Week of January 24. During this period, IEP staff completed an initial review of various sources of resident pelagic fishes and salmon data.

January 24. The CDFG Director was briefed on the white paper and its implications.

January 26. A briefing was held for USBR and USFWS directors on the issue. These directors agreed that the IEP should further investigate the problem immediately. Other IEP agency directors were briefed within a week or two of this date.

February 1. The IEP salmon biologists and NOAA researchers exchanged notes on recent population dynamics, and concluded that things looked pretty good for salmon.

February 3 (approximately). CDWR and CBDA were briefed on the white paper.

February 4. The IEP Annual Conference agenda was restructured to facilitate a discussion of the issue.

February 7. The IEP held a widely advertised full-day meeting at Stockton to discuss evidence for the decline and steps that should be taken in response. An IEP committee was created to develop and implement an investigation.

February 8. The USACE and SWRCB were briefed on the whitepaper.

February 10. A briefing was presented to the CBDA-Bay-Delta Public Advisory Committee.

February 15. The recently created IEP committee of scientists met to develop a plan for the proposed investigation.

February 23. The Committee met to review the status of efforts to date, and to continue planning.

March 1. The Committee met with statistician Bryan Manly to formulate trend and “regime shift” analyses.

March 3. The issue was discussed in a delta smelt session at the IEP Annual Conference.

March 14. The IEP committee met and plans for an investigation started to gel. Plans were formalized to extend field sampling in 2005 to obtain data thought most certain to be useful to the investigation. Plans were made to triage CALFED Science Program Study Proposals submissions for possibly useful proposals to help understand the observed declines. Several analytical investigations involving existing data had been launched by this date.

March 24. The IEP committee met to revise the plan to investigate the decline.

April 6. The IEP Committee met to complete the plan.

April 11. The IEP plan was completed and distributed to the Agency Directors and outside experts for review.

April 20. A phone conference among IEP committee and outside members occurred.

May 2. The IEP committee met to parse reviews and incorporate changes suggested by reviewers. Implementation of some investigative elements requiring collection of new data was begun.

May 2. The IEP Directors participated in a phone conference to discuss funding for the investigation.

May 9. The IEP Directors held a follow-up phone conference to discuss funding.

May 12. The IEP committee met with reviewers to discuss revisions to the work plan and to discuss the next phase of the investigation.

June 2. The IEP Directors approved the workplan and associated budget.

October. A synthesis of results and information, which included participation by outside experts, was prepared. The report was sent to an independent peer review panel arranged by the CALFED Science Program.

November 14. A public workshop was held to discuss the results. A 2006-2007 work plan was developed.

January 12, 2006. The IEP Directors approved the 2006-2007 workplan and budget.

All of the above activity during 2005 demonstrated an unprecedented response by IEP agencies, especially at the level of the Directorate. There was rapid movement from problem identification to reporting of results and the process included independent peer reviews, numerous meetings, briefings, and public workshops. Everything IEP had been doing since its inception now came to fruition. The IEP ran smoothly, and responded quickly to an unexpected environmental crisis. A budget of $1.7 million (50% federal and 50% state) was made specifically available for POD-related studies, of which $1 million was awarded to academic collaborators.

2005—Other Activities

Work continued on planning for IEP staff and office moves to Rio Vista and UCD; however, a new state administration caused the process to slow and be reconsidered. In February, CDWR announced they would no longer participate in a move to UCD because the Deputy Director did not want his staff that far from Sacramento. Other agencies in IEP still pursued the idea, but in May the CDWR and CDFG directors met and cancelled the move and planning for a facility at Davis. The CDWR planned to house their staff at a new facility in West Sacramento, but would still send some of their field staff to Rio Vista as had been planned.

Work continued on planning for an IEP+ monitoring program. No substantial progress was made during the year.

Discussions regarding the relationship between IEP and the CBDA science program continued, and a document was prepared to describe the roles. The document noted that IEP and CBDA had different roles, and each had responsibilities that were complementary to the other's. The report noted that IEP describes and explains status and trends of resources affected by project operations and minimizes their impacts. The CBDA, on the other hand, improves the status and trends of resources by encompassing a larger area and using adaptive management, and funds research that will fill critical gaps in knowledge. The report discussed three options for integration and the Directors chose to keep IEP program governance as a joint effort between IEP and the Science Program, but to keep funding for the IEP and Science programs separate so that IEP mandates could continue to be met. The Directors also asked that more work on integration be included in the revision of the IEP Redbook.

Discussions about revising the Red Book were held. The desire was to clearly define the integration and relationship of IEP and CBDA in the revision. The work was expected to be completed by the end of 2005. It was to be reviewed by SAG and others. CBDA considered reviewing the IEP as part of the revision. There was some discussion of signing a MOU between IEP and CBDA, but this was never done. In reality, events around

the POD and CBDA's eventual decline and replacement precluded this effort.

2006—More POD

There was much activity concerning the pelagic organism decline during 2006. The approved workplan was implemented with a separately funded budget item of $1.7 million. The IEP was responsible for its ongoing program, plus the additional POD work. There was much effort to coordinate POD activities between the POD team, IEP, and the CBDA Science program. The CBDA reviewed the POD program and did not identify any aspect of the POD plan that needed to be changed for 2006–2007. The IEP Directors remained intimately involved with the POD activities. They were updated frequently of new findings, and reviewed all written material before release. The new POD efforts included describing linkages between habitat and distributions, a POD synthesis report to be done in collaboration with the National Center for Ecological Analysis (NCEAS), submerged aquatic vegetation, food match or mismatch, and a biomarkers workshop.

On February 27, 2006 Representative Richard W. Pombo (R-CA) and members of the House Resources Committee held an oversight field hearing in Stockton regarding the declining fisheries in the Bay-Delta. Chuck Armor (CDFG) facilitated the response to the Committee, and other agency representatives also addressed the oversight group.

During late 2005, the IEP reviewed white sturgeon data available from the program and found that estimates of 8,000 to 17,000 adults were dramatically lower than peak levels of 142,000 adults estimated only a decade before. This information resulted in a rapid response from CDFG, including changes in fishing regulations, management actions, and increased efforts to limit poaching.

The IEP+ program that was still developing had evolved into a "CMARP 3" (Comprehensive Monitoring and Research Plan). CBDA put $15-30 million into their year-nine budget projection to fund the program when (if) it was implemented.

The political sensitivity of the POD issues elevated the need for IEP to develop a Rapid Communications Plan to elevate information to the Directors when needed on a quick basis. The plan consisted of the following steps: (1) The POD (or other staff) investigator would notify his/her supervisor after identification of an issue of significance—to be accomplished within one day after the data had been confirmed; (2) The supervisor would then forward the information to the IEP Program Manager, with policy and political considerations to be reviewed within one day; (3) The Program Manager would provide the information to the Coordinators; (4) The Coordinators would then discuss the information via a phone call meeting; and, (5) The Coordinators would then elevate the information to their respective Directors. Generally, this process allowed almost immediate elevation to policy level administrators in each agency before the public saw the information.

Work continued on revision of the Red Book during the year. The top priorities were to: (1) Define the CALFED-IEP relationship; (2) Outline the program review process; (3) Define the IEP base program relative to the broader program; and, (4) Develop performance measures for IEP. Also, during June of 2006 the Coordinators established a Green Sturgeon PWT to deal with emerging issues associated with the proposed listing of that species.

2007—And More POD

POD activities again took major time and resources during 2007. The SWRCB held a POD Workshop on March 22 and 23 in order to receive information regarding current studies and available results, including the results of work conducted to investigate the effects on pelagic organisms resulting from food web changes, establishment of invasive species, water exports, changes in salinity, and contaminant load in the Suisun Marsh and Estuary; proposed studies and a projected timeline for implementation; status of the scientific peer review of the work plan prepared by the POD work team; and interim actions the SWRCB should consider based on currently available information.

Resolutions were adopted by the SWRCB, Central Valley Regional Water Quality Control Board, and San Francisco Bay Regional Water Quality Control Board (collectively Water Boards) committing to take a variety of actions to protect beneficial uses in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta). In accordance with these resolutions, staff prepared a strategic workplan that described and prioritized activities the Water Boards would pursue for the next five years to address the water supply and environmental crisis in the Bay-Delta.

The Strategic Workplan touched on a wide range of flow-related and water quality actions including, but not limited to, implementation of studies to assess the effects of ambient ammonia concentrations on delta smelt survival and algal primary production; development of a regional monitoring program in the Delta; conducting a selenium screening study to evaluate the threat it could pose to fishery and wildlife resources in the Delta; development and implementation of total maximum daily loads (TMDLs); development and adoption of sediment quality objectives for enclosed bays and estuaries; and, comprehensive review of the Bay-Delta Plan, water rights, and other requirements to protect fish and wildlife beneficial uses and the public trust.

An entire session addressing POD was held at the 137th Annual Meeting of the American Fisheries Society in San Francisco. It was well attended due to high interest in that subject. The NCEAS review of the POD was deemed sufficient to warrant a peer review of the POD report; as a result, no other CALFED review was necessary.

The POD caused CDWR to redirect people from their Division of Engineering to assist with contracts so important work could continue. The POD Team was supported by about 18

separate contracts during this time. It took extraordinary agency effort to maintain these. The POD team began discussions on securing more involvement of NCEAS in POD activities. The POD Team planned to establish a parent team to oversee the NCEAS activity. Personnel from NCEAS were to meet first in early April. There were also discussions about having a CBDA Independent Science Review Board review the POD work.

During this time Chuck Armor, who was the lead person on the POD efforts, was promoted and began to reduce his involvement in the Management Team, POD, and Program Manager duties. In time he would take over the role of Chair of the Coordinators. In response to this, the Coordinators began discussions on a Program Manager succession plan. As discussions evolved, it became clear that IEP needed more staff help in Program management. An IEP Lead Scientist position was discussed and there was a movement to establish such a position using a position provided and funded by CBDA. The succession plan was presented to the Directors on March 23, and it included IEP Program Manager and IEP Lead Scientist positions. The scientist position differed from the CBDA scientist in that it was to be IEP-centric. More work was needed to flesh out differences between the two positions. However, affiliation of the scientist position with CBDA also strengthened IEP's coordination with CBDA's Science Program.

An interesting series of articles appeared in the Newsletter in the summer of 2007; those articles addressed the hydrology of the Estuary during water year 2005. Each section was written by a University of California student as part of a course taught by USGS Scientist David Schoelhamer. His objective was to provide "real world" experience to students, and to provide IEP with useful data summaries; this was a further example of IEP's continuing tie to academia.

The summer Newsletter also contained a list of 123 articles published in scientific journals, and in another 7 books. Approximately 20% of these articles included IEP staff as authors, were funded in part by IEP, or relied on IEP data or samples. During the year over 25 manuscripts were published or accepted for publication. That publication record reflected the strong commitment by IEP and others to producing scientifically rigorous information about the region and its biota, and distributing that information to the broader scientific community in an effort to foster future collaborative activities elsewhere.

2008—And More POD

One of the controversial issues surrounding POD work centered on whether the POD Group should make recommendations about how to fix the problems they were investigating. The SWRCB was disappointed that the Group did (would) not make recommendations. The POD Group argued, and the Directors agreed, that they should maintain their scientific integrity and not take sides on solutions. Most IEP personnel agreed, but occasionally managers pushed the Group for solutions. For example, the

BDCP process, then in full stride, needed information from POD. For the most part the Group held fast and stuck only with science. As POD work continued, the role of NCEAS in developing a synthesis diminished, and the report became largely an IEP Management Team product. The new plan was for the NCEAS group to review the work when completed.

As time passed, reports on POD became available and more became known about the reasons for the decline. Concern was expressed, that the opinions of the Management Team and the Coordinators were not congruent about the future direction of the POD program. More discussion was needed, and that issue would need to be elevated to the Directors.

During the year, IEP staff met with the CBDA Independent Science Board (ISB) to discuss IEP and its role in the Estuary, both historically and in the future. As part of the mandate to oversee the quality and use of science in the Bay-Delta system, the CALFED ISB conducted a broad review of the IEP. The goal was to promote innovation in, and modernization of, IEP as well as integration with efforts outside the Delta. The ISB encouraged the IEP Directors to engage with the Delta Vision Process, BDCP, and CALFED Science Program. They recommended that : (1) The IEP form the foundation of a comprehensive and integrated monitoring program; (2) The IEP become more anticipatory, hypothesis driven, comprehensive, and focus on the entire Bay-Delta system; (3) The Program should support and expand data analysis and interpretation; (4) The Program should seek greater integration and collaboration with other programs in the Delta; (5) The IEP needed a strategic analysis of current sampling protocols and locations with the goal to improve their effectiveness and design; (6) The IEP should undergo periodic independent review; and, (7) The Program should evaluate the efficacy of current funding and governance structures.

The ISB concluded that it, “feels that the IEP has served and will continue to serve a vital role in managing the Bay-Delta.” After the meeting, staff felt that the ISB was operating under a set of outdated assumptions about the role and activities of IEP. A follow-up letter from the Chair of the Coordinators to resolve these misconceptions was sent to the ISB. The letter committed to use some of the recommendations in several venues, and to work with the ISB members in the future.

As always, issues regarding how best IEP should link with the emerging Delta Vision Process, the BDCP effort, and future monitoring needs continued. The relationship with others was always an issue with IEP over the long term. Other programs came and went over the years, but IEP remained and was the established scientific entity in the Estuary.

By June 2008, the activity to develop a comprehensive monitoring program (formerly called, CMARP, IEP+, CMARP 3, etc.) had faltered. Sam Luoma, former Chief Scientist of

CBDA, had been asked to provide a conceptual framework for development of such a program. At the June 5 meeting of the Coordinators, Luoma gave a verbal review of his monitoring and assessment plan. At that time it was really just a “plan for a plan.”

A “grass roots” sturgeon PWT was formed during the year when 11 interested people started meeting to discuss issues surrounding the species. The Coordinators supported the effort, and asked them for a report on their activities.

Thirty-seven articles were published in regional, national, and international scientific journals. More than one-third of those articles included IEP staff as authors, were funded by IEP, or relied heavily on IEP data or samples.

After considering the applications of six people for the IEP Lead Scientist position, Dr. Anke Mueller- Solger (who had worked with the IEP Environmental Monitoring Program and the POD team at DWR) was chosen to fill the position. That new position was sponsored by the CALFED Bay-Delta Program. Dr. Mueller-Solger started her new job in July 2008 on the same day as the new CALFED Lead Scientist, Dr. Cliff Dahm, of the University of New Mexico.

2009—Budget Constraints and Shortfalls

In 2009, the IEP still was discussing how it could be most useful in supporting all of the ongoing efforts (Delta Vision, BDCP, etc.). Additionally, discussions were held on how ERP and BDCP monitoring should best interface with the broad scale interests of IEP. A CDFG staff person was tasked with developing performance measures and putting them into context. If IEP was to be the “go to group” for others, then new resources and infrastructures needed to be put in place.

During 2009, the POD Group felt they had gone about as far as they could go without further instruction from the Directors and that they would be wrapping up some of their research during the next year. They decided to write a “straw” proposal of questions that could develop into a study design for proposals on how IEP should use its resources to address fall X2 and other stressors. Also, as a result of some uncertainty, the POD Management Team felt the POD work over the years had shown a regime shift from one type of pelagic estuarine environment to another with a different set of conditions. The Management Team wanted the future theme of the POD to be about this shift, and how future shifts should occur with various management actions. The POD Group was concerned with this theme change and thought it could affect funding because managers would not recognize the issues under a new name.

During a Coordinators meeting, the IEP Lead Scientist provided a list of topics she was working on. The list included scheduling workshops, website issues, status review of PWTs, ammonia surveys, local contaminants, PWT funding, NCEAS contaminants work

team, etc. It was instructive to see how IEP work had moved from the early, single focus on water project issues and impacts.

The winter Newsletter provided a new feature that was meant to provide timely news to managers in the agencies. The first article presented new information on possible alternative life history strategies for delta smelt. The article reported that a portion of the delta smelt population may not migrate, but likely remains in upstream spawning locations through adulthood because of favorable environmental conditions. The article concluded that different management actions could be necessary to support these subgroups of the population. Once again, IEP was striving to be practical in presentation and use of data.

A new smelt larva survey was implemented on January 5, 2009 to support information needs of CDFG under the listing of longfin smelt. This survey was planned to provide near-real-time information on larval distributions to be used by agency managers assessing entrainment vulnerability. The survey results for longfin smelt were placed on the World Wide Web for easy access by managers and policy administrators.

For the first time in many years, budget constraints and travel restraints affected the structure of the IEP workshop traditionally held at Asilomar Conference Center. In lieu of one, three-day conference in Pacific Grove, IEP held a series of smaller, local, and focused workshops primarily aimed at scientists, but open to all. Participants were asked to consider several overarching questions in their presentations and discussions to facilitate an overall goal of improving IEP and associated monitoring in the Estuary. The series of meetings culminated in a final workshop about long-term and emerging monitoring questions, needs, tools, and initiatives relevant to environmental assessment and management of the Bay- Delta system. The workshops included: (1) Physical Modeling and Fishery Management with expert Review Panel; (2) Food Webs and Invasive Species; (3) Ammonia Summit; (4) Modeling the Pelagic Organism Decline—Results From IEP-NCEAS Systems Ecology Group; and, (5) Bay-Delta Monitoring Questions: Tools for the 21st Century.

During 2009, State budget shortfalls resulted in state employees being furloughed on certain days of the month. Such reductions in staff involvement began to have big impacts on IEP and were heading the Program toward “Stop Work Orders.” At that time, staff prepared a summary of activities that could be affected if such orders occurred and the managers worked to find “bridge funding” when state budgets were cut and stop orders were issued. Funding was needed until 2008-2009. The budget issues also resulted in the Directors asking that the 2010 Annual Workshop be held locally again and with a reduced effort.

As another strategy to facilitate the exchange of funds between agencies, CDFG made a request to become a member of, and was accepted into, the California Cooperative

Ecosystem Studies Unit (CCESU). After signing an MOU with the group CDFG became a partner rather than an agency. This allowed CDFG to receive funds from participating federal agencies via grants rather than contracts. The benefit of moving money within IEP is obvious. This was another example of IEP ingenuity and flexibility.

In addition to budget problems, IEP began to question its role. The Directors discussed planning and funding a delta smelt refugium during IEP meetings. They were interested in that subject because the species was in such trouble, but it was not really an IEP issue; the only connection was that IEP used some of the smelt raised in the conservation and culture facility during their studies.

During May, discussions began on the IEP MOU, which would expire in September of 2010. The discussions centered on whether SFEI, CALFED, or CVRWQCB should be added to IEP.

The CDWR and CDFG signed an MOU establishing an agreement for the Rio Vista Field station. The agreement recognized that space planning had already been approved and that a 5-year timeline for development, construction, and move-in had been established.

2010—Program Redesign—Again and Collaboration

By 2010 a new PWT had been established in IEP to look at turbidity and migration issues. Turbidity had emerged as a factor that could affect the distribution of delta smelt in the Estuary, and if the relationship could be described, management during water operations could be enhanced to benefit that species. The new PWT was named the Fish Migration PWT. It was charged with answering several questions: (1) Is turbidity an effective indictor for migration of delta smelt, longfin smelt and races of salmon?; (2) To what extent can operable structures (gates), the Clifton Court Forebay, the Delta Cross Channel gate, etc. be used to manipulate turbidity or suspended sediment and thereby affect migration of endangered species?; and, (3) What would be the outcomes for species protection and water exports under a range of feasible management alternatives using these studies?

Data management continued to be an issue of importance. During 2010, more guidelines for proper archiving of IEP data were developed to ensure a base level of access and secure storage of IEP field data sheets across all programs. The guidelines recommended that data sheets be digitally scanned after investigators returned from the field, the digital images be maintained on a server that is backed up, and the original data sheets be kept for a minimum of five years.

Once again, efforts were begun to “re-design” IEP and to work on the Program's “strategic direction.” A new set of Directors, desire to coordinate with the BDCP, and a Science Advisory Group (SAG) modeling review stimulated this effort. The SAG made a recommendation to establish three coordinated and interacting modeling groups

supported by IEP. The existing strategic direction was revised; and it was determined that the program needed to: (1) Find new partners and collaborators; (2) Determine how to expand Coordinator time involved in the Program; and, (3) Determine the right entity to conduct new work.

During the same period, the Coordinators heard a presentation from the California Water Quality Monitoring Council (CWQMC) about their “Futures Discussion” and considered ways to work with them. The CWQMC was formed as a result of a MOU signed by the Secretaries of the California Environmental Protection Agency (Cal/EPA) and the California Natural Resources Agency, as mandated by Senate Bill 1070 (Kehoe 2006). The MOU and Senate Bill 1070 (Water Code Sections 13167 and 13181) required that the CWQMC develop specific recommendations to improve the coordination and cost-effectiveness of water quality and ecosystem monitoring and assessment, enhance integration of monitoring data across departments and agencies, and increase public accessibility to monitoring data and assessment information. A key recommendation of the CWQMC was to provide a platform for intuitive, streamlined access to water quality and ecosystem information that directly addressed users’ questions and decision-making needs. To implement its vision, the CWQMC and its theme-specific workgroups began developing the “My Water Quality” Web site (www.CaWaterQuality.net) to provide a single, global access point to a set of theme-based internet portals. The website is designed around clear, intuitive questions that are readily understood by decision-makers, agency managers, legislators, scientists, and the public (e.g., "Are our aquatic ecosystems healthy?").

At the same time, the Unified Monitoring, Assessment, and Research Program (UMARP) (a continuation of the original attempts to develop an overall monitoring program–CMARP) was not making much progress toward completion. The project was funded for 2.5 years but had been on a hiatus due to a freeze of bond money. Sam Luoma explained that UMARP was a framework that sought common ground that the many different monitoring programs would be able to use to describe how the system worked and responded to a changing environment. He described it as being similar to the National Water Quality Program. At this point the UMARP group identified a set of core parameters or “grand challenges” to be addressed, which were: (1) Changes in infrastructure and management actions; (2) Ecosystem restoration activities; (3) External changes in human activity; and, (4) Exogenous processes.

