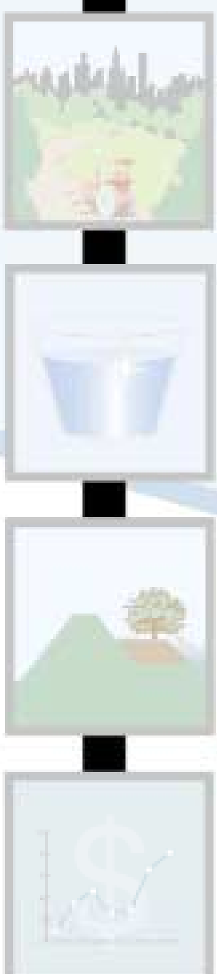

Ecosystem Restoration Program

Draft Stage 1 Implementation Plan

August 2001

CALFED
BAY-DELTA
PROGRAM

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1.0 INTRODUCTION

Background

The CALFED Ecosystem Restoration Program (ERP) is designed to maintain, improve, and increase aquatic and terrestrial habitats and improve ecological functions in the San Francisco Bay and Sacramento-San Joaquin Delta (Bay-Delta) to support sustainable populations of diverse and valuable plant and animal species. The ERP is also designed to achieve recovery of at-risk species dependent on the Delta and Suisun Bay, as identified in the CALFED's programmatic Multi-species Conservation Strategy (MSCS), and support the recovery of at-risk species in San Francisco Bay and in the watershed above the estuary. A foundation of the ERP is the restoration of ecological processes associated with streamflow, stream channels, watersheds, and floodplains.

Implementation of the ERP over the 30-year implementation period will be guided through an ecosystem-based adaptive management approach. ERP goals and objectives for ecosystem, habitat, and species rehabilitation are designed to produce measurable and progressive improvements to the Bay-Delta ecosystem resulting in a level of ecosystem health and species recovery that exceeds existing regulatory requirements. The first seven years of restoration efforts (Stage 1) are structured to accomplish significant improvement in Bay-Delta ecological health through a large-scale adaptive management approach. The pursuit of ERP goals and objectives will support management decisions in later stages of the implementation. To accomplish these objectives, the CALFED Program solicited and encouraged the participation of the public, academia, and stakeholders in carrying out restoration actions.

Draft Stage 1 Implementation Plan

This Draft Stage 1 Implementation Plan (Plan) is the second iteration of an implementation plan for the ERP. It expands on and revises the implementation plan embedded in the 2001 Proposal Solicitation Package. The purpose of an implementation plan is to formulate and present the restoration and information gathering priorities that guide subsequent solicitation and selection of projects for implementation. This year, we have separated the Plan from the Proposal Solicitation Package to clearly distinguish between Stage 1 priorities for restoration and science actions and the identified actions for which the ERP will solicit competitive bids on an annual basis, in this instance, for 2002.

This Plan emphasizes restoration priorities for implementation during years 2 through 7 of Stage 1. In keeping with commitments made by the CALFED agencies in the CALFED Programmatic Record of Decision (ROD) (August 28, 2000), implementation incorporates: (1) public involvement in setting restoration priorities; (2) local involvement in accomplishing restoration actions; (3) emphasis on adaptive management and information richness in the design of restoration actions; (4) coordination with other CALFED Program elements; and (5) coordination with non-CALFED Program restoration efforts, both public and private. This Plan also presents Draft Stage 1 restoration and science priorities from a regional perspective, consistent with the CALFED Program's regional approach.

In the near term, elements of the Plan will continue to be refined, and regional workshops will be held during early 2002 in order to improve and identify restoration and science priorities for 2003 and beyond. This process will establish the boundaries of actions and information-gathering efforts needed not only to conform to the regulatory commitments contained in the ROD during Stage 1 but to meet regional restoration and science needs as well.

Single Blueprint for Restoration and Recovery

The CALFED agencies will establish, through the ERP and the MSCS, a "Single Blueprint" for restoration and species recovery within the geographic scope of the ERP. The ERP is the CALFED Program's Single Blueprint for restoration of the Bay-Delta.

The purpose of the Single Blueprint is to provide:

- A unified and cooperative approach to restoration as defined by integrated, shared science;
- A set of ecological conceptual models to provide a common basis of understanding about how the ecosystem works;
- A shared vision for a restored ecosystem; and
- A management framework that defines how parties with management and regulatory authorities will be coordinated and integrated over time.

Development of the Single Blueprint's conceptual models will be a priority in the ERP the Plan.

To ensure that the ERP is implemented in a manner and to an extent to sustain compliance with the programmatic Federal Endangered Species Act, California Endangered Species Act, and Natural Community Conservation Planning Act for all program elements, the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (CDFG) have developed MSCS-ERP Stage 1 Milestones (Attachment 1). These milestones define the manner and level of ERP implementation necessary to help achieve the MSCS's species goals. The USFWS, NMFS, and CDFG expect and intend that the MSCS-ERP Milestones will be achieved with annual ERP funding of $150 million (ROD 2000).

The Single Blueprint requires integration of numerous programs. Over the past number of years, there has been a significant effort to improve coordination between restoration programs. In particular, there was a strong effort to coordinate and integrate the ERP, Anadromous Fish Restoration Program (AFRP) and Anadromous Fish Screen Program (AFSP) pursuant to the Central Valley Project Improvement Act (CVPIA) in 2000. This year additional CVPIA programs are being integrated including Habitat Restoration Program, the San Joaquin River Riparian Habitat Restoration Program and the Gravel Replenishment and Riparian Habitat

Program. The CALFED Program also has been working closely with the State and Federal Sacramento-San Joaquin River Basins Comprehensive Study. It is the intent of the CALFED agencies to seek additional opportunities for integration to facilitate the Single Blueprint.

Regional Perspective

The CALFED Program as a whole recognizes the need for regional strategies and solutions and has developed a regional approach to representing goals, strategies and progress. All regions of the state will benefit from CALFED Program actions. The CALFED Program has identified five regions.

The five regions are:

- The Sacramento Valley Region
- The San Joaquin Valley Region
- The Delta Region
- The Bay Region
- Southern California Region

- **The Sacramento Valley Region:**
  --Provides 80 percent, or 5 - 35 million acre-feet of the water flowing into the Delta
  --Offers major habitat/spawning ground for many threatened and endangered fish species
  --Contributes significantly to the state's farmlands and agricultural output

- **The San Joaquin Valley Region:**
  --Produces 45 percent of the nation's fruits and vegetables
  --Drains 7 seven major rivers from the Sierra Nevada range
  --Anticipates population to double over the next 20 years

- **The Delta Region:**
  --Captures 47 percent of State runoff and provides drinking water to 22 million Californians
  --Supports 750 plant and animal species
  --Provides irrigation water to California's $27 billion agricultural industry
  --Supports 120 fish species, including 80 percent of the State's commercial salmon fisheries
  --Contains the largest wetland habitat in the western United States

- **The Bay Region:**
  --Forms the coast's largest estuary
  --Drains more than 40 percent of the State's water
  --Forms centerpiece for America's fourth largest metropolitan area

- **Southern California Region:**
  --Provides housing to 16 million people as a major urban area
  --Consumes 60 percent of total water in California
  --Uses 8 percent of water for agriculture

The geographic scope for the ERP as described in the CALFED Program's programmatic documents falls within the first four regions. Therefore, this Plan focuses on the Sacramento, San Joaquin, Delta, and Bay regions. See Sections 6-10 for the draft Stage 1 implementation priorities by region.

CALFED Program Implementation Commitments

The CALFED agencies made numerous commitments to carry out the CALFED Program:

Local Leadership: The ERP is developing a process that will involve local governments and stakeholders in the reviewing and developing annual restoration priorities.

Stakeholder Consultation: The ERP will work with stakeholders through a subcommittee of the Bay-Delta Public Advisory Committee to acquire stakeholder input into the process for developing and refining the Plan.

Environmental Justice: The CALFED agencies are committed to seeking fair treatment of people of all races, cultures, and incomes, so no segment of the population bears a disproportionately high or adverse health, environmental, social, or economic impact resulting from CALFED programs, policies, or actions. The CALFED agencies will be developing environmental justice goals and objectives for each program area in the Plan. Projects selected through this PSP will be consistent with this overall commitment and with environmental justice goals and objectives as they develop.

Tribal Consultation: The CALFED Program is continuing to engage federally-recognized tribal governments in planning and developing projects within their respective tribal jurisdictions.

Land Acquisition: Successful implementation of the CALFED Program will affect agricultural lands in the Delta region. As an important feature of the State's environment and economy, agricultural lands will be preserved during implementation of the Program in a manner consistent with meeting program goals, while minimizing impacts to agriculture. Some of the land needed for program implementation is already owned by the Federal or State government and that land will be used to achieve program goals. Partnerships with landowners, including easements with willing landowners, will be pursued to obtain mutual benefits if public land is not available for the intended purpose. Acquisition of fee title to land will be from willing sellers only, and will be used when neither available public land nor partnerships are appropriate or cost-effective for the specific need. Such acquisitions will consider the potential for third-party and redirected impacts.

The ERP involves conversion of land in the Delta Region to habitat and ecosystem restoration, levee setbacks, and floodways. In general, agriculture is the dominant land use on the non-conveyance side of levee structures in the Delta. Habitat restoration in the Delta Region could affect water supply because some aquatic habitats use more water for evapotranspiration than some of the current agricultural land uses. Seasonal wetlands on lands that will continue agricultural practices generally use water in fall and winter when evaporation is relatively low. Therefore, the water requirements for flooding these areas may be less (1 or 2 acre-feet per acre per year) than for other aquatic habitats.

Not all of these water supply needs would result in reduced availability of water for agriculture. During times when excess water is flowing from the Delta to the Bay, no impacts on water supply diversions or exports would occur. In addition, some of the tidal habitat restoration would involve dredging or filling existing open-water habitat to create shallow-water or slough habitat, which would not affect water supply because the restored habitat already is open water. Effects on other water users cannot be determined until the location and other specific details of the habitat restoration are known.