IEP staff advised that the BDCP, UMARP and the water quality efforts be joined to avoid overlap. As a result, the Directors asked the Coordinators to put more thought into data management, modeling, and analysis, BDCP, extension of geographic scope, and expansion of coordination in the system. Various Coordinators took the lead on these issues. Additionally, the Directors asked the Coordinators to meet with the CWQMC and come back with a firm recommendation on whether IEP should participate in the issue-

specific California Estuary Monitoring Workshop and development of an Estuary portal.

Through all this activity a major question was, "How should IEP coordinate with all the new programs or entities and governance issues?" This was not new. It was certain that better coordination was needed with BDCP. At this time all IEP resources were fully committed. If more work was to be taken on there were only two options: cut back on existing work or secure more resources. An expansion would require more Coordinator time and involvement in IEP. At that time agencies questioned the direction of IEP. CDFG wondered if CALFED's successor should conduct synthesis and analysis, which historically had not been a CDFG role. CDWR suggested more special studies be focused on monitoring for BDCP, and USFWS wanted to focus on applied aspects of models through better coordination. The USFWS also felt it would be desirable to expand the geographical scope of IEP, but that expansion would need to be "applied." The SWRCB wanted to see some high level of direction from the Directors on what the focus of IEP was relative to other large programs. The SWRCB wondered if the purpose of IEP was to conduct the program effectiveness monitoring needed by BDCP. The National Marine Fisheries Service wanted IEP to focus on near-term water project activity and also to emphasize adaptive management issues highlighted in their Biological Opinions. The USCOE liked the ecosystem focus that IEP had maintained, as did USBR. The USBR was getting more pressure from their constituents to conduct cost-effective monitoring and obtain more information on other stressors so that a broader picture could be obtained. The EPA wondered how IEP could bring added value to other efforts like RMD, BDCP, and the San Joaquin River Management Group. EPA did not want to "reinvent the wheel" but thought IEP could coordinate a large part of the RMD.

As can be seen from the above list of agency comments, there was some confusion with respect to IEP's future role. At this time, the Coordinators agreed to put more effort into data management, modeling and analysis, to accommodate the needs of BDCP, expansion of geographic scope, and expansion of IEP's coordination in the system. The Coordinators agreed to meet with the Monitoring Council and bring a firm recommendation on whether IEP should participate in the California Estuary Monitoring Workshop being formed under the guidance of the CWQMC.

CDFG hired two people to serve as an interface between IEP and BDCP while Carl Wilcox (CDFG Coordinator) drafted a document that described a new structure of governance between IEP and BDCP. This document would reflect a broadening of IEP.

While these events were unfolding, the POD Group held a retreat and proposed to transition from focusing on the four POD species to a more holistic approach that would allow the program to do more to benefit native species and salmonids. The POD Group thought this would bring salmon back into IEP's focus. The group also decided that it needed to produce a final draft report in collaboration with NCEAS. The group determined

to complete the 2010 Pelagic Organism Workplan and Synthesis Report prior to December 8, 2010 when the National Research Council meeting would be held, because the IEP Lead Scientist would present the POD work there.

Activity continued on developing a research station at Rio Vista. The program was now called the Rio Vista Estuarine Research Station (RVERS) and would house about 15% of the IEP field staff. An MOU was signed with the City of Rio Vista and the City wrote a grant for an interpretative center that would help translate scientific findings to the public. The State Water Contractors agreed in concept to the RVERS project, which meant funding would be likely. The facility was approved by the California Department of General Services because the capital outlay would be recouped in 20–25 years.

Discussions on a new MOU, which was due on September 30, 2010, were put off for two years because of uncertainty in IEP direction. The budget was changed to reflect the removal of name “POD” and replacing it with “Directed.” This subtlety would better reflect the broad nature of the desirable short term studies that had the ability to address POD questions. Also, a substantial amount of work funded by USBR was redirected by them to salmonid work by outside contractors who were not part of IEP, but would be coordinated with IEP.

A report by CDFG (Carl Wilcox) noted that IEP should be the vehicle to conduct monitoring required by BDCP, while the state and federal Contractors (SFCWA) formed a Joint Power of Authority agreement with a budget of $2 million. That report brought to the forefront the continued need to increase coordination of fact-finding in the Estuary.

Once again, the IEP found itself at a crossroads. How would it relate to the future and all its new programs, activities and mandates? Based on the history of that multi-agency Program, its strengths and long term stability will allow it to survive and be a strong scientific force in Bay-Delta issues.

Conclusion: What Can Be Learned from this History of the Interagency Ecological Program?

The above section of this report chronicles forty years of history of the Interagency Ecological Program. Relationships between two of the cooperating agencies (CDWR and CDFG) go back even further. The IEP continues to actively engage in water issues in San Francisco Bay and the Sacramento-San Joaquin Delta, and is one of the longest running and most successful cooperative programs in California. It has been said that if we do not learn from history, we may be condemned to repeat it. In the case of the IEP, such a “condemnation” might not be too bad; however, it is still valuable to glean knowledge from this cooperative program. The remainder of this report will discuss factors that influenced and shaped the IEP and the strengths and weaknesses of the Program, and will include a

short consideration of the Program's future. Persons planning future multi-agency, cooperative programs might find this discussion instructive.

Influencing Factors

Throughout the history of the IEP, certain factors substantially influenced its shape and development. Some of the most influential ones are briefly discussed below.

The State and Federal Water Projects

The single most influential factor that affected the IEP was water project development in California. The planning and construction of the Central Valley Project in the early 1950s and 1960s, and the State Water Project in the early 1960s provided the impetus for formation of the cooperative efforts. Those projects had the potential to impact the landscape of the entire state and, therefore, a large-scale effort to assist in the planning and impact assessment of the efforts was needed. That need, however, was not universally accepted in the beginning. Some people thought the overall benefits of the water storage and delivery projects outweighed the need to consider protection of the environment, which was being substantially altered during the process of development. In fact, throughout the history of the Program, there was always a “tension” between the “development” proponents and the “conservation” proponents, both within the agencies and among society as a whole.

This tension became more acute as time passed and more environmental advocacy groups evolved, and as environmental protections and laws were passed in response to deteriorating environmental conditions in the Bay and Delta during the late 1970s and 1980s. Nevertheless, to the credit of the project development agencies, they understood that ecological considerations would be mandatory as water project development unfolded in the state, and that these considerations would best be addressed through cooperation with the state and federal fish and wildlife agencies.

During the first 20 years, little attention was given to issues that were not directly tied to the water projects. All study efforts had been established to document impacts in the Delta that were directly associated with water removal from the system by large state and federal pumps in the south Delta. Most of the funding for IEP—if not all—came from the state and from water contractors who were purchasing and using the water, and from Congress. Some funding and the Antioch boat facilities were provided by CDFG.

The Program remained essentially “project centric” until 1984, when the IEP Annual Report noted the following: “The Interagency Ecological Study Program is designed to evaluate impacts of the State and Federal water projects on the Estuary. Other human activities and natural events also affect the system. The effects of changes in volume and quality of municipal and industrial wastes, irrigation return flows, dredging, bay filling,

flooding of Delta islands and major climatic events such as El Nino must be considered when trying to assess the impacts of diversions on the estuarine health. Studies by various entities outside the interagency program increased understanding of estuarine processes and helped sort out cause and effect relationships." From this time on, the program was to be influenced by other outside forces besides the water projects, but to date these influences have not been as great as the water projects, or the agencies sponsoring those projects.

The Peripheral Canal

In 1960 the electorate of California approved construction of the State Water Project, which included some facilities in the Delta to facilitate water conservation, water supply and transfer across the Delta, and flood and salinity control and related functions. By 1972, CDWR selected the Peripheral Canal as the preferred Delta transfer facility. Results of fishery studies by CDFG and CDWR in the 1960s were a major consideration driving the decision. The primary objective of that canal was to convey good quality water from the Sacramento River, to the existing SWP and CVP pumping plants in the southern Delta, for export. The canal was further meant to correct environmental conditions associated with "through Delta diversions" that were adverse to the Delta fishery resources, such as reverse flows that affect fish migration patterns, transport of fish, and fish eggs and larvae across the Delta and to the pumps; reduction of food supplies (zooplankton); and, poor circulation and associated water quality problems in dead-end sloughs in the southeastern portion of the Delta.

A multitude of studies had been conducted and reports prepared concerning these issues, most of them by members of the IEP. In 1965 an Interagency Delta Committee recommended the Peripheral Canal concept as the best alternative for meeting the full range of water-associated needs in the Delta while also meeting the water transfer requirements of the state and federal projects. In November 1972 the Director of CDWR announced that the Department was proceeding with preconstruction engineering on a full-sized Peripheral Canal, and released a draft EIR on Sept. 3, 1974. This direction guided most of IEP's efforts during this time. The canal was always controversial. Delta farmers drove the initial opposition. Soon many environmental groups joined the opposition, fearing the canal would divert excessive amounts of water.

The CDWR and CDFG led an effort to develop protective measures, which many environmental groups supported. These measures were incorporated into SB 200, and backed by a constitutional amendment that would incorporate the protections in the state constitution. SB 200 and the constitutional amendment passed the legislature and were signed by the governor. However, some San Joaquin Valley farmers feared that the environmental protection measures were too stringent. They and the Delta farmers led an effort to place a referendum on the ballot to overturn SB 200 and the constitutional

amendment. Popular dissent was on their side, and SB 200 was overturned through a referendum process. In northern California, about 90% of the voters opposed SB 200. The elimination of the PC as part of the SWP caused DWR to phase out all planning for the canal. Emphasis was shifted to evaluation of ongoing operational impacts and development of information for general use in future planning. These politically driven changes in the program were greatly felt in the Fish Facilities Program. Consensus was reached between staff and the Fish Facilities Consulting Board regarding the concept of the first stage of the PC, but the defeat of the proposition caused major portions of the program to be terminated with the result that continuing effort was directed toward the evaluation and improvement of existing facilities, among which was the John E. Skinner Fish Protection Facilities. The remaining Fish Facilities Program elements were shifted to emphasize existing and other proposed facilities, and evaluated the need for screening agricultural diversions in the Delta.

By 1983, the IEP changed the second broad goal from, “Provide design and operational input for Peripheral Canal planning so the canal will meet fish and wildlife needs” to, “Provide design and operational input for Delta water facilities planning so the facilities will meet fish and wildlife needs.” Beginning in 1983, the Program shifted attention to evaluating alternatives other than the Peripheral Canal for diverting water from the Sacramento-San Joaquin Delta.

The 1976–77 Drought

Nineteen seventy-six was the first year of a two-year drought. It was the worst drought since the 1930s. The Fishery Program in IEP noted that survival of young striped bass in 1976 declined below expected levels; indeed, biologists found it to be the lowest since 1959. Until 1976, sportfishing records spanning a period of 40 years had shown that the number of bass entering the fishery was proportional to the Delta outflows in spring and summer of the year when young hatched. With such low inflows during the drought, bass numbers were very low. As a result of the drought, the Water Quality Program was addressing the important question of why phytoplankton production was so low during1976. All this uncertainty led the Environmental Protection Agency (EPA) to contract with USBR in the spring of 1976 to increase water quality monitoring and examine the effects of predicted low flow conditions on the Delta during the summer. A second investigation was aimed at studying characteristics and effects of the entrapment zone during low Delta outflow. It was found that salt intrusions were detected upstream 10 miles further in 1976 than in 1974. These efforts changed the direction of the IEP water quality efforts.

Nineteen seventy-seven was the second year of the severe drought and brought additional uncertainty to the understanding of the Estuary and the realization that the system was changing: the drought was causing observations not consistent with past

knowledge. As a result, USBR began a series of Algal Growth Potential (AGP) studies to examine the relationship between productivity and potential inhibitory factors (e.g., low-level toxicants), but the results were inconclusive. Concurrently, monitoring of marine filter-feeding organisms was expanded to see if they were possibly affecting phytoplankton through grazing. The changing conditions associated with the drought caused the IEP managers to reconsider and clarify broad Program goals. These drought-driven, revised goals affected the individual programs. The Fishery Program had been looking primarily at striped bass; as a result of drought-associated redirections, the study was reduced to a monitoring program. The most important remaining question was why the survival of young striped bass was much lower than anticipated during the 1976-77 droughts. The most probable cause seemed to be low food production in the system with reduced production in the "entrapment zone" being particularly important. Concurrently, the Fishery Program directed its efforts to chinook salmon and resident fishes.

The Water Quality study was also confounded by the drought and had been examining factors controlling production in the Delta with emphasis on the area of the "entrapment zone." The study produced mathematical models, which previously simulated phytoplankton production reasonably well; however, they did not adequately describe cause and effect relationships for low production during the drought; indeed, no causative factor for the observations was identified. As a result, the Water Quality Program identified low production during the drought as the most important observation. This effect was contrary to the concerns that originally had prompted the study.

State Water Resources Control Board Water Rights Hearings and Water Quality Control Plans

Throughout the history of IEP, and indeed Delta water project development, the regulatory authority of the SWRCB was keenly felt. The SWRCB has regulatory authority with respect to water rights and water quality protections in the Delta. As such, the Board has great influence over the activities of the SWP and CVP and, therefore, IEP. In 1966 the SWRCB held hearings to establish water rights with respect to the state and federal water projects in the Delta. New information collected by the then "fledgling" IEP was presented at the hearings, and prompted the SWRCB to solicit recommendations from the IEP member agencies; such recommendations previously had not been formulated by cooperative groups. As a result, the SWRCB adopted Water Right Decision 1379, which mandated a standard be set for *Neomysis* and striped bass spawning. IEP was to monitor these new standards. Ultimately, data collected by the agencies for the SWRCB resulted in the USBR and the US Bureau of Sport Fisheries (US Fish and Wildlife Service) joining the program and the Four Agency Program was born after development of a new Memorandum of Understanding in 1970.

During a SWRCB water rights hearing in 1978, which would lead to Water Right Decision 1485 (D-1485), much information was presented about conditions and needs in the Delta.

Protective standards were debated and supported by much new biological, hydrological, and engineering data developed by the IEP, but little mention was made of the system downstream of Suisun Marsh.

The SWRCB heard the testimony and D-1485 included a mandate that CDWR and USBR carry out studies on freshwater outflow downstream in the San Francisco Bay. The SWRCB did not specify that the work be done in the IEP, but all parties agreed that was the logical forum within which to begin the work.

The SWRCB noted that the eventual purpose of the new study would be to provide information necessary to identify any restrictions on reductions in Delta outflow necessary to protect fishery resources. The IEP moved in response to the SWRCB and established the Delta Outflow/San Francisco Bay study. This resulted in new members and an increased spatial scope for IEP.

The SWRCB held another water rights hearing for the SWP and CVP in 1987. In preparation for that hearing, the IEP spent substantial effort summarizing the available data and preparing comprehensive reports for all Program elements. Some normal activities were curtailed to make time for report preparation. Most of the staff time during 1987 and 1988 was spent on the ongoing SWRCB water rights hearing. The hearing continued for months while data, management recommendations, and requirements were debated by lawyers, engineers, biologists, water agency managers, environmentalists, and consultants representing many perspectives. During this time IEP data were prominently presented and discussed, but not always by IEP personnel. This process became adversarial and each agency generally presented their own perspectives on the data. There was no “IEP” presentation, but Program data still provided the basis of information about the system, and activities of IEP were profoundly affected by the Board’s mandates.

Changing Ecological Conditions

The Delta is not a static system, physically or biologically. All the water project related activities altered the system dramatically, as did other activities such as shipping, waste discharges, land reclamation, dredging, and fishing and other recreational activities. The biological baseline that was needed to aid in project planning and management became a “moving target.” The baseline that IEP established one year with their monitoring programs became different the next. In the early years of the IEP, striped bass (introduced from the east coast into the Delta in 1876) was the premier sport fishery in the system and was used as an indicator of system health. In fact, this species supported a commercial fishery for many years, until over-fishing and other impacts took their tolls. When serious declines were observed during the drought, IEP adjusted its activities to determine what was happening with striped bass. The SWRCB supported workshops to determine the causes of declines, all to no avail. The real reason for the declines has not been determined, yet the Program was adjusted many times in attempts to help find the cause. The bass decline

was a major factor influencing the IEP over the years, until other biological changes occurred. The introduction of striped bass, American shad, and several species of catfish and sunfish in about 1880 must have changed the ecosystem in ways one can only speculate about.

Introduced species influenced the activities of the IEP. Biologists have found hundreds of invasive species in San Francisco Bay and have determined that it is one of the most invaded estuaries in the world. Since the 1970s the upper San Francisco Estuary has been invaded by eight species of exotic copepods and two species of mysids. As has already been mentioned, the striped bass was introduced from the east coast of North America. An introduced zooplankton species (*Sinocalanus doerrii*) was discovered by the Program in 1980. A manuscript was written on this introduction in 1982. Also in 1982 another exotic, *Limnoithona sinensis*, was discovered in the Estuary. The clam, *Potamocorbula*, was first observed in the spring of 1986 near Carquinez Strait; populations of this clam would greatly expand and influence the trophic dynamics for years to come. In 1987, an additional copepod, *Pseudodiaptomus forbesi* was first observed. This species was significant because it was not as good a food source as was the native genus, *Eurytemora.* Another similar species, *P. marinus* was also detected about this time. A mysid shrimp and Chinese mitten crabs were also found about the same time that chameleon gobies became abundant. All of the above species were introduced from other aquatic systems and not only changed the dynamics of the Estuary, but also caused the IEP to alter its monitoring program in an effort to track the effects of these introductions. It is generally accepted that most of these species were introduced from the Far East in ballast water from ships.

The most dramatic biological impact affecting the Program was the so called Pelagic Organism Decline. In January 2005, IEP staff presented a white paper stating that the 2004 adult delta smelt index was the lowest in the 38 year record, and the 2002-2003 delta smelt indices were the 6th and 10th lowest, respectively. The striped bass indices for 2002-2004 were the 2nd, 3rd and 1st lowest on record. Threadfin shad indices were the 6th, 7th and 5th lowest on record, and longfin smelt were the 12th, 4th and 3rd lowest on record. The IEP biologists did not know the cause of these low indices, but knew that all the affected fish species spawn at different times of the year and rear in different parts of the Estuary. Thus, it was concluded that the mechanism(s) affecting these species must operate through much of the year and throughout most of the upper Estuary, or operate during summer, when those species have young-of-the- year in the pelagic environment.

The white paper listed three possible causes; toxic effects, food web effects, and export effects. The biologists that prepared the report suggested several potential actions while acknowledging that there were substantial gaps in knowledge. They recommended more sampling and studies on toxicity; as part of the POD, the Contaminants Project Work Team was reformed and became very active and productive. The Lead Scientist carried

out analyses on ammonia in the system that drew substantial attention to the role of domestic sewage discharges in the system. The question of toxics as a cause of the pelagic organism decline required a lot of bioassays and other testing, much of which was funded by IEP. The Program was able to get the “right” people from EPA, SWRCB and Regional Water Quality Control Boards involved, and investigators emphasized feeding success and origin, data analysis, and modeling. These investigators also asked the IEP staff to convene a dedicated meeting of the Estuarine Ecology Team (EET). A significant effort emerged in the Program to search out the cause of these serious declines in important species.

The POD investigations led to increased budgets, increased contracts with outside researchers, and cooperation with academia and regulatory agencies. The POD caused an unprecedented response on the part of the Program Directors in terms of increasing funding that would authorize new programs. The information gathered by IEP regarding the POD would shake the scientific and political communities all the way to Washington, DC. The effort included work on contaminants, and was the first truly ecologically oriented effort in the system.

Species Listings Under the State and Federal Endangered Species Acts

Over the years, several species of fish declined to such low levels that they became listed under state or federal endangered species acts. The winter-run salmon were listed in 1994, the spring-run salmon in 1999, the delta smelt in 1993, green sturgeon in 2006, and the longfin smelt in 2009. Such listings caused significant impacts to the Program, from having to expand sampling programs for these species and monitoring their progress (or lack thereof), to obtaining authority to “take” these species as part of normal sampling operations. The listings stimulated the development of the Real Time Monitoring Program so that information on those listed species could be obtained and supplied to policy makers and managers who could use that information to ensure protection of those species while water operations continued. Much staff effort was expended writing and monitoring take permits at the expense of IEP staff work, and this time was expended at the expense of IEP staff work. This was necessary because IEP staff were the only “experts” on these species. There was internal discourse on the problem of IEP staff working on regulatory issues in addition to collecting and interpreting data. This perceived “conflict of interest” caused interagency tensions that took managerial attention to resolve.

Other Programs

Other programs in the Bay-Delta ecosystem have had a significant influence on the IEP over the years. Most of these efforts have come and gone, or evolved into other activities, while the IEP has remained a long term effort with similar objectives. In almost all cases, IEP has been the program that provided information to be used in the other related efforts that were established to restore fisheries, coordinate study efforts, resolve flow and

pollution problems in the Estuary, or to restore the system to some defined level. In some cases, this put pressure on staff of the IEP to provide information on some outside imposed timeline or in some other format than IEP was using. This caused staff to be drawn away from their Program-related activities and caused workload issues. From a managerial point of view, the other programs usually required IEP time and effort to determine how IEP could, or if it should, mesh with the new project. In some cases, new activities looked at the budgets of IEP as a potential fund source to support their objectives, and they represented competition for limited sources of support. On other occasions, the new programs drew staff away from the IEP to support their efforts. Some of the more influential programs are discussed below.

Central Valley Project Improvement Act (CVPIA)

The CVPIA was a federal program that most importantly established fishery protection as an objective of the CVP, and required that the populations of anadromous fish should be doubled. The Act was meant to implement specific management actions to improve the status of fish and wildlife in the Central Valley, and fisheries on the Trinity River. It included a variety of resource, planning, monitoring assessment, and investigations that were relevant to IEP. Implementation of the CVPIA resulted in flow alterations and reductions in yield for the CVP and downstream users. IEP became involved when baseline populations had to be established so that “doubling” could be measured. The data to be used came from IEP salmon and striped bass programs. IEP technical experts were also drawn off onto technical committees that were formulating recommendations associated with the CVPIA. Interestingly, the CVPIA required that the striped bass population be doubled, but that mandate was never pursued.

As time progressed, the environmental community and others began to perceive striped bass as an “introduced exotic” and a predator of endangered smelts and salmon. Efforts were established and lawsuits were filed to reduce or minimize bass populations or their influences on the system. At the same time, the fishing advocacy groups that were influential in including striped bass in the CVPIA continued the uphill battle to improve the bass fishery in the Delta; supporters pointed out that a few years previously all of the species in question were simultaneously much more abundant than they had become.

San Francisco Estuary Project (SFEP)

Growing public concern for the health of the Bay and Delta led the Environmental Protection Agency to establish SFEP. This five-year cooperative effort was established to promote more effective management and restoration of the Estuary, primarily those areas downstream of the Delta. The SFEP was jointly sponsored by the State of California and this required the input from the IEP agencies. The absence of any substantial effort to determine the effects of pollutant discharges on the Estuary lead the EPA and the SWRCB to advocate establishment of an appropriate entity. The pollutant element in IEP’s Delta

Outflow/San Francisco Bay Study was one call for such a project. That entity was initially called the Aquatic Habitat Institute, but later renamed the San Francisco Estuarine Institute. Its structure differed fundamentally from IEP in that it was a non-profit corporation governed by a board of directors, with no civil service protection. The Board was (and is) composed of three representatives of regulatory agencies, three of waste discharge entities, three of public interest entities, and one University of California professor specializing in water quality. This structure largely reflected the desire of the waste dischargers to have a direct say over the SFEP, rather than the indirect say that water diverters had in IEP.

Initially, the Chair of the IEP Coordinators was appointed as one of the public interest representatives on the SFEP board. This, and countless hours spent by IEP staff helping develop the SFEI, placed a considerable demand on IEP. The scientifically based SFEI initiated significant monitoring programs in the Bay and later expanded them upstream.

Bay-Delta Oversight Council (BDOC)

The Governor of California created BDOC to assist and advise the state administration in designing a comprehensive program to resolve the many problems affecting the Estuary. The mission of BDOC was to design a long-term solution to the conflicts of the Delta. This was one of many efforts with a similar objective. The group was made up of 22 members representing environmental, water, and agricultural interests. The BDOC reported to a Water Policy Council chaired by the Resources Agency Secretary; John Amodio was the Executive Director. Several 6-8 person technical advisory committees were established. By executive order, all state agencies and departments needed to cooperate with BDOC, so IEP took on the role of making pertinent information available to BDOC. Further, staff, because of their established expertise in the Delta, became involved on many of the various committees associated with BDOC. As an example, Perry Herrgesell and Randy Brown were appointed as technical advisory committee members on the aquatic resources committee. A further extension of this program was the establishment of the Bay-Delta Advisory Council (BDAC). Again, IEP was the primary data source for these planning efforts.

CALFED and Its Predecessors: The 1994 "Framework Agreement" and The "Water Accord"

In the summer of 1994 the state and federal agencies responsible for the management and protection of the Estuary's resources signed a "Framework Agreement" (Agreement) that was intended to provide improved coordination and communication, and a process for developing long term solutions to the Estuary's problems. In the Agreement, IEP was identified as one of the primary sources of technical information; IEP filled this role and provided information as requested. December 15, 1994 marked the historic Bay-Delta Water Accord (Accord) and the signing of its associated "Principles of Agreement." The

Accord established, or led to, many specific Bay-Delta management, protection, and restoration actions and processes that directly influenced the ecological information needs of the IEP's member agencies and, therefore, the monitoring, special study, and research activities of IEP. Although the intent of the IEP was always to respond to the changing information needs of member agencies, the Agreement and Accord were clearly "watershed" events requiring a comprehensive review of IEP activities. The Directors recognized this and instructed agency staff to develop an appropriate revision of proposed IEP activities, which was presented to and approved by the Directors. This revision resulted in involvement with stakeholders through the IEP's Management Advisory Group, Management Team, and Project Work Teams. All of this led to Program changes and resulted in the establishment of the "CALFED" process.

CALFED was intended to replace the BDOC as a forum to develop long-term fixes for the Bay-Delta. As CALFED developed over the years, it became one of the largest Delta related programs ever implemented. Various offshoots from the CALFED program developed and consumed staff time. Some of these were the Operations Group, the Data Assessment Team (DAT), the Data Review Team (DIRT) and the Data Summary Team (DuST). As the CALFED Science Program developed, a point of contention emerged, and the question became, "How did CALFED's Science Program relate and interact with, or differ from, IEP?" Much effort was expended trying to define the respective roles of the two programs. The bottom line was that IEP had long-term expertise in monitoring programs and data acquisition and generation, while the CALFED Science Program had oversight and broader science involvement (contracts, peer review, workshops, and data synthesis, among others).

In retrospect, it appeared that CALFED built on and expanded upon what IEP had done: for example, more stakeholder input than MLAG, more science input than SAG, more program approvers than IEP Coordinators, more monitoring, and a wider scope of studies investigating more basic science.

California Bay-Delta Authority (CBDA)

As the CALFED Program developed through the years, it started to suffer from its complexity and an eventual lack of fiscal and political support. Many millions of dollars were spent on restoration programs, and yet the problems with listed species in the Delta persisted and actually became worse. The Pelagic Organism Decline documented the serious problems of the Delta ecosystem. As the CALFED program wound down, its successor became the California Bay-Delta Authority (CBDA), which was part of the California Resources Agency. The IEP once again had to spend effort determining how it related to this new (recycled) entity.

Delta Vision

As problems escalated in the Delta and water diversions were more influenced by endangered species and the Pelagic Organism Decline, the Governor established a group to develop a “Vision” for the Delta. This group of special appointees spent much effort debating the future of the system and provided a “balanced” view of how the Delta should look in the future. It proposed that water projects and environmental concerns should be equally important considerations. Again, IEP was a major data source for this effort.

Bay-Delta Conservation Plan (BDCP) and the Stewardship Council Comprehensive Delta Plan (SCCDP)

The emergence of the BDCP as a vehicle to meet Endangered Species Act biological opinions and the Delta Plan put forward by the Stewardship Council (which evolved from the Delta Vision process) also influenced the IEP. The IEP had to adjust its long-term vision, its key scientific activities, as well as its near-term planning and coordination with other existing or emerging projects. The IEP had to evaluate how to better coordinate with these and other efforts.

California Water Quality Monitoring Council (CWQMC)

The CWQMC was formed in response to Senate Bill 1070, and was charged with developing specific recommendations to improve the coordination and cost-effectiveness of water quality and ecosystem monitoring and assessment, enhance the integration of monitoring data across agencies and departments, and increase public accessibility to monitoring data and assessment information. Many state, federal and local agencies, regulated dischargers, water bond grant recipients, and other entities were spending millions of dollars each year monitoring, assessing and reporting on the condition of the San Francisco Bay-Delta Estuary. While some coordination efforts currently existed (e.g., IEP and the San Francisco Bay RMP), there was currently no overall structure to coordinate all of these activities. As a result, inconsistent monitoring objectives and methods to collect, assess, store and access data made efforts to integrate data from different studies difficult.

In an effort to better coordinate and enhance California’s monitoring, assessment, and reporting efforts, the CWQMC and its workgroups developed the “My Water Quality” Web site to provide a single, global access point to a set of theme-based internet portals for water quality and ecosystem monitoring and assessment information. The website is designed around clear, intuitive questions that are readily understood by decision-makers, agency managers, legislators, scientists, and the public (e.g., Are our aquatic ecosystems healthy?). The CWQMC came to IEP to discuss how to better coordinate efforts, and IEP staff time again was diverted to consider other needs.

Public Influence and Various Advocacy Groups

Over the years, the general public influenced IEP through the ballot box or through public

hearings or workshops. During the SWRCB water rights hearings that resulted in Water Right Decision 1485, the public and environmental groups (Save the Bay) made the point that more needed to be known downstream in the system below the Delta. As a result, the State Water Quality Control Board mandated that the water agencies carry out studies to determine the outflow needs of the Bay. IEP expanded to take on these studies. In 1982, the public voted to stop development of the Peripheral Canal as a facility to transfer water around the Delta as had been legislatively mandated. This change in direction caused significant alterations in IEP objectives and goals. When political opposition forced the governor to ask the SWRCB to withdraw a protective SWRCB water right decision (Draft D-1630), EPA stepped in and promulgated a "salinity standard" (X2), which altered IEP's work. Instead of documenting outflow and fishery relationships, the IEP had to shift its efforts to determine salinity relationships that were really only a surrogate for the factor(s) influencing species abundance. On other occasions, public agencies like the California Urban Water Agency (CUWA) lobbied to become directly involved in Program management, and led to expansion of the advisory groups serving the IEP.

Personalities and Leadership

As is true in any organization, the successes are really an extension of the dedication and involvement of the people in the organization. In that regard, IEP has always been a "labor of love" to a special group of scientists and administrators, and the success of IEP is owed to its agency staff and some political leaders. It is not the intent of this report to mention all the influential personalities that shaped IEP over the years, but several stand out. Certainly, Don Kelley, the leader of the early Four Agency Program is noteworthy. He was involved in establishment of the original studies that led to the greater Program. Later, Pete Chadwick, who basically took over from Kelley for the Department of Fish and Game, greatly influenced the direction of the Program through close relationships with the water community and the trust that stemmed from sound and dependable scientific advice and recommendations. Within CDFG, Chadwick was known as the "go to" person on water issues in the Delta. Pete had the remarkable ability to listen to and understand differing points of view and to work with others to find common ground, or at least more common ground, with them.

For the most part in the early days of Delta work, Directors did not really get involved in the issues. The issues were too technical and specialized. In CDFG, Chadwick developed the expertise and was allowed to advance CDFG water policy as he could through the various forums, including water rights hearings and legislation. Chadwick chaired the IEP Coordinators since the Program was instituted in the early 1970s until his retirement in the early 1990s. During those years, Chadwick's focus and efforts were primarily water issues and IEP.

Randy Brown, the CDWR Coordinator stands out as a scientific leader within the IEP.

When Randy became very involved in the Program, as the Chief of CDWR's Environmental Services section, the face of the IEP began to change. Brown convinced the Directors to think more broadly on a spatial and programmatic scope. Brown encouraged more involvement from outside academicians and scientists. He provided contracts for others to do work for IEP that internal staff were unable to do. He instigated the IEP Newsletter, which soon became an outlet for knowledge generated by the Program. In short, Brown put a "scientific face" on IEP.

Over the years, certain Directors affected the program. As noted above, and as a general rule, the Agency Directors did not become heavily involved in Program management. They met annually and approved budgets prepared by the Coordinators, who usually had already resolved the "tough" issues. One CDWR Director, however, was an exception. David Kennedy saw the importance of the Program and its implications for water management and development in the state, and became greatly involved in Program management. He was a career water management engineer, but he saw the value and need to be concerned with the fishery issues associated with water management: on his office coffee table one could find technical reports on salmon and associated issues. One of his greatest influences was the change of the name of the Program from the Interagency Ecological Studies Program (IESP) to the Interagency Ecological Program (IEP). This was done to emphasize to stakeholders, and perhaps some IEP staff, that there was more to IEP than carrying out open-ended studies. Politicians were not akin to supporting a study program to gather information for its own sake, and Kennedy saw the implications of this. At the time, some of IEP staff were concerned that the name change might suggest a lack of commitment to good science but, over time, the Program grew and developed into a respected science program in spite of the name change.

Another Director, David Houston of the USBR, also had an influence on the direction of IEP. During his time he influenced two things that improved the IEP. First, he was instrumental in encouraging USGS to become involved in the Program. They had expertise in hydrodynamics and the IEP was now starting to see the importance of modeling and circulation in the system as it was affected by the various water delivery projects. One may say this was done out of selfish interest to protect the Project's activities, but in the long run the knowledge gained through USGS involvement added validity to the efforts of IEP. USGS initiated measurement of flows and developed a better understanding of the Delta hydrodynamics and, over the years, USGS data and models changed some of the previous thinking. Their work on pesticide runoff also resulted in major changes in how pesticides were (and are now) used. The insistence of USGS on thorough science aided the fishery programs greatly. David Houston was instrumental in pushing the program toward better data handling, processing, storage, and dissemination. He forced the Program to move toward STORET. Although, that system proved to be inadequate for IEP needs, the move set the IEP on a direction that eventually resulted in a widely acknowledged and accepted data handling system housed at IEP.

Certainly, these were not the only influential people in the organization. Examples abound throughout the Program at all levels. Dedicated biologists and engineers, who spent countless hours on foggy, damp, and cold mornings on boats in the Delta or long hours on a computer analyzing data for some real or politically driven deadline, also have made the Program what it is. It can be said that people in the IEP have taken ownership in it over the years and, as such, have made it great.

Budget/Fiscal Support

Any large program is influenced by money and fiscal support. The IEP, as a rule, has been well supported throughout the years. That support stems from at least two factors. First, the political leaders in each agency recognized the importance of water-related issues and sound, knowledge-based management to the welfare of the state. As such, IEP-related activities that were affecting water development were well supported. IEP activities were perceived as high priority, and funds were made available to support them, resulting in relative stability throughout the years. Secondly, much of the funding for the Program came from the water users who bought that resource from the state and federal water projects. Throughout the years, this provided a consistent source of revenue for the Program. Additionally, IEP budgeting was consistent partially because it was a cooperative effort. Over the years, it seemed that when the State of California was short on money, the federal government was able to make up the shortfall, and vice-versa. Further, since water contractor money was not part of California's general budget, it was not as susceptible to political whims or shortfalls. The Program was able to balance lean years and times using state and federal funds, and user fees. All of this resulted in relative stability over the life of the IEP; however, there were times when situations resulted in shortages. After the state and federal agencies took budget hits associated with the economic downturn following the attacks of 9/11 and the subsequent recession, the Program suffered shortages and some important aspects of IEP had to be reduced. Notably, research activities outside of IEP’s base programs were cut. Over the years much staff effort was expended on balancing the IEP budgets, and the result owed its success to dedicated managers who saw the value of the Program to the state and federal governments.

One management problem for IEP, however, was that sometimes general state hiring freezes adversely affected staffing levels, even when money was available. While the IEP was sometimes able to get exemptions from the freezes for the highest priority activities, such freezes did adversely affect IEP.

IEP Strengths and Weaknesses

When one reviews the history of the Interagency Ecological Program, several strengths and weaknesses of the multi-agency model become apparent. It is instructive to list these strengths and weaknesses so that this, and other programs, can better perform large environmental monitoring and planning efforts. Thus, I have included a brief discussion

highlighting strengths and weaknesses of the IEP. It is the author's opinion that the strengths far outweigh the weaknesses.

Strengths

Emphasis on Applied Work

Throughout its existence, the IEP has emphasized work that had practical and relevant implications, rather than work of purely academic interest. The IEP produced information that was useful to agency policy managers and that could be used to plan, develop and manage water development in California. This emphasis was not to the exclusion of academic work, but was balanced in a manner that made the Program both “useful” and “useable.”

Flexibility and Ability to Expand or Redirect

Many large programs become inflexible and unable to respond to evolving needs as times change; this was not so for the IEP. Its formal existence for almost 40 years provides testimony to this fact. As data needs changed when the Peripheral Canal was removed from water project planning, the Program responded in a positive manner and began to emphasize information necessary to improve existing facilities. In other cases, when outside forces—like the SWRCB mandate to study Delta outflows in the Bay—appeared, the Program was able to expand and use resources from the various member agencies to meet those needs. When the need arose to develop expertise in modeling, IEP was able to draw on other agency expertise (USGS) to provide the necessary personnel and expertise. When there was a need to provide “real time” data to help manage diversions and meet Endangered Species Act mandates, the Program was able to quickly develop and implement an effective field program in short order. When budgets were cut, it was usually able to redirect expertise to other efforts to reduce the impacts of lost expertise and institutional knowledge. The Program evolved over time, yet remained relevant to current issues.

Prioritization

The IEP has been adept at prioritizing its efforts. A classic example occurred whenever the SWRCB scheduled an important hearing or workshop, and the IEP was able to reduce lower priority work efforts and emphasize data analysis. When budget constraints dictated, the Program was able to assess which outside efforts were not crucial to meeting immediate objectives, and was able to eliminate or delay those efforts. Such prioritization and flexibility was commonplace over the years.

Outreach

The IEP has always been open to outreach. In the early days, the technical experts sought out information from other systems in order to better understand how to study fisheries in

the Delta. Program scientists looked to Aswan High Dam, the Saint Lawrence River, and the Potomac River in Maryland. Over the years, the scientists reached out to academia to learn more about their efforts and relate it to their areas of responsibility, and much of this was accomplished through the Academic Involvement Program. The IEP reached out to the public through various forums and workshops over the years and, in response to input received, revised certain efforts. The Program reached out to member agency managers through the Management Level Advisory Group. These, and many more outreach efforts, resulted in responsiveness to outside needs. Despite these efforts, some have criticized the IEP for not reaching out enough to its stakeholders.

Shared Resources

In reality, budgeting has been a double-edged sword because of the multi-agency involvement but, overall, the Program enjoyed flexible budgeting and this resulted in Program stability. On one hand, trying to coordinate state and federal budgets on different fiscal year timing was difficult. The state was on a July 1 through June 30 fiscal year, while the federal government was on an October 1 through September 30 schedule. Developing programs supported by funds from two different fiscal years was sometimes a challenge, but also provided flexibility that usually could be used to the Program's advantage. As previously mentioned, when one government was lean, the other was generally not and, thus, could make up the slack in funding. Sometimes when one agency had to close out the books at the end of its fiscal year and could not make purchases, the other could make the purchases for critical field work because they were not closing their books. Overall, the fact that several different fiscal years were being used by Program agencies, IEP was more diverse; and, just as an ecosystem is more stable when it is diverse, it was more stable over the long run. Appendix C provides a general depiction of Program budgets over the years.

Balance of Power

The IEP is made up of development agencies (CDWR, USBR and USCOE), management and regulatory agencies (CDFG, USFWS, NMFS, EPA and SWRCB), and a scientific agency (USGS). As such there is a “balance of power” of sorts. All agencies have representatives “at the table” and have an equal vote, although decisions are usually made by consensus. It can be said that IEP is process driven and consensus based. Decisions are made through mutual discussion and debate. In some cases, funding agencies have final authority but, over the years, this rarely yielded a negative result. In order to enhance the unbiased image of the Program, which is primarily funded by the water development agencies, the IEP was set up to have management or regulatory agency personnel act as chair of the Coordinators, the Directors, and the Management Team. Over the years, CDFG has chaired the Coordinators and the Directors meetings. This balance of power has served the Program well. Parenthetically, sometimes within agencies there has been the feeling that the management agency staff (whose positions

are funded by a development agency) are not free to act as they might if they were funded by their own agency; over the years, however, that perception has proven to be erroneous.

Emphasis on Science

A significant strength of the IEP has been its emphasis on science rather than perception or politics. Over the years, the Program has taken major strides to improve its ability to do good science. From time to time, it was criticized for not doing good science, and came primarily from entities that were affected by policies developed using IEP data. Yet, over the years, many academic and outside review panels have validated the unbiased nature of IEP science. As the academic community has become enlightened regarding environmental issues, the IEP has evolved to reflect those same principles. This was particularly noticeable in the early 1970s as society and its government institutions began placing a higher value on environmental stewardship. The IEP responded by seeking greater academic involvement and review. In reality, the science carried out in the IEP was usually more rigorous and grounded than other activities of the respective member agencies.

Independence

The IEP remains a multi-agency program, with each agency's staff housed within a state or federal agency. But, even though this is the case, the IEP as a whole is independent from the agencies. It is a program unto itself, with agreed-upon goals and objectives. The Program is under the purview of Agency Directors, yet since funding comes from various sources, individual programs within IEP sometimes reflect activities not highly prioritized by a particular agency. For example, monitoring of various fish species in the Delta is an important goal of the Program, but due to shortage of internal funds, long term monitoring is not an activity routinely carried out by CDFG. Likewise, other agencies participate in programs in IEP that their individual agency would not be able to carry out alone. This independence from single agency restrictions continues to allow the IEP to be effective and maintain long term programs that are sometimes immune to short term variances due to funding shortages, political direction, or constituency mandates within individual agencies. For example, some CDWR and USBR constituents may not agree to spend their monies on fishery issues and programs, but since such work is necessary and has been found to be a part of water operations within state law, CDWR spends their dollars on fishery programs within IEP. The bottom line is that the IEP is independent from some of the single agency goals and objectives and, as such, can be more effective in assessing projects impacts.

Reasonable and Practical Goals

Even though the IEP is independent of individual agencies, as described above, the Program does not set unreasonable goals that would violate the general needs of individual agencies. The program goals of IEP over the years have always been practical

and intended to be consistent with the overall goals of the member agencies. The Program does not do “science for the sake of science” or studies just to be doing studies; remember that the Program changed its name from the Interagency Ecological Studies Program (IESP) to the Interagency Ecological Program (IEP) to emphasize this point. The IEP developed the never-tried-before “Real Time Monitoring Program” to assist in the real-time assessment of fish abundance and populations that were being affected by pumping rates and operations. The Real Time Monitoring Program was not established to learn how to sample and process data faster, but to provide information to be used in a dynamic management program to attain flexible and efficient water delivery, and yet protect endangered species in the Delta. All the other information developed in the early years of the Program was aimed at helping to plan for and build the needed Peripheral Canal, which was a final phase of the SWP. The Delta Outflow/San Francisco Bay Study was started in 1979, not merely to study the Bay, but to develop flow needs of the downstream aquatic resources to avoid impacts associated with greater upstream diversions. The more recent POD work, although more research-orientated than most other IEP work over the years, was geared to find the causes of the declines so that impacts could be reduced and the system restored. In simple terms, knowledge acquired by IEP was applied to real-world problems.