Environmental Documentation: All projects that receive funding through a CALFED solicitation package will be evaluated to ensure that the agencies meet their environmental commitments. For those projects subject to NEPA and/or CEQA, environmental documents must tier from the CALFED or CVPIA Programmatic EIS/EIR, depending on the source of funding. Projects funded by CALFED must incorporate applicable mitigation strategies described in Appendix A to the ROD to avoid or minimize the project's adverse environmental impacts. Applicants are encouraged to review the CALFED Programmatic EIS/EIR and Appendix A to the ROD and incorporate mitigation strategies in developing their projects and environmental documents. (Applicants desiring additional information about the ROD can contact the CALFED Program at (800) 900-3587 or (916) 657-2666, or by visiting the CALFED web site at: http://calfed.ca.gov.) CALFED Program staff will assist grant recipients and project lead agencies in identifying the necessary environmental review requirements for their projects and necessary mitigation strategies.

Permit Clearinghouse: All projects funded under a solicitation will be required to obtain any necessary permits. This will include endangered species incidental take authorizations by tiering from CALFED Program's MSCS. If permits are required under Section 404 and 401 of the Clean Water Act and the Coastal Zone Management Act, they should tier from the programmatic MOUs and Consistency Determination. The CALFED Program staff will assist grant recipients in preparing their permit applications and tiering their endangered species documentation from the MSCS. Applicants are encouraged to review the MSCS and incorporate MSCS conservation measures in developing their proposals and their environmental documents. A list of MSCS Milestones can be found as Attachment 1 of this document. Recipients of grant funds for the ERP will also have access to the CALFED Program's newly established Permit Clearinghouse to assist them in obtaining the necessary permits and approvals to implement approved projects.

2.0 DESIGNING ECOSYSTEM RESTORATION PROJECTS USING AN ADAPTIVE MANAGEMENT APPROACH

The Ecosystem Restoration Program (ERP) and CALFED Bay-Delta Program (CALFED Program) are committed to implementing restoration actions in an adaptive management context. The CALFED Program's Implementation Memorandum of Understanding provides 11 implementation principles. One of the principles addresses adaptive management (see box).

Adaptive Management

> **Science-Based Adaptive Management Approach**
> The CALFED Agencies will implement the CALFED Program using a science-based adaptive management approach. This approach will rely on constant monitoring and evaluation of actions in all Program elements.

Restoring and managing the Bay-Delta ecosystem requires a flexible management framework that can generate, incorporate, and respond to new information and changing Bay-Delta conditions. Adaptive management provides such flexibility and opportunities for enhancing understanding of the ecosystem. Within an adaptive management framework, natural systems are managed to ensure their recovery and/or improvement, while increasing the understanding of how they function. In this manner, future management actions can be revised or refined in light of information generated from previous restoration and management actions.

A hypothesis-testing approach is used in all adaptive management actions to ensure that information is generated relative to the specific needs of the restoration program. Project implementors explicitly cast their actions in the context of existing knowledge about ecosystem structure and function, and design restoration actions to test current hypotheses concerning ecosystem restoration. In this respect, adaptive management treats all restoration actions as experiments.

The key to successful ecosystem restoration is learning from all restoration and management actions. Learning allows resource managers and the public to evaluate and update the problems, objectives, and models used to direct restoration actions. Subsequent restoration actions can then be revised or redesigned to be more effective or instructive.

Conceptual Models

Many resource managers, scientists, and stakeholders interested in the restoration and management of the Bay-Delta ecosystem have implicit beliefs about how the ecosystem functions, how it has been altered or degraded, and how various actions might improve conditions in the system. Conceptual modeling is a process of articulating such knowledge and understanding that enables others to see the reasoning behind the restoration action, and how specific actions fit into a broader restoration framework. Conceptual models can provide several benefits. The knowledge and hypotheses about ecosystem structure and function summarized in conceptual models can lead directly to potential restoration actions. They can highlight key uncertainties where research or pilot projects might be necessary to resolve issues or experimentally test approaches. There is no one correct conceptual model of an ecosystem. Rather, alternative conceptual models can point to areas of uncertainty, allowing the development of suitably-scaled restoration experiments designed to both benefit the system and explore it. Conceptual models also can help to define monitoring needs, and can provide a basis for quantitative modeling.

There is no recipe for developing conceptual models, nor is there a template for what they should look like. Conceptual models should be designed for a particular purpose and should contain only those elements relevant to solving a particular problem, including alternative explanations that lead alternative solutions. As a feature of any project, the proponent should present a conceptual model that describes the causal interconnections among key ecosystem components. It should be based on the best currently available information, and should demonstrate how physical and biotic system components respond to anticipated stressors or limiting factors. Models can be presented graphically or as a narrative, and should clearly articulate the role of the proposed solution in reducing uncertainty about system function.

Defining Restoration Actions

Conceptual models help to shape the character of restoration actions by identifying key uncertainties or by revealing the level of confidence at which a particular action will achieve a given objective. Using an adaptive management approach, ecosystem restoration projects are designed and implemented based upon a hierarchy of knowledge (Figure 1). Three types of management actions can be selected for implementation:

> **Targeted Research** may be necessary to resolve critical issues about ecosystem structure and function that preclude us from even defining problems sufficiently for pilot restoration actions to go forward.
>
> **Pilot or Demonstration Projects** can help to determine the practicality or effectiveness of restoration actions, allowing resource managers to evaluate alternative actions or build confidence in the ability of a particular action to achieve an objective.
>
> **Full-scale Implementation** can begin for those restoration actions that have demonstrated success at the pilot project scale, and for which there is reasonable confidence that the objective will be achieved.

These three types of actions are not mutually exclusive, and all might be used to address a particular problem. All projects must provide the justification for the type of restoration action proposed. Targeted research projects should address critical issues and resolve uncertainty. Pilot or demonstration projects should be based on appropriate research. Full-scale implementation projects should have a strong foundation in the related research and demonstration projects.

In areas where there is a high level of uncertainty, projects are primarily designed as research, evaluations, or simulation modeling to answer basic ecosystem restoration questions. Where considerable research has been done and more is known about ecosystem functions and processes, projects become more physically oriented toward pilot or demonstration projects and then full-scale implementation. All ecosystem restoration actions are treated as experiments. The projects must be designed to generate information as well as accomplish an action. In this way, information generated by ecosystem restoration projects can be used for future decision making. All projects should cite specific references and include a supporting base of knowledge.

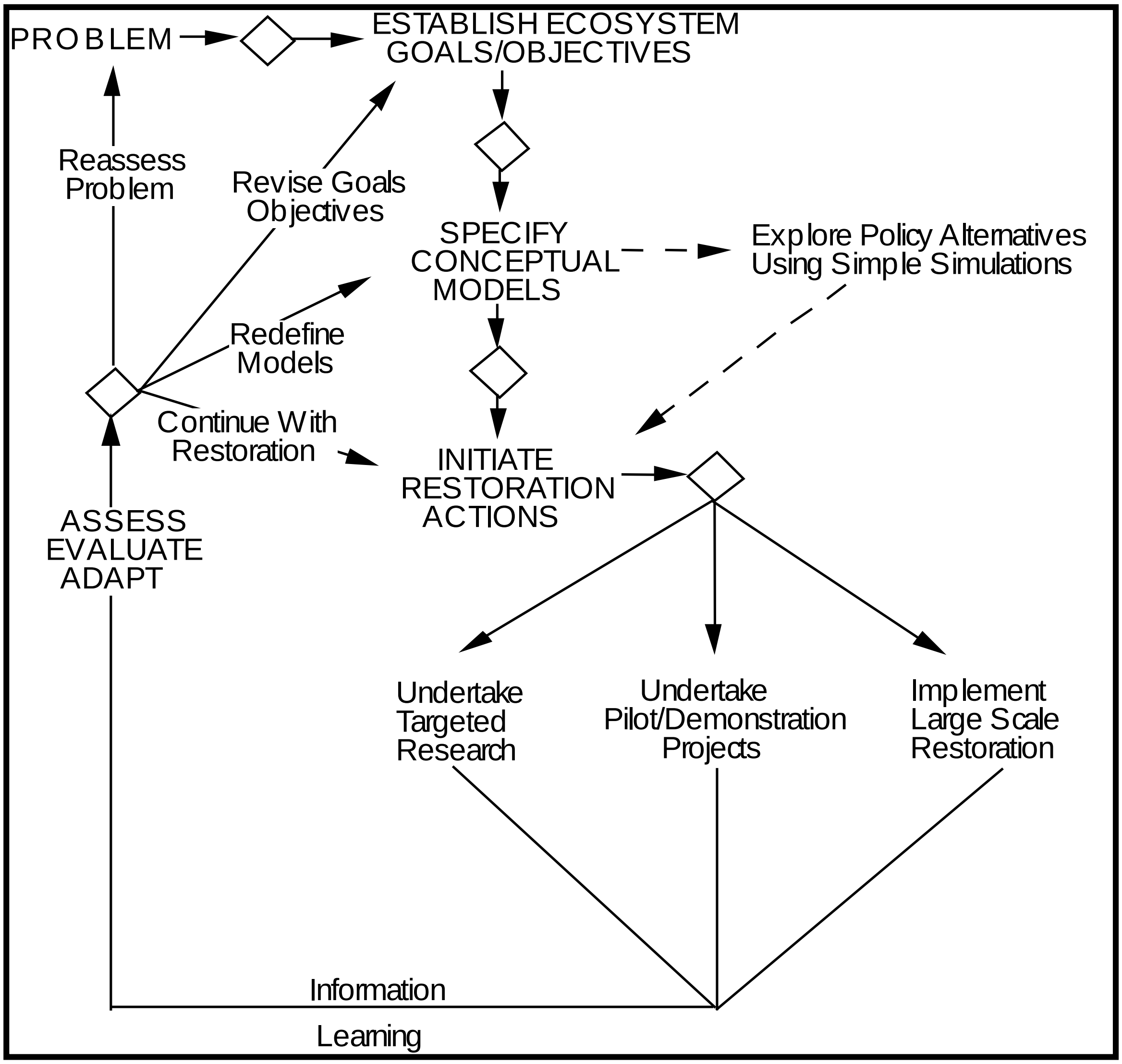

Figure 1. Adaptive Management Process

3.0 PROGRAM GOALS

Because this Draft Stage 1 Implementation Plan (Plan) will support the 2002 PSP for the Ecosystem Restoration Program (ERP), CALFED Science Program, and some programs from the Central Valley Project Improvement Act (CVPIA), goals of these programs are presented here. All actions implemented under this Plan must strongly link to one or more of these goals. This will require restoration actions of all types (targeted research, pilot and full-scale implementation) depending on the level of uncertainty being addressed.