Internal Organization

Possibly the most important strength of IEP has been the fact that it has a strong internal organization. The early Program Managers recognized that need when the Program was formed. In a January 12, 1971, memo titled, “Management Memorandum of Agreement re Ecological Studies in Sacramento-San Joaquin Estuary” the managers made the case that it was desirable to establish a formal management structure to implement the 1970 agreement to carry out ecological studies in the Estuary. Those managers noted that the function of the new structure would be to assure close coordination among the various agencies at the working level, and to provide for a rapid solution of problems at the management and policy levels. The managers referred to the fact that “past experience with technical studies being conducted jointly by several agencies indicates that such a management structure is important to program success.” As a result, the Directors approved a structure involving a formal committee of Directors to establish policy. The Management Team created an interagency management committee (the Coordinators) to provide overall direction and to recommend policy to the Directors, and set up technical management committees for each area of study. Those technical committees were responsible for technical direction of studies and coordination of working-level activities, and report preparation. Although some of the names of the groups changed over the years (Technical Committees became Project Work Teams), the basic structure remained the same and provided a solid, stable, and effective structure to oversee the Program.

Program Staff

Just as IEP has been influenced by its leadership and management, it has also been greatly shaped by staff at all levels. Over the years, the staff housed in the member agencies has sometimes numbered more than 200 biologists, engineers, clericals, boat operators, seasonal aids, mechanics, data handlers, budget analysts, typists, human resources specialists, and other classifications (Souza, personal communication; see "Notes"). Without this contingent of dedicated personnel, IEP would not have been able to sustain its longevity or program effectiveness.

All of the field programs depend upon collection of data from the Bay-Delta itself. In almost all cases, this involved using a boat as a sampling platform, whether it was pulling a trawl or setting a remote monitor in the water. Over the years, the IEP agencies had a fleet of 15–20 vessels ranging in size from the 52-foot *San Carlos* (CDWR) and the 42-foot *Longfin* (CDFG) to many unnamed skiffs and other motored vessels. In each case, staff was needed to maintain, transport, and operate those boats on a demanding schedule that was subject to all types of weather and conditions. The same personnel were expected to construct and repair nets and other sampling gear. In most cases, those personnel were not recognized individually, but without them data and subsequent reports, publications, or policy recommendations would not exist.

Likewise, laboratory personnel who spent countless hours peering through a microscope counting zooplankton, identifying larval fish, or aging fish scales were key to developing an understanding of estuarine biology. On numerous occasions field data collected on one day were needed literally the next day by the Water Operations Management Team so that they could make informed decisions regarding diversions from the Delta that were in compliance with ESA Biological Opinions. In some cases, decisions made on millions of dollars of water for California users were based on data collected by field personnel and processed overnight for use by agency policy managers.

Typists, responsible for transcribing study plans, annual reports, or peer-reviewed publications from a hurried staff person's "chicken scratching" also kept the Program going. Budget analysts continually allowed the Program to remain solvent after going through the difficulties of managing multi-year, multi- agency budgets and spending constraints. Human resources specialists seemed to do the "impossible" by hiring permanent and seasonal staff in time for the "next" field season or a pending program expansion.

Over the years, IEP has consistently benefited from dedicated staff at all levels, most of whom were performing above and beyond job specifications because they cared about the resources they were working with, and their respective agency mission—whether it was fish and wildlife resources protection or providing water resources for human consumption. The IEP staff resources have been a strength that has made the program successful. The IEP staff is truly a case where the "sum of the whole is greater than its parts." The current

Lead Scientist is fond of saying, “We is smarter than me.” These comments illustrate the philosophy that permeates through IEP, and that has made a better program combined than the agencies could have made apart from each other.

Weaknesses

Ineffective Conversion of Data Into Information

The IEP has been criticized for being slow or ineffective in turning data into useful information. The Program has a great reputation for planning and implementing long term monitoring activities (e.g., the Fall Midwater Trawl Program- 50 years; the San Francisco Bay-Delta Outflow Study- 30 years) but sometimes is slow in analyzing and using the information gleaned from its efforts. Similarly, the Program has sometimes spent a lot of effort studying a problem and then not being able to resolve it. Many years were spent monitoring and studying striped bass, but the Program was never able to fully explain why the populations declined so dramatically after the drought years of 1976 and 1977. Another example is the Delta Outflow/San Francisco Bay Study, which began in 1979 and collected reams of data from the system. It is probably one of the best long-term databases on estuarine fishes in the world, yet there remains a paucity of publications and reports based on that work. Indeed, one of the first summaries of that information was prepared by a post-doctoral student from UC Davis in the late 1980s. This student was not an IEP member at the time of that work, but part of the problem had to do with lack of time allocated to analysis in deference to keeping a field program running. It takes significant effort to maintain long-term field programs, which sometimes has prevented staff from processing data and turning them into useful information. Another potential reason for the perceived lack of data processing relates to staff stability. In most of the agencies, staff must move and change jobs in order to move up the professional ladder. When that happens, expertise is lost and data stay behind and remain unanalyzed. Also, most state and federal agencies do not reward data analysis and publication, although the USGS is an exception and promotions are based, in part, on professional publications. If this were true in all IEP member agencies, more information would have come out of the Program in the past and such would be the case in the future. Recruitment of high-level scientists who are proficient in data analysis has also been a problem for IEP member agencies over the years. The civil service system does not always retain the highest caliber professionals to serve in public service; private industry is able to pay more and can obtain more qualified people.

Lack of Staff Co-location

Another weakness that has hampered the IEP has been the inability to co-locate its staff. Each member agency, with the exception of CDFG and USFWS, has housed their respective staff in separate locations. This has hampered communication and coordination and led to more of a “stove pipe” organization than might be optimal for good

collaboration. The co-location of staff has many benefits and efficiencies, such as sharing equipment, but most of all it leads to “cross pollination” of knowledge and expertise. The value of an informal discussion over the lunch table between an engineer and a biologist working on the same project cannot be underestimated. The Program has attempted to deal with this in several ways over the years. In the early 1980s, the new Delta Outflow/San Francisco Bay Study staff traveled to the USGS offices in Menlo Park on a regular basis to communicate and exchange information. This was somewhat effective, but soon collapsed under the weight of travel on a regular basis. The technical committees and many forums the Program set up over the years also attempted to compensate for separate staff locations. The annual workshops at Asilomar were originally designed to encourage staff interactions and exchanges, and were quite effective in using a three day and night format to encourage relationship building. Finally, the most recent attempt to co-locate staff was the establishment of the Consortium. Plans originally called for the co-location of staff at a site on the UCD campus, with another field site at Rio Vista. That plan was stalled when a new state administration came into power during tight budget times. Plans still are underway to establish the Rio Vista site, but plans for co-location are reduced from those previously in place.

Time Spent on Attempts to Integrate With Other Programs

Some of the most time-consuming and least productive activities that the IEP engaged in, and that had minimal positive impact, were the attempts made over the years to determine how IEP related to other programs that came and went as efforts were made to resolve problems in the Estuary. Staff at all levels, from the Coordinators to the field biologists, attended innumerable meetings to discuss the formation and establishment of many new and associated programs like the Aquatic Habitat Institute, the Central Valley Project Improvement Act, the San Francisco Estuary Project, the Bay-Delta Oversight Council, the Delta Vision Process, and the “Grand Daddy” of them all, the CALFED Program. Staff sat on planning level and management committees, and biologists and engineers sat on committees that planned monitoring programs that would never be implemented. All of these “extracurricular” activities took time away from the primary work of the IEP staff. Although these types of efforts were politically necessary, and in some cases led to improved programs, they were generally detrimental to IEP priorities.

Contracting and Budget Issues

Since the IEP is a multi-agency program with state and federal agency members each having separate funding sources and different guidelines, regulations, and fiscal years, inordinate time was spent at all levels on contracting and budget issues. Programs had to be constructed so that they met budget guidelines and objectives. Budgets had to be balanced between 20 to 30 different elements, and then balanced overall at the end of the year. The Program Manager spent significant time preparing spread sheets to explain expenditures to the Coordinators, the Directors, and the constituents and other advisory

groups who help support the Program. Spread sheets were to reflect where the money came from, to whom it went, how much supported each element, and whether it was mandated. Each change in one program affected the bottom line and necessitated changes and justifications elsewhere. The information had to be understandable and meaningful. Hundreds, if not thousands, of hours have been spent on this effort over the years and *without* the help of professional fiscal staff. Program biologists were primarily responsible for all budget work; it was only because of dedicated staff that the budget process served the program as well as it did.

Data Management and Dissemination

Despite well intentioned, but maybe too few, efforts, IEP has been criticized for not managing its voluminous data in a manner to satisfy all potential users, both internal and external. Early attempts to incorporate IEP data into the federal STORET system took much effort, but essentially were overtaken by the advent of personal computers and desk-top analytical programs. The efforts to implement the BDAT within IEP have also met with limited success. Data users have complained that they need to go to individual sources to get access to needed information. A centralized source of all IEP data available to all potential users has not been available, and this has resulted in the perception that the IEP has not been effective in generating information needed to manage the Delta or better understand ecosystem dynamics. The work associated with the recent POD investigations has helped to make data available, but the IEP could certainly make improvements in data management and dissemination.

Challenges for the Future

The Interagency Ecological Program has been an extraordinarily effective cooperative effort over the years. Even in the early 1980s, agency members present at a national conference on flow studies in Texas estuaries noted that the IEP model was special, and that they were not able to attain such cooperation and coordination between development and resource agencies in their respective states. The preponderance of this report on the history of IEP documents the accomplishments and special nature of the Program. However, if the Program is to continue as effectively into the future as it has in the past, several issues must be dealt with. These are briefly discussed below.

Funding

The current recession provides IEP with a special challenge. Money is not as available for monitoring activities as it has been in the past. Agencies are concerned with maintaining staff and other programs critical to their respective missions. Further, recent large and expensive efforts like CALFED have spent hundreds of millions of dollars and results have been minimal. Conditions in the Estuary are worse than they were before expenditure of the money, and trust must be rebuilt with respect to the expenditure of large sums of

money. The IEP will need to be effective in procuring support in lean times now and into the future.

Commitment

Over the years that IEP has been in existence the member agencies have, for the most part, been committed to Program objectives. Now that funds are short and other objectives within agencies are elevated in priority, IEP needs to shore up high level commitment to the Program. Other efforts, such as the BDCP and the larger Stewardship Council are receiving significant interest, and this could draw emphasis away from IEP. The policy-level commitment to IEP should be maintained at the highest priority.

Lack of Historical Leadership

Over the last several years, there has been a significant turnover of leadership staff in IEP. All of the managers and biologists that were present when the program was founded have retired or moved to other positions. Some of the newer managers have not “grown up” within the IEP “culture” and, as such, do not have the same ownership for the Program. Part of the success of the IEP has been based on the fact that the staff has seen the Program as a “labor of love.” The Program needs make up for the loss of historical leadership and develop a new set of advocates for the IEP within the member agencies.

Lack of Institutional Knowledge

Associated with the exodus of historical leadership is the lack of institutional knowledge. Looking at problems in the Delta, one can see that problem identification and solution finding has been cyclical. A prime example was the Peripheral Canal. Evaluations under the original authorization of the SWP led to the conclusion that construction of a Peripheral Canal to transport water around the Delta and eliminate the problems associated with diverting water directly from the biologically crucial nursery in the Delta was desirable. The Peripheral Canal was a recommendation of the early IEP. The vote of the people of California eliminated that option in 1982, but it is being reconsidered in the BDCP process. Participants who were not around in the early days now question the validity of this proposal. This lack of institutional knowledge is leading to inefficiencies and duplication of effort in the current planning processes. The IEP needs to preserve the institutional knowledge it has acquired over the years. Hopefully this written history will assist in the preservation of that knowledge.

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Appendix A: Significant Events that Influenced the Interagency Ecological Program

(including the date it occurred and page(s) where it is discussed)

Event	Date	Page
Completion of Central Valley Project	1951	Page 1
Completion of State Water Project (SWP)	1968	Page 1
DWR contract with DFG to establish “Delta Fish and Wildlife Protection Study”	August 10, 1961	Page 1
MOU that established the “Four Agency Program”	August 1970	Page 4
Davis Dolwig Act enacted	1963	Page 2
Co-location of USFWS and DFG	1973	Page 4
Formalization of program structure	Jan 12, 1971	Page 5
Suisun Marsh Management Studies Implemented	1972	Page 9
Establishment of the Fish Facilities Consulting Board	1974	Page 13
Program first called Interagency Ecological Studies Program (IESP)	1974	Page 13
First year of significant drought	1976	Page 14
Lowest striped bass abundance index to date	1976	Page 14
State Water Resources Control Board water rights hearing	1976	Page 15
Program revised in response to drought	1978	Page 16
Water Right Decision 1485	1978	Page 18
Delta Outflow San Francisco Bay Study started	1979	Page 19
Development of a common data storage and retrieval system	1981	Page 23
Defeat of Proposition 9 (No PC)	June 1982	Page 24
Introduction of Sinocalanus and Limnoithona	1982	Page 26
U.S. Geological Survey and State Water Resources Control Board join IEP	1984	Page 27
Revision of MOU	1985	Page 28
Data summary and preparation for 1987 water rights hearing	1985-86	Page 28
Suisun Marsh moved from planning mode to management mode	1989	Page 30
First Asilomar Workshop	1990	Page 33
Potamocorbula first observed in system	Spring 1987	Page 30
Schubel program review	July 12-14, 1988	Page 31
First volume of IEP Newsletter published	June 1989	Page 33
First IESP Study Manager filled	1990	Page 33
Revision of MOU	April 1990	Page 34
Revised Program Goals	1990	Page 34

Event	Date	Page
University Academic Involvement Program implemented	1990	Page 35
Delta smelt decline observed	1990	Page 36
Environmental Protection Agency joined IESP	1991	Page 36
Schubel X2 workshop	August 1991	Page 36
First use of program Fact Sheets	1992	Page 38
First Public (constituent) Forum	March 28, 1991	Page 38
DFG office in Stockton elevated to a Division	1991	Page 40
Revision of MOU	March 1992	Page 158
The Framework Agreement signed	July 1994	Page 47
The Water Accord signed	Dec 15, 1994	Page 47
“RedBook” revision of program	1993	Page 43
Listing of delta smelt on endangered species list	March 1993	Page 45
MOU to provide alliance with SFEI	April 1993	Page 45
Pete Chadwick retired	July 31, 1993	Page 45
USGS Toxics study implemented	1994	Page 45
Project Work Teams established	1994	Page 45
Science Advisory Group established	1994	Page 46
Pat Coulston becomes new Study Manager	May, 1994	Page 46
CALFED replaces BDOC	1994	Page 47
Monitoring Program revised	Jan 1995	Page 49
Jim Arthur retired	March 1997	Page 52
Coordinator meeting to consider program scope	July 30-31, 1997	Page 53
Comprehensive Monitoring and Research Program (CMARP) development	Fall 1998	Page 53
Chuck Armor Appointed to Program Manager	April 1, 1998	Page 54
IEP Budget Approved at CALFED meeting	1998	Page 55
Fish Facilities Coordination and Review Team formed	1998	Page 56
CMARP report prepared	1999	Page 57
Official name for program-Interagency Ecological Program for the San Francisco Estuary	2000	Page 58
Post Doc Program established	2000	Page 59
Consortium discussions begin	Winter 2001	Page 60
Management Team Forums held	2001	Page 62
Marty Kjelson retired	April 25, 2002	Page 63
Review of Environmental Monitoring Program	2002	Page 64
UC Davis decides IEP Consortium is a good fit for the University	March 2003	Page 67
IEP Workshop held at Lodi, California	2004	Page 68

Appendix B: Interagency Ecological Program Products

Over the years, a substantial amount of information has been developed by the IEP. Some of it has been included in this history, but much of it exists in raw form in the data files and metadata files, newsletters, technical reports, and journal publications. For a complete listing of this information, the reader is directed to the IEP Web site.

This site includes a listing of availability of the IEP Newsletters from 1989 through 2010. It also lists 72 technical reports published by IEP from 1982 through 2004, and an IEP bibliography consisting of >330 papers funded by IEP. Other publications in the San Francisco Estuary Science News and Pelagic Organism Decline publications can also be found at this site.

Appendix C: Approximate IEP Budgets from 1970 through 2010

This table is to be used only to give a general impression of how the program grew over the years. Exact values, for various reasons, are difficult to reconstruct.

Year	Budget (in millions of $)
1970-71	0.858
1971-72	1.14
1972-73	1.5
1973-74	1.66
1974-75	2.42
1975-76	2.6
1976-77	2.4
1977-78	2.7
1978-79	2.9
1979-80	4.0
1980-81	4.0
1981-82	7.4
1982-83	5.7
1983-84	5.8
1984-85	4.3
1985-86	4.548
1986-87	N/A
1988-89	5.426
1989-90	7.242
1990-91	7.242
1992	9.021
1993	10.0+
1994	N/A
1995	12.041
1996-97	12.699
1997-98	12.112
1999	14.1
2000	13.748
2001	N/A
2002	N/A
2003	14.359
2004	12.5 (approx)
2005	16.646
2006	24.405

Year	Budget (in millions of $)
2007	24.296
2008	N/A
2009	N/A
2010	32.696

Appendix D: Comments from IEP Constituents

These comments were provided by various people who have been associated with IEP over the years. The comments are listed as provided by the authors and were not edited, and are followed by the name and affiliation, in bold font, of the individual(s) submitting the comments.

I have been involved with the Interagency Ecological Program (IEP) in one way or another for most of the time since 1976. Back then the program was morphing from the 4 Agency Program into the 6 Agency Program and then into the Interagency Ecological Study Program. As more cooperating agencies has been added to this effort over the years, its administration and the types of studies have evolved to match changing science and needs of the program partners.

Taking the theme from an old movie of the early era of IEP, let me capture my thoughts in IEP into the good, the bad and the ugly.

The Good

IEP is a long-term stable program that has collected one of the best long-term databases on Estuary biological changes and processes in the United States and perhaps world.

The key to the long-term nature of IEP has been a stable funding source from the two large water projects (the State Water Project and the Central Valley Project) and requirements written into their water right permits by the State Water Resources Control Board. Without this stable funding source this program would have gone the way of every other good monitoring program when general government funds get short. It would have been reduced or eliminated since monitoring, science and planning are typically the first things cut in financial hard times. The water projects and the SWRCB have taken the long view in the need for good science, much to their credit.

The IEP program has morphed and changed focus several times while still keeping a balance between the need for both long-term stable data collection programs and the need for special studies. Change is hard for any established program and while IEP still struggles in this area, it does have the capability to change and should continue to change as the needs for new science changes.

IEP has collected data on many aspects of the trophic dynamics in the Estuary. While the initial focus of this program was fish, IEP has collected information early in its development on phytoplankton, zooplankton and the benthic community. This data has been extremely helpful in the attempts to understand the changes that have occurred in the Estuary over time.

The coordination with the efforts of other agencies is perhaps one of the greatest strengths of IEP. This has reduced duplication of efforts, enhanced the sharing of

data and information and lead to cooperative studies where the expertise of these different agencies are brought to bear on specific issues and studies.

The annual IEP Conference has helped with the exchange of information that has been developed over the year and the sharing this information with the partners in IEP and with those parties interested in the results of these studies. It has also been a great place for new staff to get the experience in presenting papers in a relatively small and safe forum.

The Bad

Like any program IEP could be more responsive to its customers. More outreach is needed to the water community who increasingly see IEP as an obstacle to better science rather than a focus of better science. Many of the “new” hypotheses about water project impacts have come from IEP scientists and the challenges to these hypotheses have been resisted by these IEP scientists. A better open exchange of these ideas is needed. Instead of quick defense, IEP should be assisting in the inquiry.

More time needs to be taken to convert monitoring data, into clear analysis and then take that analysis and develop information that can be used by decision makers. IEP collects a lot of data but its ability to analysis this data into published papers still lags.

The Ugly

Data management of the complex and extensive aspects of the IEP data collected has been elusive. IEP data is available but a good comprehensive approach to its data management has not yet been found. The data spans water quality, toxicological, and biological data for numerous species. It is perhaps too complex for any one data system but a good coordinated distributed set of databases would be extremely helpful.

Jerry Johns - August 8, 2011 (Former Deputy Director for CDWR)

My exposure and involvement with IEP started in 1981 and concluded in 2007. From 1981 to 1993 my interaction was thru the lens of Wildlife Law Enforcement, first as Warden and eventually as Regional Patrol Chief. Because of the on water research of Bay-Delta Studies and law enforcements response to illegal take of sturgeon, striped bass, and salmon, coordination and communication was a mutual asset. This was also an era where significant bay and delta legacy pollution and contaminate abatement was needed and a priority with DFG law enforcement. I strongly believe that much of the progress in the health of SF Bay and Western Delta was quietly achieved by the combination of Bay-Delta Studies, DFG Regional Water Quality Biologists, and Wildlife Law Enforcement. While the scientists called it research, the Wardens called it evidence and when combined the local water quality DFG Biologists had significant tool either civil or criminal to

achieve compliance with subsequent benefit to natural resources.

Post 1993, the Interagency Ecological Program became integral to a progression of duties that included positions as Regional Manager, Deputy Director, Chief Deputy Director, and Director. As Deputy Director I represented the Director in the post 1994 Bay-Delta Agreement era where Cal Fed was spawned. The research and opinions of IEP were critical to my policy representation of DFG and the credibility of DFG in performance of those duties. It was because of that long standing relationship, understanding, and confidence that I requested the suspension of delta pumping in 2007 to protect delta smelt.

Ryan Broddrick (Former Director of CDFG)

I really don't have an opinion about the IEP. I know that the IEP is an incredibly important effort to collect and distribute scientific information related to the Bay-Delta. However, it is less clear to me how that information is used to influence management of the Estuary.

Good luck with your publication.

Tom Birmingham (Westlands Water District)

The monitoring done by the Interagency Ecological Program (IEP) has provided the observational foundation for our current scientific understanding of ecological conditions in the Bay-Delta ecosystem. As we move forward with the Delta Plan and ecosystem restoration, the IEP monitoring will be crucial in assessing ecosystem status and trends and in evaluating consequences of management actions. The IEP of today will need to continue its evolution as both a monitoring and research entity as it adapts to new challenges, opportunities, and priorities. In moving forward, the IEP needs to be more responsive to stakeholder input on monitoring and assessment activities. The lack of joint fact-finding has fueled controversy and litigation. We need a new more inclusive model for moving forward more productively.

Byron Buck, Executive Director (State and Federal Contractors Water Agency)

Val Connor, Science Manager (State and Federal Contractors Water Agency)

I first became involved with IEP in 1988 when I joined the Food Chain Group, later to become the Estuarine Ecology Team, which I have chaired for longer than I can remember. I have received much of my research funding from IEP over the years. My comments on the IEP are as a sort of inside-outsider.

IEP has been very successful at designing and carrying out monitoring programs, and much less so at figuring out what those programs were showing. Although IEP funded several efforts aimed at interpretation of data, most of the interpretation to date has been conducted by people outside IEP, only some with IEP funding. In the last 8-10 years this has begun to change as IEP agency

scientists have used IEP data to investigate particular problems, e.g., delta smelt habitat.

Nevertheless, the lack of any staff dedicated to, and capable of, analysis of the extensive IEP data sets is a serious shortcoming.

Data management is irregular. Some data sets (e.g., the FMWT, STN, and 20mm surveys) are available both as bubble plots online and (with permission to gain access to the ftp sites, readily granted in my experience) as Access databases. This makes these data sets easy to get, update, and use. Some (Bay Study, zooplankton) are generally available online but some require personal contact with the program managers. Some others (EMP benthic and water column) are available on request. The continuous monitoring data are readily available online but it does not seem to be possible to get archived data for more than one station at a time, which makes data retrieval tedious. The BDAT experiment was a flop, and there does not seem to be any follow-up effort; however, I find the Access databases to be more convenient than anything else.

IEP's support for research to complement its monitoring has been irregular, with a long period in which funding for outside researchers was unavailable because of budget problems. The POD efforts have reversed that trend and also integrated IEP scientists much more fully into the scientific community.

The EET has gone from a small club of a dozen or so "regulars" to a rather large and engaging forum for new science and discussion. The last meeting (July in Tiburon) drew about 60 people, including quite a few people from stakeholder groups as well as agency and academic scientists. This success has come at a cost: the meetings are now somewhat more formal and presentations often focus on rehashing issues (usually involving delta smelt and water) rather than presenting some of the huge quantity of new science that is coming out day by day.

The IEP newsletter once bulged with up-to-date reports of recent scientific findings, but at present is on its last legs as a useful medium of communication. The lesson is that maintaining this report requires more than a passive editorial capability - it requires somebody willing and able to chase down researchers and get their commitment to write an article. With or without that, the time from submission to publication is longer than for some journals, and the incentive to publish there has gone. The IEP newsletter should be replaced by a more modern mode of communication.

Hope that is useful!

Wim Kimmerer (SF State University)

I think the big picture thing that stands out about the IEP program was the sometime slow transition from the study game fish (stripers) to focusing on native and listed species. Though my memory maybe a bit hazy the early efforts to make that change did not go to well.

However, once the boat got turned around the objective to better understand the native, listed species become the rule. The other key point was the strong reliance on the data as various agencies carried out their individual authorities. This reliance may best be displayed in how the FWS used it to considering listing of species and recommendations for state and federal pumping both in section 7 biological opinions and the day-to-day operations considered by the Interagency Water Operations Management Team. And finally even with all the data and all the studies it was never enough. Trying to answer one question lead to several other questions- the endless problems when trying to understand such a complex and highly modified biological and hydrological system. But without it we would have been driving blind.

I have no strong authorship here so if you want to modify a bit that is fine as long as the main points are there. Hope you are having fun with this.

Wayne White (USFWS, Retired)

The Interagency ecological program has developed the best long term data set on fish in the Estuary that can be imagined. In addition, it has taken on massive new scientific monitoring and analysis projects, leading towards the Pelagic Organism Decline (POD) studies. These studies are core to our understanding of the evolving Estuary, and an essential part of our ability and willingness to move forward with operational permits in the Delta. As the demands of the policy community for information to enable effective operations in the Delta increases, the activities of the IEP will have to evolve to meet those demands. This may change the organization, and the challenge to the IEP Managers is to ensure that they are prepared for that change.

John McCamman (CDFG, retired)

Apparently collaboration between the Aquatic Habitat Institute (AHI) and IEP was intended from the start, as AHI's original mandate addressed Delta water issues, and collaboration began immediately. Both former AHI Director Margaret Johnston and the IEP managers worked together on the creation of the San Francisco Estuary Project, and several IEP Directors were also Directors of AHI (EPA, SWRCB) and continued so as AHI changed into SFEI in 1994. SFEI and IEP maintained a Memorandum of Understanding to "cooperate as much as possible" for many years.

My interactions with IEP began immediately when I came to AHI in 1992. My job was to find ways to interact and collaborate with other organizations active in Bay and Delta science. My first major assignment was to get AHIs Regional Monitoring Program (focused on contamination) started in the Bay. IEP had already been monitoring in the Delta and North Bay for decades, so it seemed to us that there should be a high level of collaboration with them.

IEP conducted an enviable monitoring program. They had decades of data and understanding, which provided a model for the RMP. Close collaboration seemed

obvious. For example, IEP did not monitor contaminants, but RMP did, and IEP conducted fish monitoring but RMP did not. RMP sought to team up with IEP by providing complimentary or new into the Central and South Bays. However, that level of collaboration never materialized. Now, almost 20 years later, the RMP has decades of data on the Estuary, and SFEI has started managing a new Delta RMP.

There was excellent cooperation between SFEI and IEP staff at many levels. SFEI staff attended IEP Coordinators meetings, served on the IEP Management Team and several Project Work Teams. SFEI assisted with the Research Enhancement process, and participated in several monitoring and redesign workshops. When CALFED started, SFEI worked with IEP on CMARP and other several other CALFED work teams. Randy Brown served on SFEI's Science Advisory Committee and Board of Directors. SFEI worked closely with the BDAT group to become a 'data node' for SWAMP. Large amounts of IEP data were always gladly shared. I have used and published DWR's benthic data on several occasions.

I personally learned a great deal about Estuary and Delta science from the EET meetings and IEP Annual Meetings at Asilomar. The IEP personnel held much knowledge about the Bay and Delta, and I considered it a privilege to be able to learn and discuss it with them.

Bruce Thompson (San Francisco Estuarine Institute)

Appendix E: Interagency Ecological Program Agency Directors and Coordinators

This table lists the agency Directors and Coordinators and the time periods in which they served IEP. The table is as accurate as possible, yet some may have been omitted, and others may have served during different time periods.

Department	Director	Years Spent as Director	Cordinator	Years Spent as Cordninator
DFG	G. Ray Arnet	1970-1973	Harold "Pete" Chadwick	1970-1993
DFG	E. C "Charlie" Fullerton	1974-1981	Harold "Pete" Chadwick	1970-1993
DFG	H.D. Carper	1982-1983	Harold "Pete" Chadwick	1970-1993
DFG	Jack Parnell	1984-1989	Harold "Pete" Chadwick	1970-1993
DFG	P. Bontadelli	1990	Harold "Pete" Chadwick	1970-1993
DFG	Boyd Gibbons	1991-1994	Harold "Pete" Chadwick; Perry L. Herrgesell	1970-1993; 1994-1999
DFG	C. Raysbrook	1995-1996	Perry L. Herrgesell	1994-1999
DFG	J. E. Schafer	1997-1999	Perry L. Herrgesell	1994-2000
DFG	R. Hight	2000-2004	A. Barroco; Perry L. Herrgesell	2000-2001; 2002-2008
DFG	R. Brodderick	2005-2007	Perry L. Herrgesell	2002-2008
DFG	D. Koch	2008-2009	Perry L. Herrgesell; Chuck Armor	2002-2008; 2009-2010
DFG	J. McCamman	2010	Chuck Armor	2009-2010
DWR	Gianelli	1970-1972	Reynolds	1970-1972
DWR	Teernik	1973-1975	G. Cox; R. Bond and D. Steinwert	1973; 1974-1977
DWR	Ronald B . Robie	1975-1982	R. Bond and D. Steinwert; Dick Kretsinger	1974-1977; 1978-1984
DWR	David Kennedy	1983-1998	Dick Kretsinger; Randy Brown	1978-1984; 1984-1999
DWR	Thomas Hannigan	1999-2003	Randy Brown; Barbara McDonnell	1984-1999; 2000-2007
DWR	Spear, Adams	2003-2004	Barbara McDonnell	2000-2007
DWR	Lester Snow	2004-2009	Barbara McDonnell; Steve Ford	2000-2007; 2008-2010

Department	Director	Years Spent as Director	Cordinator	Years Spent as Cordninator
DWR	M. Cowin	2009-2010	Steve Ford	2008-2010
USBR	Pafford	1970-1972	J. Cook	1970-1972
USBR	Bill E. Martin	1973-1978	Don Swain; Ken Collins	1973-1974; 1975-1981
USBR	M. A. Catino	1979-1981	Ken Collins; Don Swain	1975-1981; 1981-1982
USBR	David Houston	1982-1989	Don Swain; Jim Arthur	1981-1982; 1983-1989
USBR	Hancock	1990	Ken Lentz	1990-1994
USBR	Roger Patterson	1990-1999	Ken Lentz; P. Howard; Ken Lentz and Ron Silva	1990-1994; 1995; 1996-2005
USBR	Lester Snow	2000-2004	Ken Lentz and Ron Silva	1996-2005
USBR	Kirk Rodgers	2005-2007	Ken Lentz and Ron Silva; M. Chotkoski	1996-2005; 2006-2007
USBR	Don Glaser	2008-2010	E Van Nieuwenhuyse	2008-2010
USFWS	J. Findlay	1970-1972	L. Edward Whitesel	1970-1976
USFWS	R. Kahler Martinson	1973-1981	L. Edward Whitesel; Martin Kjelson	1970-1976; 1977-2002
USFWS	Richard J. Myshak	1981-1984	Martin Kjelson	1977-2002
USFWS	Rolf Wallenstrom	1985-1989	Martin Kjelson	1977-2002
USFWS	Marvin Plenert	1990-1996	Martin Kjelson	1977-2002
USFWS	Michaeel J. Spear	1997-2004	Martin Kjelson; Russ Bellmer	1977-2002; 2003-2005
USFWS	Steve Thompson	2005-2007	Russ Bellmer; Vacant	2003-2005; 2006-2007
USFWS	Ren Lohoefener	2008-2010	Kim Webb	2008-2010
SWRCB	Don Maughan	1985-1996	Dave Beringer	1985-1996
SWRCB	Walt Petit	1997-2004	Jerry Johns; A. Low; V. Whitney; Jane Farwell	1997-1999; 2000; 2001; 2001-2005
SWRCB	Celeste Cantu	2005-2007	Jane Farwell; Gita Kapahi	2001-2005; 2006-2007
SWRCB	Dorthy Rice	2008-2009	Tom Kimball	2008-2010
SWRCB	T. Howard	2009-2010	Tom Kimball	2008-2010
USGS	T J Conomos	1985-1988	Pete Antilla	1985-1990
USGS	John Klein	1989-1996	Pete Antilla; S. Deverel; Larry Smith	1985-1990; 1991; 1992-2000;
USGS	Michael V	1997-2010	Larry Smith; John	1992-2000; 2001-

Department	Director	Years Spent as Director	Cordinator	Years Spent as Cordninator
	Shulters		Burau; Roger Fujii	2004; 2005-2010
USACE	S Phernambucq	1990-1991	M. Dettle; Tom Wakeman	1990; 1991-1996
USACE	Leonard Cardoza	1992-1996	Tom Wakeman	1991-1996
USACE	R G Thompson	1997-1999	G. Chatfield; B. Optiom	1997-1998; 1999-2000
USACE	Gen. Peter T Madsen	2000-2004	B. Optiom; Paul Bowers	1999-2000; 2001-2008
USACE	Col. Ronald N Light	2005-	Paul Bowers; M. Dietle; T. Toland	2001-2008; 2009; 2010
USEPA	Daniel Mc Govern	1991-1996	H. Seraydarian; Partick Wright	1991; 1992-1996
USEPA	P. Wright	1997	Bruce Herbold	1997-2010
USEPA	Felicia Marcus	1998-2000	Bruce Herbold	1997-2010
USEPA	Karen Schwinn	2001-2010	Bruce Herbold	1997-2010
NMFS	H. Diaz Soltero	1995-1997	J. Lecky; A. MacCall	1995-1996; 1997
NMFS	William Hogarth	1998-2009	Jim Bybee; Michael Aceituno; Maria Rea	1998-1999; 2000-2007; 2008-2009
NMFS	R. McInnis	2010	Vacant	2010

Appendix F: Selected Organizational Charts of the Interagency Ecological Program

This appendix provides the reader with a sense of how the structure changed over the years.

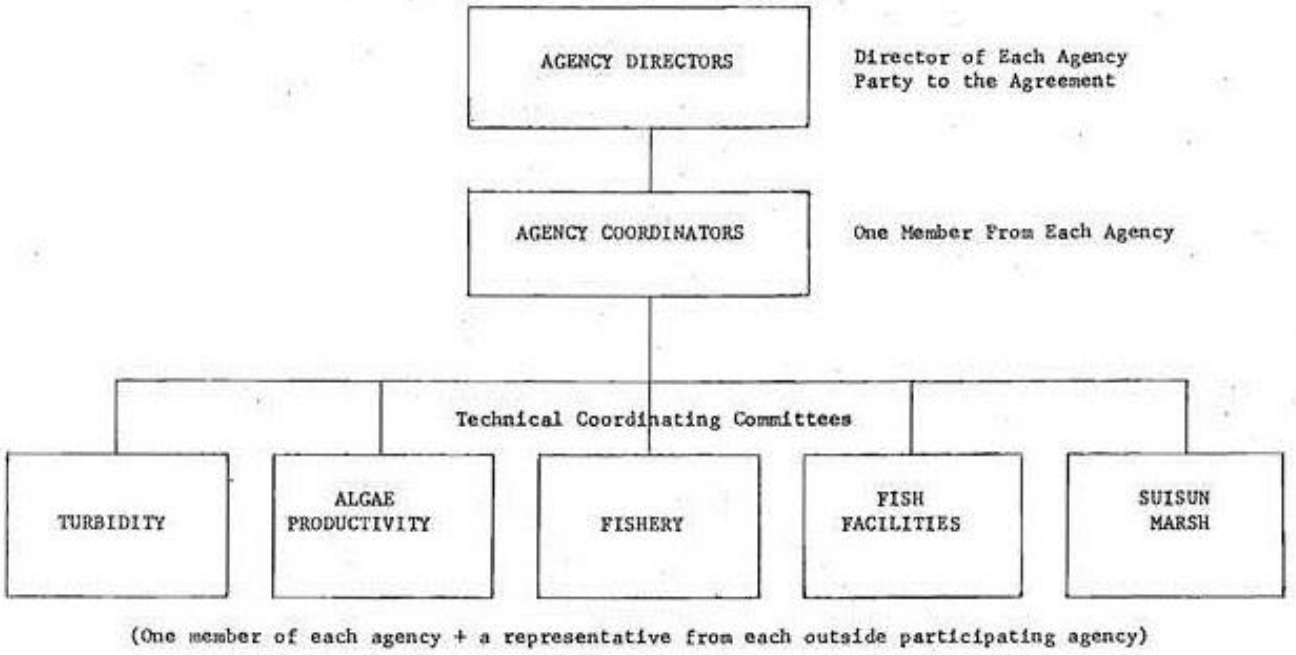

Figure 1. Organization for Implementation of the Interagency Memorandum of Agreement in 1972 when it was first signed and IEP was formed.

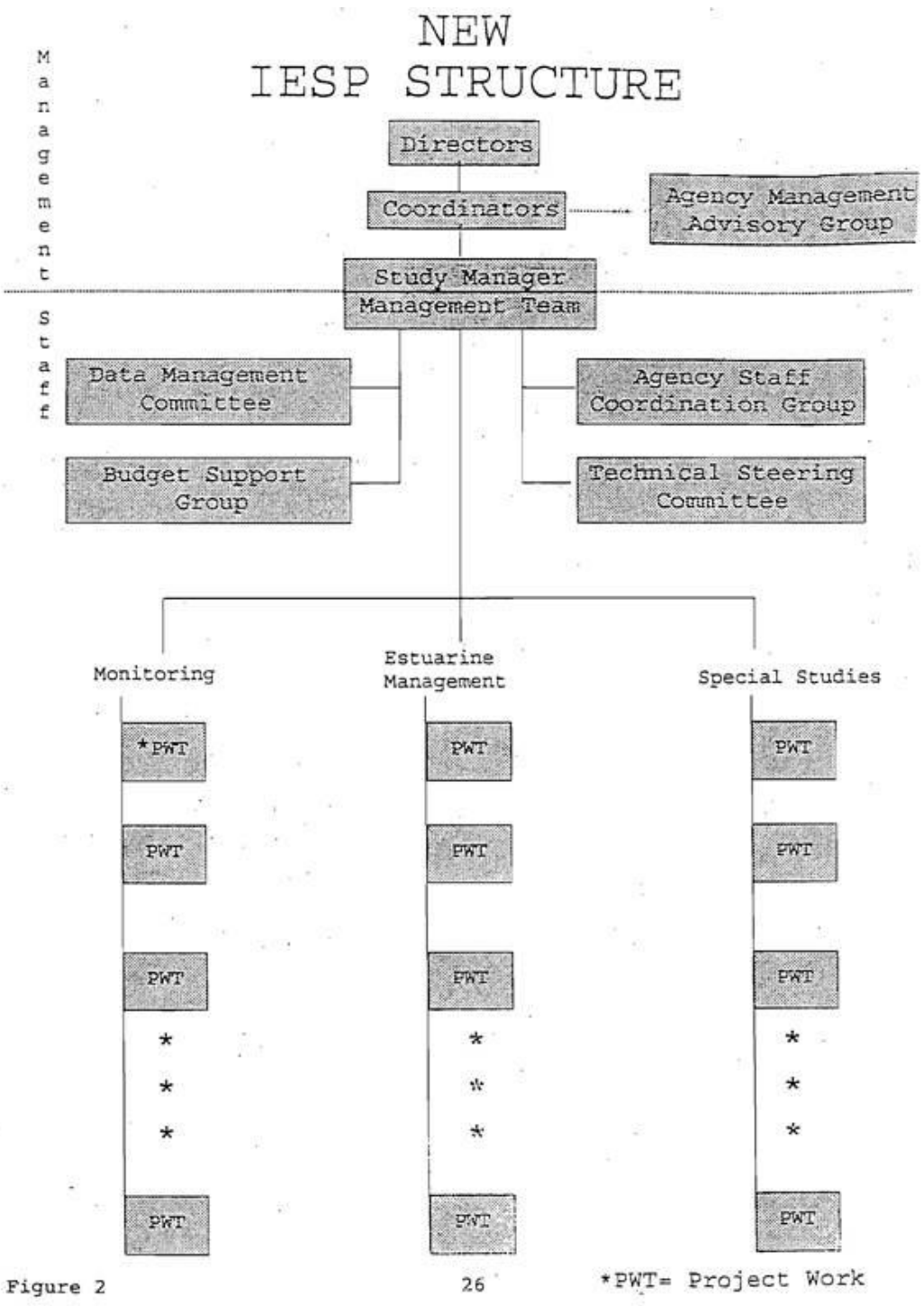

Figure 2. IEP structure in 1993 after the program was revised during the “Red Book” exercise.