Ecosystem Restoration Program Strategic Goals

In 1998, six strategic goals were developed by a core team of scientists on behalf of the ERP and refined by an agency and stakeholder team. The goals and associated objectives are listed in Attachment 2. The ERP strategic goals provide the basis for a vision of restoring ecological health to the Bay-Delta system and provide the framework for implementing ecosystem restoration actions. Each of the six strategic goals is interrelated. Often accomplishments towards one goal also provide benefits to others.

Goal 1: At-Risk Species

Achieve recovery of at-risk native species dependent on the Delta and Suisun Bay as the first step toward establishing large, self-sustaining populations of these species; support similar recovery of at-risk native species in San Francisco Bay and the watershed above the estuary; and minimize the need for future endangered species listings by reversing downward population trends of native species that are not listed.

The conflict between protecting at-risk species and providing reliable supplies of water for urban and agricultural uses was a major factor leading to the formation of the CALFED Program. "At-risk species" are those native species that are either formally listed as threatened or endangered under State and Federal laws or have been proposed for listing. Goal 1 places highest priority on restoring populations of at-risk species that most strongly affect the operation of the State Water Project and Central Valley Project diversions in the south Delta, such as delta smelt, all runs of chinook salmon, steelhead trout, and splittail. Goal 1 gives highest priority to the recovery of species formally listed under the Federal and California Endangered Species Acts (ESAs) because of the high degree of legal protection given the species (ERP Strategic Plan 2000).

There is considerable uncertainty about why at-risk species are in decline, and how best to facilitate the recovery of these species. ERP actions must address the immediate needs of at-risk species as well as gain additional information about how they respond to modifications to ecosystem functions and processes. In the early stages of implementation, improving population health of at-risk species is critical. At the same time, we need to maximize opportunities that improve our understanding of the best methods for restoring at-risk species and their habitat. Scientific uncertainties, such as freshwater outflow through the Delta (X2 relationships), diversion effects of pumps and the importance of the Delta for salmon, are thought to have a direct influence on the ability to achieve this goal.

Goal 2: Ecosystem Processes and Biotic Communities

Rehabilitate natural processes in the Bay-Delta system to support, with minimal ongoing human intervention, natural aquatic and associated terrestrial biotic communities and habitats, in ways that favor native members of those communities.

This goal recognizes that an ecosystem restoration plan must include restoration and maintenance of ecosystem processes, such as seasonal fluctuations in flow of streams and salinity of the estuary, to support natural aquatic and associated terrestrial biotic communities. Two key aspects of this goal are to have self-sustaining biotic communities that will persist without continual high levels of human manipulation of ecosystem processes and species abundances, and to have communities in which the dominant species, as much as possible, are native species. This goal emphasizes rehabilitation rather than restoration because so many of the physical and chemical processes in the watershed have been fundamentally altered by human activity. Scientific uncertainties that may influence the ability to achieve this goal include questions about the ability to simulate natural flow regimes and threshold flows for critical ecosystem processes, and a better understanding about channel dynamics, particularly how they affect habitat restoration and at-risk species, and declines in food web productivity and the implications for restoring ecological health.

Goal 3: Harvestable Species

Maintain and/or enhance populations of selected species for sustainable commercial and recreational harvest, consistent with the other ERP Strategic Goals.

This goal recognizes the importance of maintaining certain species in numbers large enough to sustain harvest by humans. Many of the actions undertaken to benefit at-risk species as defined in Goal 1, or to achieve the other strategic goals, have the potential to benefit harvestable species such as chinook salmon and steelhead.

The CALFED Program recognizes that current commercial and recreational harvest of some of these species is greatly supported by production from mitigation hatcheries. However, a great deal of scientific uncertainty exists relative to contemporary hatchery management practices and their compatibility with watershed restoration programs (e.g., Battle Creek).

Goal 4: Habitats

Protect and/or restore functional habitat types in the Bay-Delta estuary and its watershed for ecological and public values such as supporting species and biotic communities, ecological processes, recreation, scientific research and aesthetics.

Habitats are usually defined through some combination of physical features and conspicuous or dominant organisms, usually plant communities (such as salt marsh and riparian forest). Plant communities are often highly visible natural features and have important roles in the function of the ecosystems of which they are a part. The ERP identifies major habitat types in the estuary and watershed, and Moyle and Ellison (1991) identify at a finer scale freshwater habitat types. By definition, different habitats support different species or combinations of species and play different roles in the dynamics of the Bay-Delta system. It therefore becomes important to protect and restore large expanses of the major habitat types identified in the ERP and at least representative "samples" of other habitat types as identified by Moyle and Ellison (1991) and others.

Many direct benefits arise from protecting a wide array of habitats, including the recovery of at-risk species and the production of economically important wild species (such as salmon and waterfowl.) Equally important are the aesthetic values of natural landscapes containing mosaics of habitats. Less appreciated, but also important, are the ecosystem benefits provided by natural habitats, such as water and air purification and nutrient delivery to systems producing fish and other economically important aquatic organisms. Though the importance of restoring additional habitats is not debated, there are difficult choices ahead regarding the relative importance of restoring different habitat types on regional and local scales, and there is a pressing need to develop better tools to make these decisions. In addition, scientific uncertainties that have direct influence over the ability to achieve this goal include uncertainties associated with restoring freshwater wetland, tidal and riparian processes and functions; the value associated with flood bypasses and floodplains for recovery of ecological health; and the relationship of upland areas to the riparian zone.

Goal 5: Non-native Invasive Species

Prevent the establishment of additional non-native species and reduce the negative biological and economic impacts of established non-native species in the Bay-Delta estuary and its watershed.

This goal is arguably part of the first four goals because protecting and enhancing species, communities, and habitats in an estuary and its watershed implies reducing the effect of non-native invasive species. However, the introduction of new species into the system is still occurring so frequently, and the potential for ecological damage by further invasions is so high, that the necessity for halting (not just reducing) further introductions needs to be emphasized. Hobbs and Mooney (1998) document how invasions by non-native species are a major ecological force for change in California. Cohen and Carlton (1998) have labeled the San Francisco estuary as the most invaded estuarine ecosystem in the world and document the accelerating rate at which new species continue to become established, mostly as the result of their deliberate release through the dumping of ships' ballast water. Other sources include illicit introductions by anglers (e.g., northern pike) and aquarists (e.g., Hydrilla). This problem needs to be dealt with quickly and directly because new invading species can negate the effects of millions of dollars spent on habitat or ecosystem restoration. Likewise, already established non-native species, such as water hyacinth and the Asian clam (*Potamocorbula amurensis*), continue to have major negative impacts on native species in the system, and methods of control need to be developed. However, control methods must be less harmful to native species than the ecological disruption caused by non-native species.

The ERP Strategic Plan identified non-native invasive species as one of the most important issues facing the ERP. Non-native species invade all areas of ecosystem restoration activities. Many questions remain about the competitive relationships between native and non-native species, how non-native species use and colonize existing and restored habitats and the most effective ways to prevent new populations and manage those that already exist. In 1998, the CALFED Program established the Non-Native Invasive Species (NIS) Program. The NIS Program is supported by ERP funding and managed by the U.S. Fish and Wildlife Service with the support of numerous agencies, universities and stakeholder groups. The NIS Program has developed a Strategic Plan for managing non-native invasive species in the Bay-Delta, which emphasizes the need for taking a strategic approach to addressing non-native species and recognizes that prevention is the most practical, economic and environmentally safe method of dealing with non-native species.

Goal 6: Sediment and Water Quality

Improve and/or maintain water and sediment quality conditions that fully support healthy and diverse aquatic ecosystems in the Bay-Delta watershed and eliminate, to the extent possible, toxic impacts to aquatic organisms, wildlife, and people.

A problem equally as difficult to solve as the invasion of non-native species, problems associated with aquatic toxicity also could be considered part of the first four goals. Because toxic effects are pervasive and incompletely understood, developing the needed understanding has been identified as a distinct CALFED Program goal. Problems associated with toxic substances in the aquatic environment are briefly discussed below.

Persistent toxicants such as methyl mercury, selenium and PCBs can accumulate and concentrate in the aquatic food web creating health problems for carnivorous fish and for other predator organisms such as raptors and humans. (Most of the organo-chlorine compounds responsible for these effects, such as DDT and PCBs, are now banned, but residues remain in sediments and tissues of organisms.)

As older organo-chlorine pesticides and PCBs were banned because of their persistence, ability to concentrate in the food web, and harmful biological effects, they were replaced by non-persistent chemicals, some of which are acutely toxic. Residues of these materials from agricultural applications and residential use can enter watercourses and cause episodic toxicity to resident organisms, including those upon which other organisms must depend for food. Episodes of toxicity can have important effects on the aquatic ecosystem, but they can be subtle. Naturally occurring toxic substances, such as extracellular algal metabolites, can also cause toxic effects that may complicate the ability to distinguish toxicity due to activities of humans. Toxic algal blooms have not occurred to date in the Bay and their occurrence in the Delta is poorly known. Considerable potential exists for ecological disasters caused by large, sudden influxes of toxic materials, such as might be caused by flood-released toxic mine wastes (e.g., tailings from Iron Mountain Mine) or by spills of a pesticide carrier (e.g., the Cantara spill on the upper Sacramento River). Some toxic materials can accumulate in sediments where they can negatively affect benthic organisms directly, and indirectly affect food webs. This is an important mechanism for the continuing entry of metals, DDT and related water-insoluble compounds into aquatic food webs. Sediment bound contaminants are thought to be an important source of the periodic toxicity observed in bioassays from the rivers, Delta and Bay. Disturbance of sediment beds may also accentuate chemical transformation that exacerbate toxicity problems. Some chemicals are emerging as potential toxins (substances once thought to be harmless or not previously identified in the aquatic environment). Effects of these chemicals can occur in subtle ways, such as the potential for chronic, low-level stress resulting in increased susceptibility to disease or predation and reduced growth rates or fecundity (e.g., carcinogens or hormone disrupters). The effect of toxic substances draws high public awareness. Concern and environmental justice issues exist regarding the risks of consuming harvested organisms contaminated with some persistent chemicals or of drinking water from some regions of the system.

Excessive loads of organic matter and nutrients from anthropogenic sources into aquatic ecosystems cause eutrophication, low dissolved oxygen, and ammonia toxicity which has adverse impacts on aquatic organisms. Such contamination, although diminished as a result of the Clean Water Act, is still common from point and especially nonpoint sources, and needs to be addressed.

Fine sediment loads from human activities can and have degraded benthic habitat and adversely affected aquatic organisms in streams in the Sacramento, San Joaquin, and Bay regions. For example, sedimentation and turbidity adversely impact the quality and quantity of salmonid spawning habitat. These water quality issues are also topics of concern.

CALFED Science Program Goals in Relation to the Ecosystem Restoration Program

The CALFED Program covers one of the largest and most modified watersheds on the West Coast of North America (Nichols et al, 1986). Loss of habitat, water diversions, pollution, and species introductions are among the stressors considered responsible for substantial reductions in the abundance of many native fish populations and massive modification of ecosystems. The goal of ecological restoration, as described in the Ecosystem Restsoration Program Plan (ERPP), is to return this altered ecosystem to a more natural condition (Zedler and Callaway 1999). But restoration is a new science and uncertainty exists about how to most effectively restore communities and ecological function, what communities might result from what restoration efforts, and how to sustain restoration. Experience shows that restoration projects in highly modified ecosystem are not necessarily likely to proceed smoothly toward projected goals when either endangered species are used to define milestones, or when restoring ecosystem function is the target (Zedler and Callaway 1999; Arhendfeld 2000). A sustainable restoration program, therefore, must include on-going investment in science.

The long-term goal of the CALFED Science Program is to progressively build a body of knowledge that will continually improve the effectiveness of restoration actions, allow the CALFED Program to track restoration progress and allow ever-increasing understanding of the implications of interrelated CALFED Program actions. That body of knowledge must be unbiased, relevant, authoritative, integrated across the common CALFED programs, and communicated to the scientific community, CALFED agency managers, stakeholders, and the public. Five interconnected applications of science must progress together: adaptive management, monitoring, interdisciplinary knowledge of critical unknowns, improving the scientific basis of water management, and broad communication of science knowledge and scientific activities. The broad priorities are to advance simultaneously in the following ways:

- *Develop performance measures*. Tracking the success of restoration requires establishing performance measures and metrics, as well as monitoring and assessing their change through time. Scientific studies are needed to demonstrate, pilot test, and establish performance measure monitoring.

- *Conduct adaptive management experiments*. Specific adaptive management experiments can lead to improved restoration approaches, better understanding of restoration impediments or better management of water issues. It is also important to find ways to retrofit elements of adaptive management and/or monitoring to existing projects, ecosystems, or watersheds where multiple projects might be occurring.

- *Advance process understanding*. Critical to accomplishing the CALFED Program goals is advancing scientific understanding of relevant physical, biogeochemical, ecological or social processes and their implications for restoration and how those linkages, is critical to progressively improving the effectiveness of restoration and to accomplishing CALFED goals.

- *Build population models for at-risk species*. Improving the management of at-risk species is an important aspect of restoration. This requires knowledge of life history, environmental requirements and biology of at-risk species, and ultimately developing reliable models of population processes. Similar efforts for invasive species are necessary if that threat to at-risk species is to be managed.

- *Establish integrated science programs in complicated field settings.* Integrated, interdisciplinary studies are the best way to advance process understanding and attack relevant restoration questions in a complicated field setting. It is a goal of the Science Program to establish intensive site-, multi-site- or watershed-specific interdisciplinary programs in every region.

- *Compare relative effectiveness of different restoration strategies.* Effective restoration ultimately requires understanding constraints and opportunities; then analyzing how different restoration strategies overcome or take advantage of those in a specific setting. Conceptual models of the interplay between ecosystem processes and restoration are needed for specific systems and across systems.

- *Understand intertwined implications of all CALFED Program actions*. In a program with multiple goals some conflicts and re-directed effects among goals are inevitable. Identifying and improving understanding and resolution of re-directed effects, interconnections and/or conflicts among restoration and other goals is critical.

- *Advance the scientific basis of regulatory activities*. Managing water and protecting at-risk species uses science to establish regulations. Inevitably, the present state of knowledge is imperfect and uncertainties exist in the science that is applied. It is critical to continually address, explain, and advance the knowledge that can be applied to management, adapting regulatory activities as the knowledge changes. Addressing the uncertainties in the science used for management is an important goal of the CALFED Science Program.

- *Coordinate and extend existing monitoring.* A strength of the CALFED Program is the monitoring systems already in place in the system. Common questions and subsequent investments are needed to tie together the existing monitoring. New monitoring efforts are needed in some types of environments. Pilot projects testing new monitoring approaches will be an important part of this effort. High priority is necessary for environments where monitoring programs are least well developed, such as riparian zones, floodplains and wetlands.

- *Take advantage of existing data.* The existing monitoring programs and science efforts have generated decades of useful data. Full advantage has not yet been taken of all this data. So projects are encouraged that develop questions that can be addressed by interpreting existing data and that can build from that data to develop indicators and better understanding of processes, species and communities.

- *Address environmental justice issues.* Some impediments to restoration and some restoration actions have environmental justice implications. Studies that advance understanding of these implications (e.g., contamination of resource species) are encouraged.

- *Address societal issues related to restoration.* Natural science is not the only type of knowledge necessary for effective and sustainable restoration. Ecosystem restoration takes place within the context of the society it serves, and understanding the social science issues it raises is a necessary ingredient in any program.

- *Address landscape scale issues.* Although restoration actions cannot always address issues that extend across the landscape, like climate variability or earthquakes, the sustainability of restoration depends upon understanding the implications of these issues. Thus investment in understanding relevant aspects of large-scale issues is essential to develop strategies that integrate across the entire watershed and prepare the Program for the future.

The CALFED Science Program priorities are designed to simultaneously develop broad new knowledge, and, each year address specific, strategically important subject areas (areas of special, although not exclusive, interest for investment).

Central Valley Project Improvement Act Goals

The CVPIA is a federal statute jointly implemented by the Bureau of Reclamation (Bureau) and USFWS. The full text for the CVPIA can by found at the Bureau's Mid-Pacific Region web site (www.mp.usbr.gov) or at the USFWS AFRP web site (www.delta.dfg.ca.gov/afrp). Additional information regarding the CVPIA is found in Attachments 4 and 6.

Section 3402 of the CVPIA states the purposes of the Act. The following goals are consistent with the ERP:

> (a) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California;
>
> (b) to address impacts of the Central Valley Project on fish, wildlife and associated habitats;
>
> (c) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay and Sacramento-San Joaquin Delta Estuary;

The CVPIA authorizes a number of projects and programs that contribute to these purposes. Four of these programs have been identified for inclusion in this Plan, consistent with the "Single Blueprint" for restoration approach identified in the ROD. These programs are:

1) the Anadromous Fish Restoration Program authorized by Section 3406(b)(1);
2) the Habitat Restoration Program (sometimes referred to as the (b)(1) "Other" program) also authorized by Section 3406(b)(1);
3) the San Joaquin River Riparian Habitat Restoration Program also authorized by Section 3406 (b)(1);
4) the Gravel Replenishment and Riparian Habitat Protection Program authorized by Section 3406(b)(13); and
5) the Anadromous Fish Screen Program authorized by Section 3406(b)(21).

The goals of each of these programs are briefly described below.

Anadromous Fish Restoration Program - Section 3406(b)(1)

The goal of the Anadromous Fish Restoration Program (AFRP), as stated in Section 3406(b)(1) of the CVPIA, is to "develop within three years of enactment and implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991." Section 3406(b)(1) also states that "this goal shall not apply to the San Joaquin River between Friant Dam and the Mendota Pool."

Six general objectives need to be met to achieve the AFRP goal:

- Improve habitat for all life stages of anadromous fish by providing flows of suitable quality, quantity, and timing, and improved physical habitat;
- Improve survival rates by reducing or eliminating entrainment of juveniles at diversions;
- Improve the opportunity for adult fish to reach their spawning habitats in a timely manner;
- Collect fish population, health, and habitat data to facilitate evaluation of restoration actions;
- Integrate habitat restoration efforts with harvest and hatchery management; and
- Involve partners in the implementation and evaluation of restoration actions.

The CVPIA directs the AFRP to give first priority to measures that protect and restore natural channel and riparian habitat values. The Restoration Plan for the AFRP defines production targets for each species of anadromous fish covered under the CVPIA and for all Central Valley streams that supported anadromous fish populations during the 1967-1991 reference period. The Restoration Plan and other information on the AFRP can be found at the AFRP web site (www.delta.dfg.ca.gov/afrp).

Habitat Restoration Program - Section 3406(b)(1) "Other"

The goal of Section 3406(b)(1) of the CVPIA is to make all reasonable efforts to address other identified adverse environmental effects of the Central Valley Project (CVP) not specifically enumerated under the Fish and Wildlife Restoration Activities section of the Act. The Habitat Restoration Program was initiated in 1996 and is jointly managed by the USFWS and the Bureau.

The Habitat Restoration Program has two objectives:

(1) Protect and restore native habitats impacted by the CVP that are not specifically addressed in the Fish and Wildlife Restoration Activities section of the CVPIA. Initial focus will be on habitats known to have experienced the greatest percentage decline in habitat quantity and quality since construction of the CVP, where such decline could be attributed to the CVP (based upon direct and indirect loss of habitat from CVP facilities and use of CVP water). These habitats include riparian, aquatic (riverine, estuarine, and lacustrine), alkali desert scrub, wetlands (including vernal pools), foothill chaparral, valley-foothill hardwood, and grassland.

(2) Stabilize and improve populations of native species affected by CVP that are not specifically addressed in the Fish and Wildlife Restoration Activities section of the CVPIA. Initial focus will be given to federally listed, proposed or candidate species, other non-listed State and Federal species of special concern including resident fish and migratory birds, and other native wildlife species associated with the habitat types listed above.