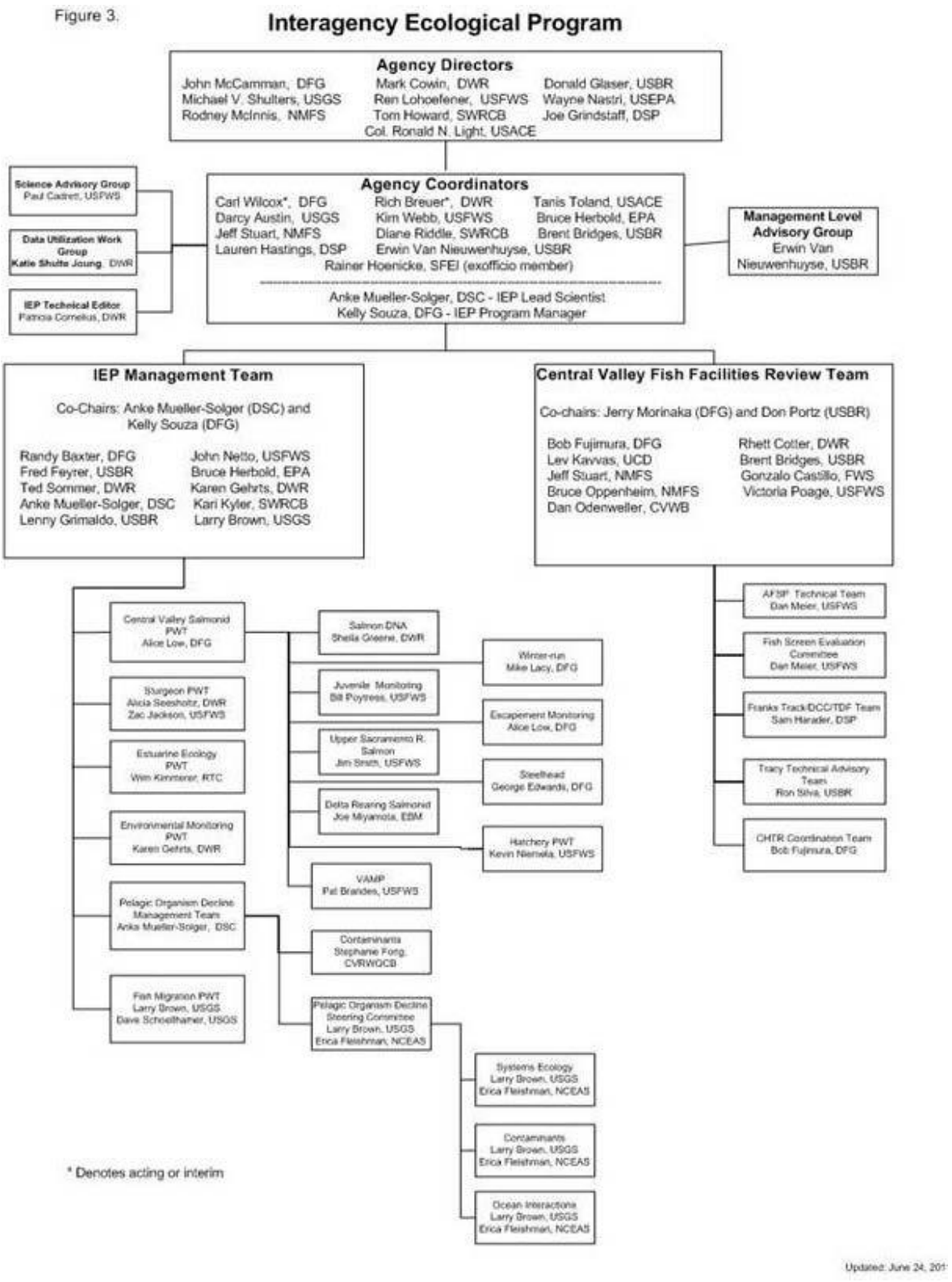

Figure 3. Interagency Ecological Program structure in 2011.

Appendix G: Abbreviations and Acronyms Used In This Report

ACT: Agency Coordination Team (CALFED)
AGP: Algal Growth Potential
AFRP: Anadromous Fish Restoration Program
AG/CUWA: Agricultural/California Urban Water Authority
AHI: Aquatic Habitat Institute
BCDC: Bay Conservation and Development Commission
BDAT: Bay-Delta and Tributaries (database)
BDCP: Bay-Delta Conservation Plan
BDOC: Bay-Delta Oversight Council
BPTCP: Bay Protection and Toxic Clean Up Program
CALFED: California-Federal Bay-Delta Program
CAMP: Comprehensive Assessment and Monitoring Program
CBDA: California Bay-Delta Authority
CCMP: Comprehensive Conservation Management Plan
CESA: California Endangered Species Act
CESU: California Cooperative Ecosystem Studies Unit
CHTR: Collection, Handling, Transport, and Release
CMARP: Comprehensive Monitoring, Assessment, and Research Program
CMARP 3: Comprehensive Monitoring and Research Plan #3
COMPMECH: Compensatory Mechanism
CUWA: California Urban Water Agency
CVP: Central Valley Project
CVPIA: Central Valley Project Improvement Act
CVRWCCD: Central Valley Regional Water Quality Control Board
CWQMC: California Water Quality Monitoring Council
DAT: Data Assessment Team
DFG: Department of Fish and Game
DiRT: Data Review Team
DRERIP: Delta Regional Ecosystem Restoration Implementation Program
DuST: Data Summary Team
DWR: Department of Water Resources
D-1485: Water Right-1485
EAP: Estuarine Assessment Plan

EET: Estuarine Ecology Team
EIR: Environmental Impact Report
EPA: U.S. Environmental Protection Agency
ERP: Ecosystem Restoration Program
ESA: Federal Endangered Species Act
ESD: DFG Environmental Service Division
ESO: Environmental Service Office (DWR)
EWA: Environmental Water Account
IEP: Interagency Ecological Program
IEP +: Interagency Ecological Program Plus
IESP: Interagency Ecological Studies Program
ISB: Independent Science Board (CALFED)
MLAG: Management Level Advisory Group
MR/V: Marine Research Vessel
MOA: Memorandum of Agreement
MOU: Memorandum of Understanding
NBS: National Biological Service
NCEAS: National Center for Ecological Analysis
NEPA: National Environmental Policy Act
NOAA: National Oceanographic and Atmospheric Administration
NMFS: National Marine Fisheries Service
PC: Peripheral Canal
POD: Pelagic Organism Decline
PSP: Preliminary Study Proposal
PWT: Project Work Team
QA/QC: Quality Assurance/Quality Control
QAMP: Quality Assurance Management Plan
QAPP: Quality Assurance Project Plan
RKI: River Kilometer Index
RMP: Regional Monitoring Program (SF Bay Regional)
RVERS: Rio Vista Estuarine Research Station
SAG: Science Advisory Group
SCS: Soil Conservation Service
SFEP: San Francisco Estuarine Project

SFCWA: State Federal California Water Authority

STORET: STOrage/RETrieval (database)

SWP: State Water Project

SWRCB: State Water Resources Control Board

TFCF: Tracy Fish Collection Facility

UARIP: University Academic Research Involvement Program

UCD: University of California, Davis

UMARP: Unified Monitoring, Assessment and Research Program

USBR: United States Bureau of Reclamation

USCOE: United States Corps of Engineers

USFWS: United States Fish and Wildlife Service

USGS: United States Geological Survey

VAMP Vernalis Adaptive Management Program WOMP: Water Operations Management Team

X2: Distance in kilometers from the Golden Gate Bridge where salinity is 2ppt near the bottom

Appendix H: IEP Memoranda of Understanding

Over the years, six memoranda of understanding (MOUs) have provided the legal underpinning of the Interagency Ecological Program. Electronic copies of these memoranda can be found at the IEP website; hard copies of each are included in this appendix. The six memoranda were signed in 1961, 1971, 1985, 1990, 1992, and 2000.

Original 1961 MOU DFG - DWR

MEMORANDUM OF UNDERSTANDING BETWEEN
DEPARTMENTS OF WATER RESOURCES AND FISH AND GAME
REGARDING OBJECTIVES AND SCOPE OF DELTA WATER PROJECT
FISH AND WILDLIFE PROTECTION STUDY

Principal Objective of State Water Resources Development System

One of the principal objectives of the State Water Resources Development System is to conserve water in areas of surplus in the north and to transport water to areas of deficiency to the south and west.

Importance of Delta Water Project in Achieving Objectives

The Delta is important in achieving this objective since it receives all of the surplus flows of Central Valley rivers and is the last location where water not needed upstream or in the Delta can be conveniently controlled or diverted to beneficial use.

Definition of Delta Water Project Area

The California State Legislature in 1959 in connection with the California Water Resources Development System and because of the unique character of water supply problems of the Delta adopted several general policy sections regarding the Delta.

Section 12220 of the Water Code describes the area of the Delta to which these general policies apply. All features, facilities and developments which are part of the California Water Resources Development System which lie within this described area will be considered in the Delta Fish and Wildlife Protection Study. The study will not include any barrier plans downstream from the Chipps Island barrier project.

Multi-Purpose Features of Delta Water Project

The economy of the Delta is dependent to a major degree upon water and because of the unique character of water supply problems in this region, full recognition of this has been given by the legislature in establishing policies to recognize the interrelated effects of the Delta Water Project upon all phases of the Delta economy. Consequently, any water program affecting the Delta must consider:

(1) Water supply of high quality for the Delta area and for transport.

(2) Salinity control.

(3) Water salvage.

(4) Flood and seepage control

(5) Vehicular transportation.

(6) Recreation.

(7) Navigation.

(8) Fish and wildlife.

Staging of Delta Water Project

The several variations of the three alternative plans for the Delta Water Project can all be constructed in stages. This is not true, however, of the Chipps Island Barrier Project.

All of the Delta Water Projects provide for salinity control and for control and transportation of water to the south and west. These several plans vary considerably, however, in the degree that they accomplish other objectives relating to the economy of the Delta.

The construction of a minimum project for salinity control and for control of water and its transport south and west must, however, be of a nature which makes possible future development and consideration for the protection of all other purposes related to the Delta's economy.

Objectives of the Delta Fish and Wildlife Protection Study

The primary objectives of the Delta Fish and Wildlife Protection Study will be:

(1) To make the necessary studies to determine how the design, construction and operation of the Delta Water Project will affect the fish and wildlife resources and their utilization.

(2) To recommend any changes in project plans, facilities or operations which are required to protect the fish and wildlife resources.

(3) To recommend means for compensation of any losses to fish and wildlife which would result from construction and operation in the Delta of any State water facilities. First priority would be compensation in the same kind of fish and wildlife as near to the area of loss as possible.

(4) To recommend measures which may be taken to enhance the fish and wildlife resources in the Delta area in connection with the development, construction, and operation of the Delta Water project.

Assumptions

(1) Up to five years will be provided to complete Fish and Wildlife Protection studies with progress reports submitted at appropriate times and previous to project decisions.

(2) Results of the studies as reflected in progress reports will be considered before decisions on final project designs.

(3) The required facilities to allow transport of water across the Delta to the West and South may be the only facilities constructed in the initial development.

(4) Additional facilities to accomplish purposes other than water transport can be anticipated in future developments.

Study Scope

(1) Studies will be designed to protect fish and wildlife in relation to

design, construction, and operation of features of the Delta Water Project, to be constructed at any future time.

(2) The investigations needed to accomplish the preservation of the fish and wildlife resources for better understanding may be divided into two types:

(a) Investigation of the changes in the environment of the Delta that will result from the construction and operation of the Delta Water Project, and

(b) Investigation of methods to protect fish and wildlife from direct damage by project features.

(3) The importance of changes in the environment must be stressed. The animals we are trying to protect are to a great degree dependent upon physical conditions meeting their requirements for food, for shelter, and for reproduction. Changes in those physical conditions will result in changes in fish and wildlife populations.

(4) The scope of investigations on this changing environment will include the following:

(a) Investigation of existing physical conditions in the Delta.

(b) Investigation of existing fish and wildlife of the Delta and their dependency upon those existing conditions.

(c) Evaluation of future physical conditions in the Delta under all plans being considered.

(d) Investigation of the environmental requirements of fish and wildlife species and other animals or plants needed by these species. Only environmental factors that may be changed by the Delta Water Project will be considered.

(e) Analysis of the above and determination of how the physical changes will affect the fish and wildlife species, and what can be done to prevent or compensate for losses and provide enhancement.

(5) Early definitions of what physical conditions are (a) important to the animals, and (b) apt to change with the Delta Water Project will be necessary to limit the investigation to relevant problems. Such environmental factors as water quality, current velocities, water temperature, turbidity, sediment transport and deposition, tidal action, and land use patterns will probably be investigated and these investigations may require engineering assistance.

(6) The scope of investigation of methods to protect fish and wildlife species from direct damage by project features cannot be clearly defined until more is known about the effects of the environmental

changes. It will be important however, to outline the major problems of this nature early in the study so that work can be started to solve them. These will include the following and may include others:

(1) Development or adaptation of fish passage facilities to move fish upstream through the control structures and locks during their spawning migrations.

(2) Development or adaptation of fish screens or structures to prevent loss of downstream migrants and fish eggs in pumps and diversions.

(7) The study will be concerned with the effects that changes in fish and wildlife populations have upon maximum recreational development dependent upon fish and wildlife in the Delta area.

Methods

(1) All engineering assistance and design work needed in connection with the Fish and Wildlife Protection studies will be provided by the Department of Water Resources.

(2) The studies will be coordinated with all other interested Federal, State and local agencies. Assistance from all other agencies to provide information, funds and actually carry out studies on selected segments of fish and wildlife studies needed will be encouraged.

(3) Specific segments of the needed fish and wildlife studies may be contracted out as part of the Delta Fish and Wildlife Protection Study.

(4) The collection and analysis of physical and biological information will be related to the accomplishment of the objectives of this study.

Basic Facilities Included

All facilities which are appurtenant to the water projects being considered and located in the defined Delta area will be considered in the Fish and Wildlife Protection Study. Among the facilities to be included are:

(1) Control structures.
(2) Closures.
(3) Floodway structures.
(4) Navigation locks.
(5) Canals.
(6) Levees.
(7) Siphons.
(8) Aqueducts.
(9) Waste drains.
(10) Pumping plants.
(11) Headworks.
(12) Fish screens.
(13) Fish ways
(14) Miscellaneous features.

Specific Features

The several reports on the Delta regarding the various Delta Water Projects include certain features, parts of which are located within the defined Delta

area and parts are outside it. Each of these will be specifically referred to, to clarify what will be included in the Delta Fish and Wildlife Protection Study.

(1) North Bay Aqueduct.

Several points of diversion are still under consideration for the North Bay Aqueduct. The points of diversion and diversion works for the North Bay Aqueduct will be included in the study. The remainder of the North Bay Aqueduct System will not be considered.

(2) Montezuma Aqueduct, Pumping Plant and the Pittsburg Pumping Plant.

These features will be considered only to the extent of any influence they may have on conditions in the lower Delta area for fish and wildlife.

(3) Delta Pumping Plant.

The Delta Pumping Plant located in the Delta area will be included in the study. The California Aqueduct and the South Bay Aqueduct will not be included.

(4) Montezuma Slough Area.

The Montezuma Slough area, even though it is located outside the defined Delta area, will be included in the study in relation to the Chipps Island Barrier Project since this project includes master levees, closures, and barge locks in Montezuma Slough as an integral part of the project.

(5) Sacramento Deep Water Channel.

Although the Sacramento Deep Water Channel is not a part of the California Water Resources Development System, it is possible that the Water Projects Plans being considered may so redistribute flows around the deep water channel that a fish facility may be required. Consequently, the deep water channel will be considered in the study in relation to effects of the State Projects upon it and the need for fish protection devices.

(6) San Joaquin Valley Waste Conduit.

The San Joaquin Valley Waste Conduit will originate outside and south of the Delta area. It will pass through a considerable area of the Delta and may discharge into the San Joaquin River within the Delta or in the Sacramento River just outside the defined Delta area. It may well have detrimental effects on the fish and wildlife resources and will be included in the study in relation to the effects of the drain water upon fish and wildlife resources at the point of discharge.

(7) Tracy Pumping Plant.

Although the Tracy Pumping Plant is not a part of the California Water Resources Development System, it is possible this facility may at least for an interim period, handle additional flows for the Delta Water Project and create fish and wildlife problems. This will be considered in the study.

(8) Contra Costa Canal.

The point of diversion and diversion works of the Contra Costa Canal in the Delta area will be considered in the study. The remainder of the Contra Costa Canal will not be considered.

(9) Minor Delta Tributaries.

There are several small tributaries which presently flow into the Delta area. These include Bear Creek, Kellogg Creek and Mountain House Creek. Certain Delta plans envision sealing off or isolating some sections of the Delta area. This would require either pumping or diverting flows from these streams at least during flood stages. The study will consider all of these tributaries.

(10) Other Features.

It is possible that project plans may be further revised because of various reasons with the result that features not now under consideration will be added for planning purposes. Such additional features will be added to the Fish and Wildlife Protection Study if it is possible that these features may affect the fish and wildlife environment or fish and wildlife populations directly.

William E. Warne, Director
Department of Water Resources

Walter T. Shannon, Director
Department of Fish and Game

AUG 1 0 1961

Dated _____

APPROVED FOR SIGNATURE
Executive in Charge
Date 8/29/61

State of California

Memorandum

The Resources Agency

Chadwick

To : Director

Date: January 4, 1971

From : Department of Fish and Game

Subject: Management of Memorandum of Agreement re Ecological Studies in Sacramento-San Joaquin Estuary

We believe that it is desirable to establish a formal management structure to implement this agreement which we entered into with the Department of Water Resources, Bureau of Reclamation, and Bureau of Sport Fisheries and Wildlife. The primary functions of this structure would be to assure close coordination among the various agencies at the working level and to provide for a rapid solution of problems at the management and policy levels. Past experience with technical studies being conducted jointly by several agencies indicates that such a management structure is important to program success.

Pete Chadwick has met with representatives of the other agencies and developed the attached proposal for a management structure. Each agency is reviewing the proposal with the intention of putting it or a modification of it in operation in January. Briefly the proposal would:

1) Establish a formal committee of the Directors of the agencies to establish policy.
2) An interagency management committee to provide overall direction for the study program and of the Interim Fish Protective Agreement.
3) Technical management committees for each study area to plan and direct the studies.

Each agency would have one representative on each committee, except that DWR and USBR would each have two members on the management committee. This would enable them to have representatives from both their planning and operations staffs. DWR requested this. We believe that it would be advantageous to us, because one of our past problems has been getting study results implemented, apparently because of ineffective communication between planning and operations in DWR.

State and federal agencies having management responsibilities affected by study results would be invited to send observers to meetings of the directors and management committees.

Agencies which are not parties to the agreement will participate in some studies. These agencies will have representatives on the technical committees. These representatives will have the same status on these committees as that of representatives of the parties to the agreement.

If you approve of this approach, I recommend that our representatives be:

Agency Coordinator - George H. Warner
Technical Committees
Fisheries - Pete Chadwick
Fish Facilities - John Skinner
Turbidity - Pete Chadwick
Algae Productivity - Pete Chadwick
Suisun Marsh - Rolf Mall

The fish facility technical committee should replace the Peripheral Canal Fish Facilities Work Group which was established in May 1969 for essentially the same purpose.

A chart of the proposed organizational structure and drafts of the structure and function for each level are appended for your review.

I recommend that the next step be for you to authorize me to meet with other representatives appointed to the management committee to consider any modifications proposed and to do the staff work necessary to plan a meeting of the Directors.

COPY ORIGINAL SIGNED BY GEORGE H. WARNER

George H. Warner, Chief
Anadromous Fisheries Branch

Attachments

APPROVED: COPY [illegible] DATE: JAN 1 8 1971

cc: Deputy Director
Chief of Operations
Pete Chadwick

Directors

1. Who: Agency Directors of the four parties to the Memorandum of Agreement.

2. Function:
   a) Establish policy and overall guidelines, regarding management action and study direction.
   b) Review program results and approve annual report.

3. When: As recommended by the Agency coordinators and a minimum of once a year as specified in the interagency Memorandum of Agreement. One meeting will be held during the month of February.

4. Participation at Directors' Meeting:
   a) Agency Directors.
   b) Agency Coordinators.
   c) One representative from the technical staff of each agency (party to the agreement).
   d) Representatives of interested state and federal agencies such as:
      SWRCB, C of E, FWQA, USGS, and National Marine Fishery Service.

Agency Coordinators

1. Who: One representative from both the State Department of Fish and Game and Federal Fish and Wildlife Service. Two representatives from both the USBR and DWR (one staff member responsible for the planning and one for the operation functions).

2. Function:
   a) Make the decisions required under the Interim Fish Protection Agreement.
   b) Recommend policy to the Directors.
   c) Review progress of the technical (ecological) studies to insure compliance with guideline specified in the Memorandum of Agreement.
   d) Responsible for accomplishing administrative requirements for the technical studies.
   e) Review annual report drafted by the Department of Fish and Game, composed in part by chapters provided by the individual study groups.

3. When:
   a) Meet prior to all Directors' meeting.
   b) Meet as required by the Interim Fish Protection Agreement.
   c) Meet as necessary to provide management direction to the interagency programs.

4. Participation at Agency Coordinators' Meeting

a) Agency Coordinators.

b) Members of Individual Technical Coordinating Committees and necessary staff. (Joint sections will be held with the Turbidity and Algal Study groups and the Fishery and Fish facility study groups.)

Technical Coordinating Committees

General description of the Technical Coordinating Committees for the following studies:

1. Turbidity
2. Algae Production
3. Fishery
4. Fish Facilities
5. Suisun Marsh

1. Who: Technical Administrator from each party agency and all other participating agencies.

2. Function:
   a) Provide the technical direction to the studies.
   b) Coordinate activities at the working level.
   c) Insure dissemination of technical information within the study area.
   d) Advice the agency coordinators as to the progress of the study activities.
   e) Prepare technical chapters to be included in the annual progress report.

3. When: As necessary to insure effective coordination of work.

4. Participation at Technical Coordinating Committee Meeting: Members of the Technical Coordinating Committees and necessary staff.

MEMORANDUM OF AGREEMENT

Among the State of California Department of Fish and Game, the State of California Department of Water Resources, the United States Bureau of Reclamation, and the United States Bureau of Sport Fisheries and Wildlife.

Introductory Recitals

A. It is recognized that fish and wildlife problems exist in the Sacramento-San Joaquin estuary.

B. A factor affecting fish and wildlife problems is the operation of the Central Valley Project and the State Water Project. It is anticipated that effects related to the operation of these projects can be alleviated by the construction and proper operation of the Peripheral Canal.

C. Defining design and operating criteria, which will assure protection of fish and wildlife resources, requires a thorough understanding of the requirements of these resources.

D. The intent of this Memorandum of Agreement is to provide for the performance of studies necessary to obtain a thorough understanding of the requirements of fish and wildlife resources.