Examples of the latter include native herptofauna associated with riparian and/or valley-foothill hardwood habitat throughout the Central Valley, native raptor species dependent upon valley-foothill hardwood and grassland for nesting and foraging, and neotropical species that use riparian corridors for migration, nesting, and foraging.

The Habitat Restoration Program is also closely coordinated with the Bureau's Central Valley Project Conservation Program (CVPCP). The CVPCP is a proactive effort undertaken by the Bureau, USFWS, and California Department of Fish and Game (DFG) to address the needs of Federal threatened and endangered species. The CVPCP implements projects to protect, restore, and enhance Federal threatened and endangered species, other special status species, and their habitat in areas directly or indirectly affected by the CVP. Funding for the CVPCP is provided separate from the CVPIA, but planning and selection of projects for funding are closely coordinated with the Habitat Restoration Program.

San Joaquin River Riparian Habitat Restoration Program - Section 3406(b)(1) "Other"

The San Joaquin River Riparian Habitat Restoration Program is also authorized by Section 3406(b)(1) of the CVPIA. The specific goal of this program is restoring the main stem of the San Joaquin River.

The Friant Waters Users Authority, the Natural Resources Defense Council, the Pacific Coast Federation of Fishermen's Associations and the San Joaquin River Exchange Contractors Water Authority share a strong interest in the mainstem of the San Joaquin River and have agreed to pursue mutually acceptable restoration activities. Initially, they agreed to work on riparian habitat restoration along the San Joaquin River corridor from Friant Dam to the confluence of the Merced River. The San Joaquin River Riparian Habitat Restoration Program was formed in 1997 to pursue this objective.

Initial efforts have been directed towards developing a sound scientific basis for identifying opportunities and sites where restoration has a likelihood of success. A historic biological conditions analysis, a physical process analysis, an evaluation of restoration opportunities between Firebaugh and Mendota, surface water and sediment continuity models and bathymetric and topographic surveys have been completed. Additional scientific data is being gathered in conjunction with U.S. Army Corps of Engineers (Corps), California Department of Water Resources (DWR) and other efforts.

Gravel Replenishment and Riparian Habitat Protection Program - Section 3406(b)(13)

The goal of the gravel replenishment and riparian habitat protection program under the CVPIA is to develop and implement a continuing program for restoring and replenishing, as needed, spawning gravel lost due to activities associated with the CVP. These activities include constructing and operating CVP dams, bank protection projects, and other actions that have reduced the availability of spawning gravel and rearing habitat in the upper Sacramento River from Keswick Dam to Red Bluff Diversion Dam, in the American River, and the Stanislaus River downstream from the Nimbus and Goodwin dams, respectively. The program includes preventive measures, such as re-establishment of meander belts and limitations on future bank protection activities, to avoid further losses of instream and riparian habitat.

Anadromous Fish Screen Program (AFSP) - Section 3406(b)(21)

The goal of the AFSP is to encourage and facilitate fish screen and other physical fish passageway facilities construction to avoid or minimize the entrainment and impingement of juvenile chinook salmon (all runs), steelhead trout, green and white sturgeon, American shad, and striped bass. The AFSP may provide up to 50 percent of the total cost of any such activity. Activities eligible for these cost-share funds under AFSP include, but are not limited to: constructing fish screens on unscreened diversions; rehabilitating existing fish screens; replacing existing, non-functioning screens; and relocating water diversions to less fishery sensitive areas.

To be eligible for AFSP cost-share funds projects must be below major dams on the Sacramento and San Joaquin rivers, their tributaries, the Sacramento-San Joaquin Delta, and Suisun Marsh where anadromous fish are found. AFSP guidelines for prioritizing projects consider the biological resources involved, the extent or magnitude of the benefit to those resources, the size and location of the diversion, cost of the project and the availability of cost-share funding partners (AFSP 1996).

4.0 PROCESS FOR DEVELOPING THE ECOSYSTEM RESTORATION PROGRAM DRAFT STAGE 1 IMPLEMENTATION PLAN

Stage 1 is defined as the first seven-year CALFED Program implementation period starting with the CALFED Programmatic Record of Decision (ROD) issued on August 28, 2000. Numerous CALFED Program documents provide either guidance on regulatory processes or list actions to be undertaken by the Ecosystem Restoration Program (ERP) during Stage 1. Relevant documents that will guide implementation of the ERP during the Stage 1 include:

- CALFED Programmatic Record of Decision (Volume 1, pages 35-37)
- Multi-Species Conservation Strategy (MSCS)
- CALFED Program Implementation Plan (pages 2-7 to 2-11)
- Strategic Plan for Ecosystem Restoration
- Ecosystem Restoration Program Plan (ERPP), Volume 1: Ecological Attributes of the San Francisco Bay-Delta Watershed
- Ecosystem Restoration Program Plan (ERPP), Volume II: Ecological Management Zone Visions
- Water Quality Program Plan
- Programmatic Endangered Species Act Section 7 Biological Opinions of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (ROD Vol. II)
- Natural Community Conservation Plan Approval of the California Department of Fish and Game (ROD Vol. II)
- Conservation Agreement (ROD Vol. II).

Specific guidance regarding implementation plan development is provided in the Programmatic Endangered Species Act Section 7 Biological Opinions of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service and the Natural Community Conservation Plan Approval of the California Department of Fish and Game. These opinions and approvals state that the CALFED Program will develop annual ERP implementation plans using the ERP Strategic Plan for Ecosystem Restoration and the MSCS. Members of the Science Program and the Ecosystem Restoration Program's Agency/ Stakeholder Ecosystem Team (ASET) will cooperatively participate in the development of the annual ERP implementation plans and will define the long-term priorities for the ERP. The fish and wildlife agencies will fully participate fully in the process of developing annual the ERP implementation plan. The fish and wildlife agencies' participation will

Plan Development

The Draft Stage 1 Implementation Plan was developed using the Ecosystem Restoration Program Plan (volumes 1 and 2), Strategic Plan for Ecosystem Restoration, CALFED Program Implementation Plan, Multi-Species Conservation Strategy, the CALFED ROD, Federal ESA Biological Opinions, State NCCP Approval, and information summarizing previously funded projects.

include, but not be limited to, participation in the ASET.

Process for 2002

This Implementation Plan reflects the current thinking of a diverse group of scientific advisors and is based on the best available information relative to ecosystem restoration and the Bay-Delta system. ASET, CALFED ERP staff, Science Program Staff, and CVPIA staff have worked cooperatively to develop the Draft Stage 1 Implementation Plan (Plan). This included an analysis to identify which ERP actions and targets are identified in the ROD commitments and milestones. The group also assessed the projects funded to date and how they match up to these same categories. Work on identifying the progress of funded projects as compared to goals and commitments will continue and is expected to support development of future implementation plans. Note that all the Stage 1 actions and MSCS milestones have not yet been incorporated as actions within this document, and it is the intent to include the Stage 1 actions in the next version of this Plan. Attachment 1 lists the MSCS milestones from the ROD. As new information becomes available and conceptual models are tested and refined it is anticipated that priorities will change and new issues or questions will emerge.

Endangered Species Linkage

As stated in the Programmatic Endangered Species Act Section 7 Biological Opinions of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service and the Natural Community Conservation Plan Approval of the California Department of Fish and Game, the CALFED Program will develop annual ERP implementation plans using the ERP Strategic Plan for Ecosystem Restoration and the MSCS. Members of the Science Program and the Agency/Stakeholder Ecosystem Team (ASET) will cooperatively participate in the development of the annual ERP implementation plan and will define the long-term priorities for the ERP. The fish and wildlife agencies will participate fully in the process for developing the annual ERP implementation plan.

--CALFED Programmatic Record of Decision,
August 28, 2000

Process for 2003

In keeping with commitments made in the ROD, the ERP will establish a public involvement process to include stakeholders in setting restoration priorities. This will be particularly valuable from the regional perspective. Regional workshops will be convened in each of the four regions: Sacramento, San Joaquin, Delta and Eastside Tributaries, and Bay. These workshops will be designed to revisit the Plan and to make adjustments based on public and agency suggestions. The process will be strongly keyed to science and adaptive management and will be an outgrowth of ERP performance in each of the regions. Based on revisions to the Plan, the annual proposal solicitation will be developed.

5.0 RESTORATION IMPLEMENTATION AND SCIENCE ISSUES

Implementation of the ERP, while strongly guided by numerous CALFED Program documents and regulatory requirements, is still founded upon the principles and strategies in the Strategic Plan for Ecosystem Restoration. In particular, the ERP Implementation Plan is logically structured by the Strategic Goals. To be effective in the long-term, the ERP needs to resolve scientific issues and uncertainties related to significant components of the implementation program during Stage 1. For example, there is a lack of sufficient information on the life histories of some at-risk species to effectively begin implementing measures to promote their recovery. Another example of a major uncertainty is the concern that restored tidal marsh habitat will be successfully colonized by non-native rather than native species. To be successful, the ERP must identify and resolve these types of significant questions early. To accomplish this, much of the Stage 1 implementation is designed to answer these question while also meeting requirements of the ROD, biological opinions, and other guidance documents.

Sections listed below are organized by ERP Strategic Goal into topic areas relating to the scientific uncertainties and categories of ongoing ecosystem restoration actions. The section is followed by regional presentations that provide information on the ERP four regions (Sacramento, San Joaquin, Delta and Eastside Tributaries, and Bay), previously funded projects and highlights of some of the previous and ongoing regional implementation efforts, and Stage 1 priorities for implementation.

Strategic Goal 1: At-Risk Species. Achieve recovery of at-risk native species dependent on the Delta and Suisun Bay as the first step toward establishing large, self-sustaining populations of these species; support similar recovery of at-risk native species in San Francisco Bay and the watershed above the estuary; and minimize the need for future endangered species listings by reversing downward population trends of native species that are not listed.

Strategic Goal 3: Harvestable Species. Maintain and/or enhance populations of selected species for sustainable commercial and recreational harvest, consistent with the other ERP Strategic Goals.

The recovery of at-risk species is at the heart of the ERP. During Stage 1 there is a need to better understand the life histories, abundance, distribution, and habitat requirements of species for which the CALFED Program has responsibility for their recovery or needs to contribute to their recovery. To accomplish this, it is necessary at a minimum to: (1) complete a variety of at-risk species assessments, (2) evaluate the role of the Delta habitat in the survival of chinook salmon, and (3) better understand the effects of large diversions on the survival of several species of aquatic organisms.

Restoration implementation and science issues for harvestable species during Stage 1 include efforts directed towards at-risk species including chinook salmon, steelhead trout, green and white sturgeon and splittail. The majority of the efforts for these at-risk species are embodied by the issues and uncertainties presented earlier under Strategic Goal 1, At-risk Species.

At Risk Species Assessments: Conduct monitoring, assessment, and research to improve the understanding of the ecological and physical processes affecting at-risk fishery resources and other aquatic dependent plant and animal resources of the Bay-Delta watershed. Actions should include improving and expanding the inventory and monitoring of fishery resources, assessment to better define correlations and relationships, research to establish the mechanisms that explain observed correlations. Actions should focus upon research designed to help manage the hydrologic regime in the Bay-Delta watershed streams to improve streamflows, net Delta channel flows, and temperatures for native anadromous and estuarine fish species. Projects should include genetic assessment of Central Valley salmonids, development and implementation of standardized censusing methods for adult and juvenile salmonids, assessment of reservoir operations and/or the use of temperature control devices to improve temperatures for chinook salmon spawning and steelhead rearing, and investigations regarding the nature and extent of adult and juvenile fish stranding.

Strategic Goal 1. At-risk Species
Strategic Goal 3. Harvestable Species

- At-risk species assessments
- Importance of the Delta for salmon
- Diversion effects of pumps
- Fish screens

Compared to resident and anadromous fish, the distribution and abundance of several other important ERP and MSCS non-fish species are not well known. Projects should include at-risk species surveys and studying the efficacy of reintroduction programs for these species. This information is important to guide ecosystem restoration projects so that they can provide for the protection and conservation of these species, and to ensure that projects do not inadvertently contribute to the further local decline of these species. Attachment 3 provides the study needs of at-risk species.

Importance of the Delta for Salmon: Scientific opinion varies on the suitability and use of the Delta for rearing by juvenile salmon and steelhead. Although chinook salmon use other estuaries for rearing, most research on salmon in the Delta, and resulting protective measures, focus on smolt passage. However, if substantial numbers of salmon fry rear in the Delta and these fish contribute substantial recruitment to the adult population, actions to enhance Delta rearing of fry would be warranted. Current actions to protect migrating smolts (such as pulse flows) might be modified or supplemented by actions designed to protect resident fry (e.g., extended high flows to flood shallow areas).

The CALFED Science Conference Summary, October 2000, noted that significant differences in chinook salmon and steelhead life histories and environmental requirements clearly demonstrate the need for research in these areas by distinct but complementary field, experimental, and analytical efforts. Salmon studies and conceptual models should be integrated to consider the animals' use of widely varying habitats from the upper rivers through the Delta, into the ocean and back to the rivers. Mechanisms and process links to salmonid biology have been underemphasized in studies to date, but are the ultimate means of advancing management of the species.

Diversion Effects of Pumps: Both the State Water Project (SWP) and the Central Valley Project (CVP) have large-capacity water pumping facilities located in the southern Delta. These facilities divert water into the California Aqueduct and the Delta-Mendota Canal for delivery to the San Joaquin Valley and southern California. Pumping operations generally draw water toward the southern Delta, thereby affecting the circulation of water in interior Delta channels and sloughs. The pumps are a source of mortality for several species, such as winter-run chinook salmon and delta smelt. For example, the pumps can be a source of direct morality through diversion, impingement upon fish screens, or handling mortality associated with fish salvage operations. The pumps can also expose fish to higher rates of predation by drawing them into Clifton Court Forebay, which harbors warm water fish species that prey upon native fish species. The pumps can affect the fish survival by drawing them toward the southern Delta, where there is generally less suitable habitat available to support them. By altering the normal circulation patterns of water in the Delta, the pumps can also affect fish survival by altering migrational cues.

In addition to understanding how pump operations affect fish survival, it is also important to understand details, such as the life histories of key species and what factors determine species distributions in the Delta environment. Other important questions that point to the relevant processes contributing to entrainment effects remain unanswered. How do Delta flows change in response to diversions, barrier placement, and the changing means of conveyance? How do these water management practices influence resident Delta species? What is the connection between diversions, flow regimes, and water quality and how do ecosystem processes and species populations respond to those connections? For example, how do changes in flow regimes, water quality, and engineering actions in the Delta affect species migrations? Projects should respond to these types of mechanistic questions to better understand and minimize the effects of water management practices on restoration efforts.

It is not known to what extent entrainment affects the population size of any one species of fish or other biota. It is also not known how pump operations or other sources of Delta mortality, such as agricultural diversions, affect the population size of any given species. Similarly, it is unclear to what extent water quality affects the survival of biota or the population dynamics of any given species. Because many of the mechanisms underlying the effects of pump operations are not clear, projects should evaluate which restoration strategy, or mix of strategies, will most reduce the effects of pump operations on sensitive fish species.

Projects conducted as adaptive management experiments should evaluate the relative importance and underlying mechanisms of entrainment in the SWP and CVP facilities. Implementing such projects will require advance planning to manage risks to protected fish species and water supplies, since the expense will likely be significant. The ERP currently has several work efforts underway as part of this advance planning, including scientific white papers concerning salmonids, delta smelt, splittail, and diversion effects upon fisheries and the use of an Environmental Water Account. The ERP intends to build upon the white paper effort by convening a team of scientific experts to begin developing and evaluating experimental management options pointed at better understanding the effects and mechanisms of entrainment. Because enough is generally not known to begin large-scale implementation projects related to SWP and CVP diversion effects upon fish, early efforts to address this uncertainty will focus on projects that can complement the advance planning underway.

Fish Screens: Fisheries resources have declined in recent years due to a variety of factors including alteration of instream flows and entrainment into water diversions. In many cases, high quality aquatic habitat exists upstream of agricultural and power diversions on tributaries of the Sacramento and San Joaquin Rivers. Additionally, there are a large number of relatively small diversions diverting water from the Suisun Marsh and the Delta. The smaller diversions also have the potential to entrain juvenile fish. A large number of screen projects are underway and additional screens are needed. At the same time, studies are needed to better understand how effectively fish screens protect species to better prioritize allocation of expenditures.

Strategic Goal 2: Ecosystem Processes and Biotic Communities. Rehabilitate natural processes in the Bay-Delta system to support, with minimal ongoing human intervention, natural aquatic and associated terrestrial biotic communities and habitats, in ways that favor native members of those communities.

While the recovery of at-risk species is a major focus of the ERP, better knowledge of the ecological processes and how they support natural communities is essential for a successful long-term restoration program. Uncertainties to be resolved early in the CALFED Program include: (1) examining opportunities to improve natural and modified flow regimes, (2) reevaluating and understanding better the relationship of Delta outflow and species survival (X2 relationship), (3) identifying better causes of the overall decline or alteration of the Bay-Delta food web, and (4) improving knowledge of physical processes related to stream channel dynamics and sediment transport.

Natural Flow Regimes: Human activities have fundamentally, and irreversibly, altered hydrologic processes in the Bay-Delta ecosystem. For example, changes in land use have affected how and when water drains from the land into stream channels; water diversions have changed the amount of water flowing through tributaries and the Delta; and dam development has profoundly altered the timing, frequency, and magnitude of flows. Extensive water development has generally affected the flow regime by reducing the seasonal and inter-annual variability of flows, as reservoirs capture and store stormwater and snowmelt runoff for later release and diversion to satisfy irrigation, municipal water supply, and hydropower demands. Such changes to the flow regime generally stress native habitats and species. For example, reservoirs generally reduce peak flows, which are essential for shaping channels and connecting them with their floodplains. Similarly, summer and fall reservoir

Strategic Goal 2. Ecosystem Processes and Biotic Communities

- Natural flow regimes
- X2 relationships
- Decline in productivity
- Channel dynamics and sediment transport

releases (generally for irrigation, hydropower, and municipal water supply) often increase base flows, which likely provides a competitive advantage for non-native species over native species that evolved in the context of a variable flow regime. Restoring variability to the flow regime will be an important component of restoring ecological function and supporting native habitats and species in the Bay-Delta ecosystem.

Restoring variability to flow does not necessarily imply restoring a pre-disturbance, natural flow regime, which would be impossible considering the human reliance upon the water supply infrastructure that most affects the character of flow in the Bay-Delta ecosystem. Rather, restoring flow variability will generally mean mimicking the natural hydrograph by imitating the relative timing, magnitude, and duration of pre-disturbance flows.

There likely will be limited opportunities for mimicking naturally low base flows since human water supply and quality needs rely on water releases that generally increase base flows. Also, in many reaches, re-creating low base flows may not be desirable from an ecological standpoint. Dams have prevented some sensitive anadromous species (principally spring-run chinook salmon, winter-run chinook salmon, and steelhead trout) from reaching historical holding and spawning habitats in upper watersheds, but cold water releases from the dams have permitted these fish to survive in reaches downstream of dams. Overall declines in the populations of native species may have reduced their resiliency to withstand the mortality that occurs during low-flow conditions, despite any competitive advantage they may gain over non-native species. It is important to emphasize here that limited opportunities for generally re-creating low base flows should not preclude experimental management actions that examine how low-flow conditions affect native and non-native species. Generally, there is a need to better understand the mechanisms underlying native and non-native species responses to hydrologic processes, including low-flow conditions and the role of fall pulse flows as a trigger to upstream migration for adult fall-run salmon.

Restoring flow variability likely will focus on mimicking historical peak flows to restore some measure of ecological function and to better create and maintain habitats. However, defining a flow schedule to best achieve ecological restoration objectives on streams regulated by dams is a complex task that must account for the fundamental changes that dams create, including trapping sediments and organic material from upper watersheds, as well as downstream channel adjustments to the post-dam flow regime. Historical reference conditions are instructive, but alone are insufficient to define the flow patterns that will best achieve ecological objectives. Defining ecologically functional flow schedules will also require analyzing current downstream channel and habitat conditions, and developing and testing hypotheses regarding flow requirements for various geomorphic and ecological functions. For example, many important geomorphic functions occur only above certain threshold flows. These minimum flows are required to initiate geomorphic processes such as bed mobility for habitat quality, overbank flooding for floodplain inundation, and bank erosion for channel migration. Similarly, flow is closely tied to biological and ecological function, such as adult fish passage past flow-related barriers; spawning and rearing habitat availability (areal extent) and quality (depth and velocity parameters); fish migration cues; recruitment of riparian vegetation and concentrations of contaminants and the resultant exposure of fish and wildlife.