E. The report entitled "Studies Necessary to Evaluate Ecological Effects of Water Development on the Sacramento-San Joaquin Estuary", dated May 1970, a copy of which is attached hereto as Exhibit A, prepared jointly by the undersigned parties, is accepted as a statement of:

1. The philosophy which should guide the acceptance and implementation of present and future studies.
2. The studies which are necessary now.
3. The areas of responsibility for the conduct and funding of studies.

NOW, THEREFORE, it is mutually agreed as follows:

Provisions

1. Performance of Studies. The undersigned parties to this Memorandum of Agreement agree to perform the studies described in the Report attached hereto as Exhibit A, subject to normal administrative and legislative control and appropriation.

2. Annual Review. The studies described in Exhibit A will be coordinated on a continuing basis and will be reviewed annually by the parties and may be modified as is mutually acceptable to reflect changes in engineering or biological needs. As part of this annual review, any of the parties may request alteration of existing studies or performance of additional studies necessary to satisfy the intent of this Memorandum of Agreement. The California Department of Fish and Game will have responsibility for initiating the annual review by convening a meeting of all the parties in January of each year.

3. Progress Report. The California Department of Fish and Game will prepare an annual progress report after receiving input from participating agencies. A copy of the report together with appropriate reports by participating agencies will be furnished to the State Water Resources Control Board.

4. Funding. The parties accept responsibility for funding the studies as indicated in the summary table of the report attached hereto as Exhibit A, subject to normal budgetary processes and the results of the annual review described in paragraph 2 herein.

5. Assignment of Studies. Responsibility for conduct of the studies, as numbered in the summary table of the report attached hereto as Exhibit A will be as follows:

a. The Department of Fish and Game will be responsible for biological portions of studies 1, 2, 3, 5, 8 and 11. It will be jointly responsible with the Bureau of Sport Fisheries and Wildlife for the biological phases of studies 9 and 10 as mutually agreed upon. It will also be responsible for biological review of study 13 for the state.

b. The Bureau of Sport Fisheries and Wildlife will be responsible for the biological phases of study 12 and portions of studies 9 and 10 as mutually agreed upon with the Department of Fish and Game. It will also provide biological support to the U. S. Bureau of Reclamation for study 13 and will provide federal review of the biological phases of studies 1, 2, 3 and 5.

c. The Department of Water Resources will provide engineering support for studies 1, 2, 5, 8 and 11 and will be jointly responsible with the Bureau of Reclamation as mutually agreed upon for studies 4, 6, 9 and 10. It will also be responsible for engineering review of study 13 for the state.

d. The U. S. Bureau of Reclamation will be responsible for engineering phases of studies 12 and 13 and will be jointly responsible with the Department of Water Resources as mutually agreed upon for studies 4, 6, 9 and 10.

e. Study 7 will be a cooperative program. The Bureau of Reclamation may modify its Delta-San Luis Drain Surveillance Program if necessary to provide field data for a predictive model. The state agencies will continue their current model development program, with the Department of Water Resources having primary responsibility for mathematical aspects and the Department of Fish and Game for biological aspects.

IN WITNESS WHEREOF, the parties hereto have executed this Memorandum of Agreement on July 13, 1970.

U. S. BUREAU OF RECLAMATION
Region 2

By R. J. Rutherford

CALIF. DEPARTMENT OF WATER RESOURCES

By Wm. E. Warne

Approved as to legal form and sufficiency:

U. S. BUREAU OF SPORT FISHERIES AND WILDLIFE, Region 1

By John L. Findlay
JOHN D. FINDLAY
Regional Director

CALIF. DEPARTMENT OF FISH & GAME

By

I hereby certify that all conditions for exemption set forth in State Administrative Manual Section 1221.13 have been complied with and this document is exempt from review by the Department of Finance.

By

Department of General Services
APPROVED
AUG 6 1970
Original signed by
CHARLES B. DIXON
By Charles B. Dixon, Director

I hereby certify that all conditions for exemption set forth in State Administrative Manual Section 1221.13 have been complied with and this document is exempt from review by the Department of Finance.

By Peter J. Peterson
Comptroller

1985

Study Program for the Sacramento--San Joaquin Estuary

Memorandum of Understanding

A memorandum of understanding between the United States Geological Survey, the California Department of Fish and Game, the California State Water Resources Control Board, the California Department of Water Resources, the United States Bureau of Reclamation and the United States Fish and Wildlife Service to study the biologically significant variations in hydrodynamics, salinity, and constituent transport within San Francisco Bay and net current speed and direction in selected interior Sacramento-San Joaquin Delta channels which result from changes in delta outflow, tidal pulses, and micro-meteorological conditions.

This Memorandum of Understanding made and entered into this 24th day of September, 1985, by and between the U.S. Geological Survey, hereinafter referred to as the "Survey", the California Department of Fish and Game, hereinafter referred to as the "DFG", the State Water Resources Control Board, hereinafter referred to as the "State Board", the California Department of Water Resources, hereinafter referred to as the "DWR", the U.S. Bureau of Reclamation, hereinafter referred to as the "Bureau", and the U.S. Fish and Wildlife Service, hereinafter referred to as the "Service", do hereby agree as follows:

I. General

A. It is the intent of the parties to this Memorandum of Understanding to facilitate the implementation of Element II, "Hydrodynamic/Physical/Chemical Studies," for the San Francisco Bay program segment of the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. The study plan for Element II was prepared by a hydrodynamic task committee composed of representatives from each of the participating agencies on November 6, 1984. The parties concur that this shall be the plan of study for hydrodynamics in the San Francisco Bay program segment, except as modified by this Memorandum of Understanding. The study plan for Element II, including introduction, needs and justifications, tasks, and work plan schedules, is incorporated herein as if fully set forth.

Also incorporated herein as if fully set forth is the work plan for an interior Delta current study that will determine net current speed and direction in selected interior Delta channels during various flow (Delta input/export) levels.

B. All parties to this Memorandum of Understanding agree to utilize their funds and resources, as specified herein, to meet the study objectives, as defined in the study plan for Element II and work plan for the interior Delta current study, in the most efficient and economical manner.

II. Program Coordinators

A. The Survey Program Coordinator shall be Peter Anttila.

B. The DFG Program Coordinator shall be H. K. Chadwick.

C. The State Board Program Coordinator shall be David R. Beringer.

D. The DWR Program Coordinator shall be Richard Kretsinger.

E. The Bureau Program Coordinator shall be James Arthur.

F. The Service Program Coordinator shall be Martin Kjelson.

G. A Program Coordinator shall be each participating agency's representative for execution of the Memorandum of Understanding and shall have authority to act on behalf of that agency, except as otherwise provided. All communications given to a Program Coordinator shall be as binding as if given to the party.

H. Any agency may change its Program Coordinator, by providing written notification to each of the other agencies.

III. Work to Be Performed:

All work performed under this Memorandum of Understanding shall be consistent with the objectives of the study plan for Element II, "Hydrodynamic/physical/chemical Studies" of the San Francisco Bay program segment and the work plan for interior Delta current study, except as modified by this Memorandum of Understanding.

A. The Survey shall:

1. Act as lead agency for all mathematical modeling. This shall include providing the technical supervision of the interagency modeling team as well as providing two working members to the team.

2. Act as lead agency in the deployment of current meters in the Bay and current meters and/or acoustic velocity meters (AVMs) and in interior

Delta channels and in the testing and evaluation of the Acoustic Doppler Current Profiling equipment. This shall include primary responsibility for the reduction and analyses of all current measurement data.

3. Participate in the program for field measurements of salinity profiles. Provide one boat, one crew, and one set of salinity measurement equipment during each measurement episode.

4. Retain ownership and control of all equipment procured by Survey funds during the conduct of the study.

5. Participate in the coordination and review committees described in Section VIII of this Memorandum of Understanding.

B. The Bureau shall:

1. Act as lead agency in the program of field measurement of salinity profiles. This shall include: (i) organizing and scheduling each measurement episode in consultation with Survey and DWR, (ii) providing one boat, one crew, and one set of salinity measurement equipment during each measurement episode, and (iii) reducing and analyzing all data collected.

2. Provide one member to the interagency modeling team.

3. Retain ownership and control and all equipment procured by Bureau funds during the conduct of the study.

4. Provide the DWR a 31-foot government surplus "Uniflite" boat to be used in the field studies. All costs associated with the acquisition, equipping, operation, and maintenance of the boat provided by the Bureau will be reimbursed annually by the DWR through funding agreements for the Interagency Study Program for the Sacramento--San Joaquin Estuary.

5. Participate in the coordination and review committees described in Section VIII of this Memorandum of Understanding.

C. The DWR shall:

1. Act as lead agency for the electrical conductivity (EC) measurement program at three existing

stations: San Francisco Bay Bridge, San Mateo Bridge, and Point San Pablo. This shall include reducing and analyzing data from these stations.

2. Participate in the program for field measurements of salinity profiles. Provide one crew, and one set of salinity measurement equipment during each measurement episode. Reimburse the Bureau for costs incurred by the Bureau for acquisition, equipping, operation, and maintenance of the "Uniflite" boat (III.B.4). Reimbursement will be made annually through the funding agreements for the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary.

3. Provide one member to the interagency modeling team.

4. Retain ownership and control of all equipment purchased by DWR funds during the conduct of this study.

5. Participate in the coordination and review committees described in Section VIII of this Memorandum of Understanding.

D. The DFG shall:

1. Work to facilitate coordination between the biological elements of the San Francisco Bay Program and the hydrodynamic/physical/chemical studies element. The biological elements are the primary responsibility of the DFG and consist of "Marine Species Distributions" (Element V), "Stratification-Induced Current Transportation Study"(Element VI), and "Shrimp Population Dynamics and Trophic Analysis" (Element VII). The coordination will be accomplished through regularly scheduled meetings between element study groups.

2. Participate in the coordination and review committees described in Section VIII of this Memorandum of Understanding.

E. The State Board shall:

1. Provide a list of interior Delta channels for which current data will be collected and participate in the selection of channels and flow conditions.

2. Review all reports from the hydrodynamics and interior Delta current studies.

3. Participate in the coordination and review committees described in Section VIII of this Memorandum of Understanding.

F. The Service shall:

Participate in the coordination and review committees described in Section VIII of this Memorandum of Understanding.

IV. Program Schedule:

It is the intent of all parties of this Memorandum of Understanding to complete the tasks described in the study plan for hydrodynamic studies in San Francisco by September 30, 1990 and to complete the tasks described in the work plan for the interior Delta current study by June 1, 1987.

V. Term

This Memorandum of Understanding is an outgrowth of numerous meetings of technical representatives of the cooperating agencies wherein a need for the specified hydrodynamic and interior Delta current studies was identified and becomes effective on the date of signature by the cooperating agencies, and shall remain in effect through September 30, 1990. An agency may terminate its participation in this Memorandum of Understanding upon 60 days written notice to the other cooperating agencies.

VI. Funding:

A. This Memorandum of Understanding shall continue in effect only as long as funds for this program are made available to the participating State and Federal agencies during each year of the program, and shall be subject to any conditions on funding imposed by the State Legislature, with respect to the participating State agencies, and by the Congress, with respect to the Federal participating agencies.

B. The distribution of funding by agency for the hydrodynamic and interior Delta current studies is as follows:

VIII. Program Coordination and Review:

The Program Coordinators will review the progress of the San Francisco Bay hydrodynamics study and interior Delta current study as necessary. In addition, a subcommittee of the San Francisco Bay Program Technical Committee consisting of the authorized representative of each program coordinator, shall be established to review in greater depth the hydrodynamic study progress as it relates to the overall outflow study.

This subcommittee will be chaired by the Survey and shall meet quarterly, or more often if necessary, during the conduct of the study. The purpose of this subcommittee will be to foster coordination and information transfer between the participating agencies, to assure compliance with this Memorandum of Understanding and the study plan by all parties, and to ensure coordination with overall San Francisco Bay Program objectives.

INTERAGENCY HYDRODYNAMIC AND INTERIOR
DELTA CURRENT STUDIES BUDGET
FEDERAL FISCAL YEARS (1985-90)
($1,000'S) 1/

Federal Fiscal Year 1985

Agency	Funding to Program	Matching Funds 2/ to Survey	Funds Used by Agency
Survey	191.3	--	382.6
DWR	248	109	193
Bureau	200 3/	0	146
State Board	82.3	82.3 4/	0
Total	721.6	191.3	721.6

Federal Fiscal Year 1986

Agency	Funding to Program	Matching Funds 2/ to Survey	Funds Used by Agency
Survey	310	--	620
DWR	248	80	183
Bureau	200 5/	0	185
State Board	230	230 4/	0
Total	988	310	988

Federal Fiscal Year 1987

Agency	Funding to Program	Matching Funds 2/ to Survey	Funds Used by Agency
Survey	250	--	500
DWR	238	70	183
Bureau	200 5/	0	185
State Board	180	180 4/	0
Total	868	250	868

Federal Fiscal Years 1988 and 1989

(Same as 1987)

Federal Fiscal Year 1990

Agency	Funding to Program	Matching Funds 2/ to Survey	Funds Used by Agency
Survey	167.70	--	335.40
DWR	238	70	183
Bureau	200 5/	0	185
State Board	97.7	97.7 4/	0
TOTAL	703.4	167.7	703.4

Total Funding Summary

Agency	Funding to Program	Matching Funds to Survey	Funds Used by Agency
Survey	1419	--	2838
DWR	1448	469	1108
Bureau	1200	0	1071
State Board	950	950	0
Total	5017	1419	5017

1/ 1985 dollars
2/ Matching funds administrated by separate joint funding agreements between the Survey and the indicated agencies.
3/ Funds in the amount of $54,000 transferred to DWR.
4/ Matching funds paid to the Survey in arrears no more often than monthly upon receipt of invoices from the Survey.
5/ Funds in the amount of $15,000 tranferred to DWR

VII. Changes in the Work

A. The Program Coordinators may, at any time as the need arises, authorize changes within the scope of the work without invalidating this Memorandum of Understanding, as long as such changes do not increase the amount due, increase the time required for performance, or result in a substantial change in the work detailed in the study plan as modified by this Memorandum of Understanding. Such changes must be reduced to writing signed by each party's respective program coordinator before taking effect.

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the attached Memorandum of Understanding and agrees to the terms and conditions therein.

Agency: U.S. Dept. of Interior, Bureau of Reclamation

Address: 2800 Cottage Way

Sacramento, California 95825

Telephone: (916) 978-5135

By: David L. Houston

Title: Regional Director

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the attached Memorandum of Understanding and agrees to the terms and conditions therein.

Agency: U.S. Dept. of Interior, U.S. Geological Survey
Room w-2235, Federal Building

Address: 2800 Cottage Way

Telephone: Sacramento, California 95825

By: Gilbert L. Bertoldi

Title: District Chief

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the attached Memorandum of Understanding and agrees to the terms and conditions therein.

Agency: Department of Fish and Game

Address: 1416 Ninth Street

Sacramento, CA 95814

Telephone: (916) 445-9880

By: J. D. Messersmith

Title: Assistant Director

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the attached Memorandum of Understanding and agrees to the terms and conditions therein.

Agency: United States Fish and Wildlife Service
Address: Lloyd 500 Building, Suite 1692
500 N. E. Multnomah Street
Portland, Oregon 97232
Telephone:

By: Joseph R. Blum
Title: Acting Regional Director

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the attached Memorandum of Understanding and agrees to the terms and conditions therein.

Agency: State Water Resoures Control Board
Address: P.O. Box 100
Sacramento, CA 95801
Telephone: (916) 445-1553

By: Raymond Walsh
Title: Interim Executive Director

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the attached Memorandum of Understanding and agrees to the terms and conditions therein.

Agency: State Department of Water Resources

Address: 1416 Ninth Street
Sacramento, CA 95814

Telephone: (916) 445-6582

By:

Title: Director

APR 19 1990

STATE OF CALIFORNIA—THE RESOURCES AGENCY

GEORGE DEUKMEJIAN, Governor

DEPARTMENT OF FISH AND GAME
1416 NINTH STREET
P.O. BOX 944209
SACRAMENTO, CALIFORNIA 95814-2090

(916) 322-8866

APR 10 1990

Mr. James Arthur
U.S. Bureau of Reclamation
2800 Cottage Way
Sacramento, CA 95825-1898

Re: MP-780
ACM-9.00

Dear Mr. Arthur:

Memorandum of Understanding
Ecological Study Program
San Francisco Bay/Delta Estuary

As requested, enclosed is a copy of the above captioned document which has been signed on behalf of this Deparcment.

Please provide us with a copy of the MOU when it has been fully executed.

Sincerely,

ORIGINAL signed by
James L. Christopher

James L. Christopher
Contract Manager

JLC:jti

Enclosure

bc: P. Chadwick, Bay Delta

file: Chron, Suspense

MAR 26 1990

United States Department of the Interior

TAKE PRIDE IN AMERICA

BUREAU OF RECLAMATION
MID-PACIFIC REGIONAL OFFICE
2800 COTTAGE WAY
SACRAMENTO, CALIFORNIA 95825-1898

IN REPLY
REFER TO:

MP-780
ACM-9.00

MAR 22 1990

To: Interested Parties (See attached list)

Subject: Interagency Ecological Study Program for the San Francisco Bay-Delta Estuary (Memorandum of Understanding)

Enclosed for your signature is the new Memorandum of Understanding (MOU) for the Interagency Ecological Study Program for the San Francisco Bay-Delta Estuary (Program). This new MOU will supersede all previous versions of the agreements which have governed the activities of the member agencies since the inception of the Program. This document will serve as the basis of authorization for future exchanges of funds, personnel, and equipment between the member agencies in the development and conduct of studies and required monitoring of the effects of Federal and State projects on the San Francisco Bay-Delta Estuary. Actual exchanges will be made annually on a case-by-case basis as agreed to by the Agency Coordinators and Agency Directors and will be dependent on available funding.

Implementation of this MOU is required in State fiscal year 1990 in order for the U.S. Bureau of Reclamation to make previously agreed upon monetary transfers to the U.S. Fish and Wildlife Service, California Department of Fish and Game and California Department of Water Resources. Two previous drafts of this MOU have been reviewed by the technical and legal staffs of the member agencies and their comments have been incorporated into this version.

Consequently, we request that you expedite the return of your signed MOU to our office: Attention Mr. James Arthur. Upon receiving all signed MOU's we will route a second signature sheet through the member agencies for signature by each agency director (or equivalent) on a single common sheet. We will send you a copy of the commonly signed signature sheet together with the final MOU.

Thank you for your prompt attention in this matter.

Sincerely,

NEIL W. SCHILD
ACTING REGIONAL DIRECTOR
Enclosure

cc: (See attached list)

Marvin L. Plenert
Regional Director
U.S. Fish and Wildlife Service
1002 NE Holladay Street
Portland OR 97232-4181

John Klein
District Chief
U.S. Geological Survey
2800 Cottage Way
Sacramento CA 95825-1898

LTC Stanley Phernambucq
District Engineer
U.S. Army Corps of Engineers
211 Main Street
San Francisco CA 94105-1905

David Kennedy
Director
Department of Water Resources
PO Box 942836
Sacramento CA 94236-0001

Peter F. Bontadelli
Director
Department of Fish and Game
1416 Ninth Street
Sacramento CA 95814

W. Don Maughan
Chairman
State Water Resources Control Board
PO Box 100
Sacramento CA 95801

cc: Ken Lentz
Bureau of Reclamation
2800 Cottage Way
Sacramento CA 95825-1898

Dr. Martin Kjelson
Fish and Wildlife Service
4001 North Wilson Way
Stockton CA 95205

Pete Anttila
U.S. Geological Survey
2800 Cottage Way
Sacramento CA 95825-1898

Tom Wakeman
U.S. Army Corps of Engineers
Bay-Delta Model
211 Main Street
San Francisco CA 94105-1905

Pete Chadwick (Chairman)
Department of Fish and Game
4001 North Wilson Way
Stockton CA 95205

Dr. Randall Brown
Department of Water Resources
3251 S Street
Sacramento CA 95816

Dave Beringer
State Water Resources Control Board
Bay-Delta Project
901 P Street
Sacramento CA 95814

(w/encl)

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU) is made and entered into by the U.S. Bureau of Reclamation (Reclamation) and the following Federal and State agencies:

Federal

- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Army Corps of Engineers

State

- California Department of Water Resources
- California Department of Fish and Game
- California State Water Resources Control Board

BACKGROUND: A 1970 MOU creating the Interagency Ecological Study Program and its 1985 amendment are out of date. A new MOU is required to facilitate funds, equipment, and personnel transfers between cooperating agencies needed to meet the monitoring requirements of Federal and State projects in the San Francisco Bay-Delta Estuary.

OBJECTIVE: The objective of this MOU is to provide for the coordination, conduction, and transfer of funds, equipment, and personnel between agencies to carry out ecological monitoring and evaluations of the impacts of the Federal and State projects on the San Francisco Bay-Delta Estuary.

STATEMENT OF WORK:

1. All studies and transfer of funds or personnel will be subject to approval by the Interagency Coordinators and Directors. Any Federal agency transferring resources under this agreement shall utilize the appropriate funding document, e.g., grant, cooperative agreement, contract, etc.

2. The agency transferring funds and personnel to another agency will provide a detailed statement of work including interim and final reporting deadlines, a list of deliverables, and maximum cost that can be incurred. These documents shall be incorporated into the aforementioned appropriate funding document.

3. All data collected by participating agencies pursuant to this agreement will be stored in an Interagency computerized data base.

AVAILABILITY OF FUNDS: Work to be performed under this MOU is subject to the availability of funds through the Federal and State Governments' normal budget process.

DURATION OF AGREEMENT: It is anticipated that environmental monitoring will remain a permanent requirement of Federal and State projects. Consequently, this agreement will become effective when signed by cooperating agencies and will remain in effect until September 30, 2000, or until terminated. The agreement may be extended beyond September 30, 2000, by mutual consent of the parties.