Research, monitoring, and implementation projects designed to develop a better understanding of geomorphic flow thresholds and hydrologic-biologic relationships will facilitate estimating environmental flow needs, so that environmental dedications of water are effective and efficient in achieving restoration objectives, thereby minimizing potential effects on water supply and hydropower generation.

Opportunities to acquire instream flows also exist in areas where instream flows can be exchanged for groundwater pumping. These types of projects should investigate groundwater effects as well as conjunctive use opportunities that generate cumulative and collateral benefits perhaps through non-consumptive use where appropriate. These actions may prove synergistic with the CALFED Watershed Program, Environmental Water Program and Environmental Water Account in addition to contributing to meeting the goals of CVPIA Water Acquisition Program and AFRP.

Flow Evaluation and Simulation Modeling. Projects and studies to evaluate the potential for restoring natural flow regimes and biological processes should be designed to develop a better understanding of geomorphic flow thresholds and hydrologic-biologic relationships to facilitate estimating environmental flow needs, so that environmental dedications of water are effective and efficient in achieving restoration objectives. Actions could include historical and geomorphic analysis to bracket threshold flows on regulated streams or simulation modeling to evaluate and refine hypotheses about threshold flows and resultant habitats; monitoring to evaluate bed conditions and food web structure; and evaluation of opportunities for managed flow releases on regulated streams.

Developing a better understanding of the biological responses to variable flows is another important step in defining an ecologically optimal flow regime on regulated streams and in the overall Bay-Delta ecosystem. Opportunities to augment instream flow by use of groundwater pumping and conjunctive use, on unregulated streams should be pursued in partnership with land owners. Actions could include evaluating flows to eliminate flow-related barriers to fish migration, increasing habitat availability and quality for various life stages of fish, decreasing concentrations of contaminants and exposure to fish and wildlife; evaluating flow-temperature relationships under a variety of conditions; and understanding how non-native and native species respond to flows. Process and mechanistic studies for better understanding how flow regimes exert their ecological influences are also critical.

Flows are an issue in both the rivers and the Delta. Habitat restoration, levee configuration, and conveyance changes will all affect how water moves in the Delta. Understanding hydrodynamics in and through the Delta is also critical for constituents like sediment and pollutants that might be transported and or might affect restoration of shallow water habitat. Better tools and strategies for understanding hydrodynamics and transport in the Delta are needed.

Environmental Water Acquisitions. The Environmental Water Program is being formulated by a team of CALFED staff and stakeholder and public input through a series of workshops. This team is working on program development and implementation on three parallel tracks: (1) developing a policy framework to guide implementation; (2) developing a plan for coordination between the EWP and other related programs; and (3) selecting and implementing pilot projects. The effort should identify the reaches with the most critical needs during different year types and how to satisfy those needs based on available resources and kinds of water (base flow vs. peak flow). The selection of pilot projects will be coordinated with the CALFED Science Program to ensure that each project is designed to demonstrate one or more scientifically valid hypotheses.

Pilot projects are intended to serve several purposes. Developing the framework for implementation and completing appropriate environmental documentation for implementing the full program is expected to take 2 to 3 years. The pilot projects will allow the CALFED Program to acquire small amounts of water for environmental purposes in the near term while also providing important information that will help guide EWP development. The information sought includes the effects of increasing instream flows on fisheries and ecosystem processes, and the institutional problems that may be encountered in acquiring water.

Pilot projects will be selected based on several factors including pilot watershed projects being undertaken by the CALFED Watershed Program; the availability of willing sellers; the ability to establish and test scientifically valid and testable hypotheses; and the potential to gain knowledge about the institutional feasibility of acquisitions. An evaluation of previous water acquisition strategies and biological and ecological benefits would be instructive.

X2 Relationships: Current management of the Bay-Delta system for environmental purposes is based largely on a salinity standard, the "X2" standard. This standard is based on empirical relationships between various species of fish and invertebrates and X2 (or freshwater flow in the estuary). Positive relationships with flow (negative with X2) have been observed for several estuarine-dependent species as well as some anadromous species during their migration through the Delta. As with all empirical relationships, these are not very useful for predicting ecosystem responses to various alterations in the Delta, including those caused by conveyance facilities. This uncertainty demonstrates a lack of predictive capability for determining how the ecosystem might respond to changes in its flow regime. Predictive tools for evaluating ecosystem responses are needed to support critical decisions about future restoration actions.

Decline in Productivity: Many complex processes are involved in determining food web composition and productivity. Food web composition in restored environments is not fully understood, even in the Bay-Delta. Therefore, understanding the mechanisms of food webs, their source of variability and ultimate productivity, will be key to successfully restoring native food webs in the Bay-Delta.

Productivity at the base of the food web has declined throughout the Delta and northern San Francisco Bay. Some, though not all, of this decline can be attributed to the introduced clam *Potamocorbula amurensis*, or Asian clam. The decline at the base of the food web has been accompanied by declines in several species of higher trophic groups, including mysids and longfin smelt. The long-term implications seem to be a reduction in system capacity to support higher trophic levels. Unless creative solutions can be found to increase food web productivity, there may be a limit to the extent fish populations in the Bay-Delta can be restored.

It is unclear how actions in the watershed influence estuarine food web productivity by affecting the carbon and nutrient loads delivered to the estuary through bypasses and rivers. More frequent inundation of floodplains and bypasses may stimulate estuarine and riverine productivity by supplying larger loads of carbon and nutrients to the estuary. Restoration of tidal marsh and shallow water habitat may also contribute to increasing estuarine productivity and rehabilitating estuarine aquatic food web processes. Still, a better understanding is needed of the relative importance of riverine inputs in stimulating estuarine and food web productivity in the tributaries as well as evaluations of how these inputs may act as limiting factors for different species.

Channel Dynamics and Sediment Transport: Rivers are naturally dynamic. They carry not only water, but sediment and organic material from the watershed. Alluvial river channels migrate across their valley floors as flows erode banks and deposit sediment on point bars; they occupy different channel alignments through channel avulsion; they periodically inundate floodplains; they recruit and transport sediment; and they drive the establishment and succession of diverse riparian plant communities. These physical processes provide the energy and material necessary to create and maintain healthy and diverse riverine habitats that support native populations of plants, fish, and wildlife. There is a growing recognition that the preservation of existing habitat, and the physical creation of new habitat, must be accompanied by the restoration of physical processes, not only because they help create and maintain these habitats, but also because they are fundamental determinants of habitat conditions in themselves. Restoring ecological processes as a means of restoring habitat conditions is a signature feature of an ecosystem-based management approach.

Human activities have generally reduced the dynamic processes of Central Valley tributaries, with a resultant loss of riverine habitat. Dams have reduced the peak flows essential for shaping and re-shaping channel forms and for connecting river channels with their floodplains. Dams also trap sediment and woody debris from upstream reaches, depriving downstream reaches of the fundamental building blocks for habitat. The blocking of the natural sediment supplies by dams coupled with the gradual washing out of post-gold mining sediments from the system may be causing multiple problems.

Opportunities exist to not only "restore" meander, but to also maintain or protect functioning systems, such as on the upper reaches of the Sacramento River. The main target for management is the meanderbelt or area nearest to the main river channel. This meanderbelt will consist of a channel and a corridor of floodplain forest, but may not contain the whole width of the floodplain. The potential purchase of floodplain lands or easements should describe the restoration potential that such lands provide. This includes: contiguity with other floodplain land dedicated or available for restoring ecological processes, frequency of inundation within the regulated flow regime for the existing or a proposed floodplain elevation, the potential width of riparian corridor that can be restored; potential habitat available for specific life stages of identified species; and potential ecological tradeoffs, such as potential for fish stranding or loss of existing habitat.

The CALFED Science Conference Summary noted that there is emerging recognition of the role of natural geomorphic processes of floodplains in supporting a variety of sensitive fish species and supporting food webs. The scale and balance of flow inputs, sediment, organic material and channel modifications that will restore riverine ecosystem function is generally unknown. Nor is it known how channels and habitats downstream of dams have adjusted to the post-dam flow regime and how, therefore, the re-invigoration of dynamic riverine processes will affect overall habitat. Restoring geomorphic processes so as to optimize ecosystem benefits will be a matter of both analysis and experimentation. In addition, mechanistic and process knowledge must come from workshops on the physics, chemistry and ecology of floodplains.

Strategic Goal 4: Habitats: Protect and/or restore functional habitat types in the Bay-Delta estuary and its watershed for ecological and public values such as supporting species and biotic communities, ecological processes, recreation, scientific research and aesthetics.

Habitats, physical and ecological processes, and species health, distribution and abundance are interdependent. Several of the Stage 1 information needs for habitats encompass: (1) additional information for restoring riparian habitats; (2) better understanding of floodplains and bypasses as components in restoring habitats, physical processes, and species; (3) the utility and success of restoring shallow water and tidal and marsh habitat; (4) integrating uplands and wildlife-friendly agriculture into regional restoration strategies; and (5) identifying fish passage needs and opportunities.

Strategic Goal 4. Habitats

- Riparian habitat
- Floodplains and bypasses as ecosystem tools
- Shallow water, tidal and marsh habitat
- Uplands and wildlife-friendly agriculture
- Fish passage

Riparian Habitat: Priority actions should focus on restoring and protecting natural riparian habitats to support recovery of at-risk species, enhancing and/or maintaining native biotic communities, and rehabilitating stream corridor ecological processes. In general, the success of riparian restoration projects is often variable, usually because the mechanisms that help dictate success are not understood. Plans for restoration projects can be designed to deliberately vary treatments, such as differing layering of silt, sand, and gravel to provide a range of substrate conditions, different planting patterns, and differing distances of planting from the channel. Monitoring water table elevations, root growth patterns and rates, and riparian establishment success could provide insights into the role of soil texture in root growth, riparian planting success, and ability of riparian plants to resist flood scour. The opportunities are especially important in floodplain reconstruction projects, where grain sizes can be deliberately varied to provide a range of conditions for observation, and water tables can be observed over time. In addition to direct experiments, explicit quantitative mechanistic and process studies are needed to understand how these actions affect environmental processes, ecosystem processes, and life histories of critical species. Studies that compare such effects among restoration strategies are critical for future prioritization of CALFED Program activities.