CONTRACTUAL REQUIREMENTS: Statement-of-work, products, agency obligations, delivery dates, funding, expense statements, billing procedures, and payment provisions will be arranged between the agency(s) transferring funds and the agency(s) conducting the work on a case-by-case basis.

RELEVANT LEGISLATION:

- National Environmental Policy Act (NEPA), 1969.
- California Environmental Quality Act (SEQA), 1970.
- Public Law 92-500 (Federal Water Pollution Control Act Amendments of 1972).
- State of California Appellate Court Decision - United States of America v. State Water Resources Control Board, (1986) (Racanelli Decision).
- Law enforcement on Reclamation projects in conjunction with local enforcement agencies, under Public Law 98-552, Water Enforcement (42 U.S.C. 1962, et. seq.)
- Fish hatcheries and wildlife enhancement facilities under Public Law 89-72, Federal Water Project Recreation Act (16 U.S.C. 460 1-5, 16 U.S.C. 460 1-12, et. seq.).
- Investigation of cultural resources, including wildlife mitigation under the Fish and Wildlife Coordination Act of 1934 as amended, including Public Law 93-291 which amends Public Law 86-523 (16 U.S.C. 469).
- Science research under Public Law 93-291 which amends Public Law 86-523 (16 U.S.C. 469).
- Science research under Publc Law 85-934 (42 U.S.C. 1891-2).

TERMINATION: The MOU or contractual agreements developed as part of the MOU may be terminated in whole, or in part, when any agency determines that continuation would not produce beneficial results commensurate with further expenditure of funds. The parties will agree upon the conditions of termination, including the effective date, and in the case of partial terminations, the portion to be terminated. The agency(s) will not incur new obligations for the terminated portion after the receipt of the termination notice, and will cancel as many outstanding obligations as possible after receipt of the termination notice. Each agency will allow full credit to the other agency(s) for its share of noncancellable obligations properly incurred by the other agency prior to receipt of the termination notice.

WITHDRAWAL: Any agency may withdraw from the MOU or contracts upon sixty (60) calendar days' advance written notice of such terminations. Written notices to be sent to: The Agency Coordinators. Any agency(s) contracting with the withdrawing agency will be reimbursed for its commitment extending beyond the effective date of termination to a date not later than the date upon which the contract would have expired if not terminated under this paragraph, which the agency(s) doing the work, in the exercise of due diligence, is unable to cancel. Payment of performance under the contract(s) will not exceed the obligation ceiling amounts identified in the contract(s).

AMENDMENTS: No changes may be made to this MOU or contracts unless agreed to in writing by all the parties. Changes dealing with wholly administrative matters (such as changes in paying office, changes of address) may be by written notice to all parties. No oral statement of any person shall be allowed in any manner or degree to modify or otherwise affect the provisions of the MOU and contracts.

RESOLUTION DISAGREEMENT: If interpretation of one or more aspects of the MOU or contracts should become the source of unresolved disagreement between any of the parties to the MOU, those parties, by mutual arrangement, shall make equitable provision for, and abide by the determinations of, disinterested third party qualified to perform the resolution services necessary. Any resolution must be agreed to in writing by all the parties to this MOU.

Signature Page

Federal

Regional Director
Mid-Pacific Region
Bureau of Reclamation
2800 Cottage Way
Sacramento CA 95825-1898

_____

Fish and Wildlife Service

Regional Director
U.S. Fish and Wildlife Service
Portland Eastside Federal Complex
1002 NE Holladay Street
Portland OR 97232-4181

_____

U.S. Geological Survey

District Chief
U.S. Geological Survey
District Office
2800 Cottage Way
Sacramento CA 95825-1898

_____

U.S. Army Corps of Engineers

District Engineer
U.S. Army Corps of Engineers
San Francisco District
211 Main Street
San Francisco CA 94105-1905

_____

State

Director
Department of Water Resources
PO Box 942836
Sacramento CA 94236-0001

_____

Director
Department of Fish and Game
1416 Ninth Street
Sacramento CA 95814

_____

Chairman
State Water Resources Control Board
PO Box 100
Sacramento CA 95801

_____

1990

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU) is made and entered into by the U.S. Bureau of Reclamation (Reclamation) and the following Federal and State agencies:

Federal

- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Army Corps of Engineers

State

- California Department of Water Resources
- California Department of Fish and Game
- California State Water Resources Control Board

BACKGROUND: A 1970 MOU creating the Interagency Ecological Study Program and its 1985 amendment are out of date. A new MOU is required to facilitate funds, equipment, and personnel transfers between cooperating agencies needed to meet the monitoring requirements of Federal and State projects in the San Francisco Bay-Delta Estuary.

OBJECTIVE: The objective of this MOU is to provide for the coordination, conduction, and transfer of funds, equipment, and personnel between agencies to carry out ecological monitoring and evaluations of the impacts of the Federal and State projects on the San Francisco Bay-Delta Estuary.

STATEMENT OF WORK:

1. All studies and transfer of funds or personnel will be subject to approval by the Interagency Coordinators and Directors. Any Federal agency transferring resources under this agreement shall utilize the appropriate funding document, e.g., grant, cooperative agreement, contract, etc.

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AVAILABILITY OF FUNDS: Work to be performed under this MOU is subject to the availability of funds through the Federal and State Governments' normal budget process.

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RELEVANT LEGISLATION:

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- California Environmental Quality Act (CEQA), 1970.
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- State of California Appellate Court Decision - United States of America v. State Water Resources Control Board, (1986) (Racanelli Decision).
- Law enforcement on Reclamation projects in conjunction with local enforcement agencies, under Public Law 98-552, Water Enforcement (42 U.S.C. 1962, et. seq.)
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- Science research under Public Law 93-291 which amends Public Law 86-523 (16 U.S.C. 469).
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TERMINATION: The MOU or contractual agreements developed as part of the MOU may be terminated in whole, or in part, when any agency determines that continuation would not produce beneficial results commensurate with further expenditure of funds. The parties will agree upon the conditions of termination, including the effective date, and in the case of partial terminations, the portion to be terminated. The agency(s) will not incur new obligations for the terminated portion after the receipt of the termination notice, and will cancel as many outstanding obligations as possible after receipt of the termination notice. Each agency will allow full credit to the other agency(s) for its share of noncancellable obligations properly incurred by the other agency prior to receipt of the termination notice.

WITHDRAWAL: Any agency may withdraw from the MOU or contracts upon sixty (60) calendar days' advance written notice of such terminations. Written notices to be sent to: The Agency Coordinators. Any agency(s) contracting with the withdrawing agency will be reimbursed for its commitment extending beyond the effective date of termination to a date not later than the date upon which the contract would have expired if not terminated under this paragraph, which the agency(s) doing the work, in the exercise of due diligence, is unable to cancel. Payment of performance under the contract(s) will not exceed the obligation ceiling amounts identified in the contract(s).

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RESOLUTION DISAGREEMENT: If interpretation of one or more aspects of the MOU or contracts should become the source of unresolved disagreement between any of the parties to the MOU, those parties, by mutual arrangement, shall make equitable provision for, and abide by the determinations of, disinterested third party qualified to perform the resolution services necessary. Any resolution must be agreed to in writing by all the parties to this MOU.

Executed this 19TH day of OCTOBER, 1990.

Federal

Regional Director
Mid-Pacific Region
Bureau of Reclamation
2800 Cottage Way
Sacramento CA 95825-1898

Fish and Wildlife Service

Regional Director
U.S. Fish and Wildlife Service
Portland Eastside Federal Complex
1002 NE Holladay Street
Portland OR 97232-4181

U.S. Geological Survey

District Chief
U.S. Geological Survey
District Office
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U.S. Army Corps of Engineers

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U.S. Army Corps of Engineers
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Director
Department of Water Resources
PO Box 942836
Sacramento CA 94236-0001

Director
Department of Fish and Game
1416 Ninth Street
Sacramento CA 95814

Chairman
State Water Resources Control Board
PO Box 100
Sacramento CA 95812-0100

1992

Amendment No. 001
to 0-MOU-78001

The attached Memorandum of Understanding (MOU), hereinafter designated as MOU 0-MOU-078001 is hereby amended to include the Environmental Protection Agency (EPA) as an active federal member of Interagency Ecological Study Program for implementation of the monitoring requirements in the San Francisco Bay-Delta Estuary. Participating agencies are itemized as follows:

Federal	State
U.S. Army Corps of Engineers	
U.S. Bureau or Reclamation	California Department of Fish and Game
U.S. Environmental Protction Agency	California Department of Water Resources
U.S. Fish and Wildlife Service	California State Water Resources Control Board
U.S. Geological Survey	

Executed this Ninth (9) day of March, 1992.

Regional Director
Mid-Pacific Region, USBR

for Director
Department of Water Resources

Regional Director
US Fish and Wildlife Service

Director
Department of Fish and Game

for District Chief
US Geological Survey

Chairman
State Water Resources Control Board

District Engineer
San Francisco District, USCOE

for Regional Administrator
US Environmental Protection Agency

ATTACHMENT 1

MEMORANDUM OF UNDERSTANDING

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- U.S. Fish and Wildlife Service
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- Fish hatcheries and wildlife enhancement facilities under Public Law 89-72, Federal Water Project Recreation Act (16 U.S.C. 460 1-5, 16 U.S.C. 460 1-12, et. seq.).
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- Science research under Public Law 93-291 which amends Public Law 86-523 (16 U.S.C. 469).
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RESOLUTION DISAGREEMENT: If interpretation of one or more aspects of the MOU or contracts should become the source of unresolved disagreement between any of the parties to the MOU, those parties, by mutual arrangement, shall make equitable provision for, and abide by the determinations of, disinterested third party qualified to perform the resolution services necessary. Any resolution must be agreed to in writing by all the parties to this MOU.

ATTACHMENT 2

Figure 1
ORGANIZATION, INTERAGENCY ECOLOGICAL STUDY PROGRAM

AGENCY DIRECTORS

David Kennedy	Department of Water Resources	Pete Bontadelli	Department of Fish and Game
Larry Hancock	U.S. Bureau of Reclamation	Marvin Plenert	U.S. Fish and Wildlife Service
Don Maughn	State Water Resources Control Board	John Klein	U.S. Geological Survey
Stanley Phernambucq	U.S. Army Corps of Engineers		

AGENCY COORDINATORS

Harold Chadwick, Chair, Department of Fish and Game

Randy Brown	Department of Water Resources	Marty Kjelson	U.S. Fish and Wildlife Service
Dave Beringer	State Water Resources Control Board	Pete Anttila	U.S. Geological Survey
Ken Lentz	U.S. Bureau of Reclamation		U.S. Army Corps of Engineers

STUDY MANAGER

Perry Herrgesell, Department of Fish and Game

TECHNICAL COORDINATING COMMITTEES

Fisheries/Water Quality Program

Marty Kjelson, Chair	U.S. Fish and Wildlife Service
Jim Arthur	U.S. Bureau of Reclamation
Donald Stevens	Department of Fish and Game
Harlan Proctor	Department of Water Resources
Bellory Fong	Department of Water Resources
Jim Sutton	State Water Resources Control Board

Fish Facilities Study

Dan Odenweller, Chair	Department of Fish and Game
Barry Collins	Department of Fish and Game
Marty Kjelson	U.S. Fish and Wildlife Service
Roger Wolcott	National Marine Fisheries Service
Bellory Fong	Department of Water Resources
Lloyd Hess	U.S. Bureau of Reclamation

Hydrodynamics Committee

Larry Smith, Chair	U.S. Geological Survey
Pete Smith	U.S. Geological Survey
Chuck Armor	Department of Fish and Game
Marty Kjelson	U.S. Fish and Wildlife Service
Tom Wakeman	U.S. Army Corps of Engineers
Tom Tamblin	State Water Resources Control Board
Randy Brown	Department of Water Resources
Jim Arthur	U.S. Bureau of Reclamation

Delta Outflow/San Francisco Bay Study

Chuck Armor, Chair	Department of Fish and Game
Jim Arthur	U.S. Bureau of Reclamation
Marty Kjelson	U.S. Fish and Wildlife Service
Steve McAdams	Bay Conservation/Development Commission
Tom Wakeman	U.S. Army Corps of Engineers
Randy Brown	Department of Water Resources
Rick Oltman	U.S. Geological Survey
Leo Winternitz	State Water Resources Control Board

Data Management Committee

Sheryl Baughman, Chair	U.S. Bureau of Reclamation
Joel Johnston	U.S. Geological Survey
Pat Brandes	U.S. Fish and Wildlife Service
Ann Baker	Department of Fish and Game
Sheila Greene	Department of Water Resources
Jim Sutton	State Water Resources Control Board

Table 1
PROGRAM FUNDING, FISCAL YEAR 1989-90
(Thousands of Dollars)

	DFG	DWR	SWRCB	USFWS	USGS	USBR	USCE	Total
Fisheries/Water Quality	929	1982	125	88		1400		**4524**
Fish Facilities		567				126		**693**
Delta Outflow/San Francisco Bay		423				524		**947**
Hydrodynamic Investigations		313	200		298	15		**826**
Total Administration	177	60	15					**252**
Totals	1106	3345	340	88	298	2065	0	**7242**

ATTACHMENT 3

DFG Copy

2000 MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU) is made and entered into by the following Federal and State agencies:

Federal

U.S. Army Corps of Engineers
U.S. Bureau of Reclamation
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
National Marine Fisheries Service

State

California Department of Fish and Game
California Department of Water Resources
California State Water Resources Control Board

These agencies are hereinafter referred to collectively as the "Parties" or "IEP Agencies".

BACKGROUND: There is now in effect a 1970 MOU creating the Interagency Ecological Study Program (IEP MOU). The IEP MOU was amended in 1985, 1990 and 1992. Under the terms of the 1990 amendment, the IEP MOU will expire on September 30, 2000. An additional amendment to the IEP MOU is required to address IEP activities that may take species of fish, plants or wildlife that are listed as endangered, threatened or candidate species pursuant to the California Endangered Species Act, California Fish and Game Code section 2050, et seq. (CESA). An additional amendment is also required to extend the duration of the IEP MOU.

OBJECTIVE: The objective of this MOU is to amend the IEP MOU to extend the existing MOU until September 2010 and to establish that IEP activities that may take CESA listed species shall be carried out by, or under the approval and supervision of the California Department of Fish and Game (CDFG); to establish the process by which such activities will be identified and approved; and to extend the duration of the IEP MOU.

STATEMENT OF AGREEMENT:

1. All IEP activities that may result in the take of CESA listed species shall be subject to the approval and supervision of CDFG.

2. All proposed IEP activities shall be evaluated in accordance with the "Interagency Ecological Program Quality Assurance and Quality Control Program for Collection and Evaluation of Environmental Data" (IEP QA/QC Plan) (Attachment 1) including any amendments hereto. The IEP conducts an annual planning process which includes review of all activities and the development of a comprehensive program. Each year, prior to the approval of the IEP Program for the following year, CDFG, in consultation with the Program Manager, shall identify any proposed Program elements that may cause the take of a CESA listed species. CDFG shall determine with regard to each Program Element identified whether the potential scientific benefit to California's fish and wildlife resources warrants the potential take of CESA listed species; whether the take will be adequately minimized or mitigated; and whether there is any potential to jeopardize the continued existence of a CESA listed species. Based on these criteria, CDFG will approve or disapprove the Program element. If CDFG approves the Program element, it shall identify such terms and conditions as it deems necessary or appropriate to minimize or mitigate the take of CESA listed species. and shall supervise the Program element's implementation. CDFG may suspend or terminate implementation any such Program Element, if in CDFG's judgement, suspension or termination is necessary to prevent undue harm to any listed species. In implementing IEP Program activities pursuant to this MOU, employees of the IEP Agencies shall act under the supervision of CDFG and shall therefore, for this limited purpose, act as agents of CDFG pursuant to title 14, California Code of Regulations, section 783.1(c).

3. IEP activities initiated before the effective date of this MOU that cause the take of a CESA listed species shall cease, unless the take is authorized pursuant to an existing federal Endangered Species Act incidental take permit or biological opinion and a CESA memorandum of understanding, incidental take permit, or consistency determination pursuant to Fish and Game Code section 2080.1. Any such unauthorized take shall be reported immediately, by telephone and subsequent written notice, to the IEP Program Manager. The principal investigator for the activity causing the take and the Program Manager shall consult with CDFG and shall incorporate any terms and conditions regarding the activity required by CDFG before proceeding. However, since Federal agencies cannot waive Federal sovereign immunity, they agree to this provision in the spirit of cooperation in furtherance of the mission of the IEP and to the extent permitted by Federal law.

PARTICIPATION:	Participation is limited to the maximum extent permitted under Federal and State law.
AVAILABILITY OF FUNDS:	Work to be performed under this MOU is subject to the availability of funds through the Federal and State Governments' normal budget process.
DURATION OF AGREEMENT:	This MOU will become effective when signed by each of the parties to this MOU. The IEP MOU, as amended by this MOU and the 1985, 1990 and 1992 amendments, shall remain in effect until September 30, 2010, or until terminated as provided herein. The duration of the IEP MOU, as amended, may be extended beyond September 30, 2010, by mutual consent of the parties.
CONTRACTUAL REQUIREMENTS:	Statement-of-work, products, agency obligations, delivery dates, funding, expense statements, billing procedures, and payment provisions will be arranged between the agency(s) transferring funds and the agency(s) conducting the work on a case-by-case basis.
RELEVANT LEGISLATION:	- National Environmental Policy Act (NEPA), 1969. - California Environmental Quality Act (CEQA), 1970. - Public Law 92-500 (Federal Water Pollution Control Act Amendments of 1972). - State of California Appellate Court Decision - United States of America v. State Water Resources Control Board, (1986) (Racanelli Decision). - Law enforcement on Reclamation projects in conjunction with local enforcement agencies, under Public Law 98-552, Water Enforcement (42 U.S.C. 1962, et seq.) - Fish hatcheries and wildlife enhancement facilities under Public Law 89-72, Federal Water Project Recreation Act (16 U.S.C. 460 1-5, 16 U.S.C. 460 1-12, et seq.). - Investigation of cultural resources, including wildlife mitigation under the Fish and Wildlife Coordination Act of 1934 as amended, including Public Law 93-291 which amends Public Law 86-523 (16 U.S.C. 469). - Science research under Public Law 93-291 which amends Public Law 86-523 (16 U.S.C. 469). - Science research under Public Law 85-934 (42 U.S.C. 1891-2).
TERMINATION:	The MOU or contractual agreements developed as part of the MOU may be terminated in whole, or in part, when any agency determines that

continuation would not produce beneficial results commensurate with further expenditure of funds. The parties will agree upon the conditions of termination, including the effective date, and in the case of partial terminations, the portion to be terminated. The agency(s) will not incur new obligations for the terminated portion after the receipt of the termination notice, and will cancel as many outstanding obligations as possible after receipt of the termination notice. Each agency will allow full credit to the other agency(s) for its share of noncancellable obligations properly incurred by the other agency prior to receipt of the termination notice.

WITHDRAWAL: Any agency may withdraw from the MOU or contracts upon sixty (60) calendar days' advance written notice of such terminations. Written notices are to be sent to the Agency Coordinators. Any agency(s) contracting with the withdrawing agency will be reimbursed for its commitment extending beyond the effective date of termination to a date not later than the date upon which the contract would have expired if not terminated under this paragraph, which the agency(s) doing the work, in the exercise of due diligence, is unable to cancel. Payment of performance under the contract(s) will not exceed the obligation ceiling amounts identified in the contract(s).

AMENDMENTS: No changes may be made to this MOU or contracts unless agreed to in writing by all the parties. Changes dealing with wholly administrative matters (such as changes in paying office, changes of address) may be by written notice of all parties. No oral statement of any person shall be allowed in any manner or degree to modify or otherwise affect the provisions of the MOU and contracts.

RESOLUTION DISAGREEMENT: If interpretation of one or more aspects of the MOU or contracts should become the source of unresolved disagreement between any of the parties to the MOU, those parties, by mutual arrangement, shall make equitable provision for, and abide by the determinations of, a disinterested third party qualified to perform the resolution services necessary. Any resolution must be agreed to in writing by all the parties to this MOU.

Except as hereby amended, the IEP MOU and all amendments and exhibits thereto shall remain in full force and effect.

EFFECTIVE DATE: This MOU shall become effective upon execution by all parties.

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the IEP 2000 Memorandum of Understanding and agrees to the terms and conditions therein.

DATE: 2/14/00

U.S. BUREAU OF RECLAMATION

By: _____

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the IEP 2000 Memorandum of Understanding and agrees to the terms and conditions therein.

DATE: 22 Feb 00

U. S. ARMY CORPS OF ENGINEERS

By: _____

BG, USA

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the IEP 2000 Memorandum of Understanding and agrees to the terms and conditions therein.

DATE: 2/4/00

U. S. ENVIRONMENTAL PROTECTION AGENCY

By: _____

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the IEP Memorandum of Understanding and agrees to the terms and conditions therein.

DATE: Oct. 3, 2000

NATIONAL MARINE FISHERIES SERVICE

By: Rodney R McInnis

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the IEP 2000 Memorandum of Understanding and agrees to the terms and conditions therein.

DATE: Feb 8, 2000

U. S. GEOLOGICAL SURVEY

By: Michael V Shulters

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the IEP 2000 Memorandum of Understanding and agrees to the terms and conditions therein.

DATE: 02/08/00

CA DEPARTMENT OF FISH AND GAME

By: [signature] CHIEF DEPUTY DIRECTOR

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the IEP 2000 Memorandum of Understanding and agrees to the terms and conditions therein.

DATE: 2-14-2000

CA DEPARTMENT OF WATER RESOURCES

By: _____

SIGNATURE PAGE

The undersigned certifies that he/she has received a copy of the IEP 2000 Memorandum of Understanding and agrees to the terms and conditions therein.

DATE: 11 Feb 00

CA STATE WATER RESOURCES CONTROL BOARD

By: _____