Floodplains and Bypasses as Ecosystem Tools: River-floodplain interaction is a vital component of riverine health. When inundated, floodplains provide valuable habitat for a multitude of species. They can also supply sediment, nutrients, and large woody debris to river channels, and provide a place for fine sediment deposition, which is an important function in light of flushing flows designed to cleanse spawning gravels. Inundation of floodplains also contributes to diverse structure of riparian vegetation. Human activities have aggressively and deliberately isolated floodplains from river channels, most clearly through levees designed to confine flows in channels. Dams have also contributed to floodplain isolation by reducing peak flows necessary to inundate floodplains.

Large floods in the Mississippi River Valley and Central Valley the last 10 years have nurtured a growing recognition that floods can never be eliminated, and exposed weaknesses in a purely structural approach to flood management. Levees can pulse floodwaters downstream more quickly, essentially transporting flood burden and risk downstream. Levees can also restrict flood flows, and thereby transport risks upstream. These large floods have also demonstrated the vital flood storage function of floodplains. For example, an analysis of hydrologic data for some Central Valley tributaries during the 1997 floods indicates rising flows beginning to plateau as upstream levees were breached. The plateau effect demonstrates the ability of the floodplain to absorb part of the discharge, thereby attenuating the peak flow and relieving some flood pressure on downstream reaches. Such lessons have spurred an interest in integrating floodplains as a component of flood management. The Army Corps of Engineers, DWR, and the State Reclamation Board are engaged in a Comprehensive Study of the Sacramento and San Joaquin river systems to examine opportunities for improving flood management while simultaneously improving ecological benefits.

The Yolo and Sutter Bypasses along the Sacramento River were designed to reduce flooding in urban areas. They are also important areas for farming. The realization of their relatively low-cost benefits to flood control is leading to the consideration of additional bypasses, especially in the San Joaquin Valley. Bypasses also can be important habitat for waterfowl, for fish spawning and rearing, and possibly as sources of food and nutrients for estuarine food webs. For example, when the Yolo Bypass is flooded, it effectively doubles the wetted surface area of the Delta, mostly in shallow-water habitat. Managing the bypasses for the benefit of fish and wildlife, however, may conflict with their use for flood control and farming. Therefore, projects should evaluate existing bypasses as habitat to reduce management conflicts. New or expanded bypasses and managed floodbasins should also be designed with the needs of fish and wildlife in mind.

Shallow Water, Tidal and Marsh Habitat: Both tidal and freshwater wetlands (marsh habitats) represent critical areas for many at-risk species, and species that have commercial or recreational value. The assumption that underlies ERP wetland restoration goals is that rehabilitating the appropriate physical-chemical habitat in priority locations also will provide for the recovery of sustainable populations of at risk species. The loss of these marsh habitats is assumed to be causally linked to declines in the at-risk species. These causal links have not been well established and habitat manipulations, designed as careful experiments on differing spatial and temporal scales, hold promise for determining the relationships that can help guide restoration efforts. However, a major concern remains that the restored habitat will be successfully colonized by non-native rather than native species.

Additional life history information is needed for key native or non-native wetland species relative to inundation and salinity in tidal wetlands. Identifying wetland attributes that benefit target species will also facilitate increased success of restoration efforts. Projects should include evaluation of spatial characteristics (size, shape, and connectivity) of wetland for their effect on the population dynamics of selected freshwater or tidal wetland species, especially their colonization or extinction rates. Projects should make multi-year observations of arrays of habitats that differ in size, shape, and connectivity or create such an array of habitats by planting and/or removing selected habitat patches.

Priority actions will focus on restoring and protecting natural wetland and aquatic habitats to support recovery of priority at-risk estuarine dependent species and rehabilitation of estuarine ecological processes in the Delta (including lower Yolo Bypass), Suisun Bay and Marsh, and San Pablo Bay and the tidal reaches of its tributaries. Focal habitats are tidal saline marsh, tidal freshwater marsh, shallow open water aquatic (tidal and nontidal perennial), Delta sloughs, Delta midchannel islands and associated littoral habitat, nontidal freshwater marsh, and seasonal wetlands. Habitat restoration actions contributing to the recovery of at-risk species (Attachment 1) are high priority. Pilot projects that increase estuarine productivity and rehabilitate estuarine food web processes, improve estuarine hydrodynamics, and improve and maintain estuarine ecological water quality are high priority. Full-scale implementation for areas with previously successful pilot projects as well as actions that develop, test, and evaluate estuarine wetland and aquatic habitat restoration techniques are also high priority. Also important is identifying regional support through ongoing regional or watershed planning processes and a geographic connection (i.e., habitat corridors) to other ongoing restoration efforts.

ERP restoration actions depending on their location, can have differing outcomes and unwanted affects. Consequently, understanding the processes that drive restoration outcomes and resulting food webs should be an important part of on-going restoration studies. For example, a basic question about restoration of tidal wetlands is how it will impact estuarine productivity both within wetlands, in adjacent channels, and in the ecosystem as a whole. The effects of different types or levels of productivity on drinking water quality is also poorly known. Organic carbon is simultaneously an important food web source and a drinking water contaminant. Studies that elucidate the tradeoffs between these two CALFED Program goals are needed.

Studies of hydrology, hydrodynamics, environmental water quality, ecosystem characteristics, endangered species habitat, ecology, food webs, and other ecosystem processes are needed in the Suisun Marsh. These studies are to resolve concerns have been raised that if in-Delta conveyance modifications allow increased pumping from the Delta, then Suisun Marsh may become more brackish, with corresponding effects on plant communities, fauna and beneficial uses. However inadequate knowledge exists of both the effects of the conveyance changes and the existing or future environment of Suisun Marsh.

Tidal wetland restoration work in the Delta, Suisun Marsh, and North San Francisco Bay may contribute to increases in native fish abundance and health, especially for some at-risk species such as juvenile salmonids, splittail, and possibly delta smelt. However, there are concerns that restored tidal wetlands will become dominated by both non-native plants and non-native fish which may not benefit the native fish and at-risk species and may actually result in a net loss of these species. Targeted research is needed to identify ecological attributes and anthropogenic factors that can be used to assess the likelihood of success of proposed habitat restoration actions. Understanding of environmental processes that lead to specific restoration outcomes is also needed.

Uplands and Wildlife-Friendly Agriculture: Lands beyond the riparian zone can provide multiple benefits. Drainage, construction of levees and dikes, tillage, and other disturbances of these streamsides and valley bottoms have reduced or eliminated special habitats that supported the salt marsh harvest mouse, giant garter snake, Lange's metalmark butterfly, valley elderberry longhorn beetle, and other species. Nevertheless, these lands can still support many native species at risk or in decline. Habitats beyond the riparian corridor that harbor species of concern include perennial grasslands, inland dune communities, and seasonal wetlands, such as vernal pools and flooded fields. In addition, farmlands in these areas can be managed to benefit many native wildlife species, including waterfowl, game birds, Swainson's hawks, greater sandhill cranes, California tiger salamanders and western pond turtles. Better management of these areas can also expand functional floodplains, allowing streams to meander and flood more naturally.

A better understanding of how areas adjacent to riparian zones and how particular agricultural lands influence ecological health is needed. Too little is known about how most species respond to common disturbances in riparian areas, including cropping, grazing, land development, and invasion of non-native species. Additionally, information is needed to better understand the wildlife benefits of existing agricultural lands and agricultural practices. Important questions remain about how agricultural practices can be enhanced or modified to improve ecological conditions and species' health. Pilot projects are needed to evaluate alternative pest management and fertilizer practices, cropping patterns, the use of no-till agriculture or winter flooding, the establishment of buffer zones around cropped areas, and the marketing of products from wildlife-friendly farms. These projects could yield information about how to best implement these practices on a large scale and the benefits associated with them.

Preventing urban development of farms and other open spaces that adjoin habitat areas or that have potential for future ecosystem restoration is another priority. These areas would benefit from conservation or agricultural easements that can preserve current land uses.

The risk that ecosystem restoration projects might impair nearby farmland or other private property or harm the economy of rural communities can worry landowners and others. Farmers, others from the agricultural community, and local leaders should be partners in investigating these issues to develop a collaborative program that is friendly to both agriculture and wildlife.

Natural and Managed Seasonal and Permanent Wetlands: Protecting and restoring lands that supports a mix of seasonal and permanent wetlands and associated uplands is a priority. The highest priority are projects that benefit at-risk species. Actions should help connect aquatic, wetland and riparian habitats, recover and restore native species and biotic communities, and rehabilitate ecological processes in the Central Valley and Bay-Delta. Protecting emergent nontidal freshwater wetlands, seasonal wetlands, including vernal pools, and perennial grasslands is especially important. Actions to protect and restore vernal pool habitats should focus on the vernal pool complex north and east of Suisun Marsh.

Another priority is investigating how conversions of diked wetlands and salt ponds to tidal wetlands will affect waterfowl distribution and abundance. Some species of wildlife, waterfowl and shorebirds may be harmed when diked wetlands and salt ponds are converted to tidal wetlands. But waterfowl benefit from wetland restoration in other parts of the Bay-Delta ecosystem, including CALFED-supported projects in the Delta, and the adoption of wildlife-friendly agricultural practices. Cumulative effects of these activities on waterfowl and other wildlife across the landscape are unclear. Will waterfowl relocate? Will the mix of species change? How will this affect the area's duck hunting? More analysis of these issues is needed.

Inland Dune Scrub Habitat: Locating potential new restoration sites near the Antioch Dunes is a priority. Restoring degraded inland dune scrub habitats there to support Antioch Dunes evening primrose, Contra Costa wallflower, and Lange's metalmark butterfly is also important.

Wildlife-Friendly Agriculture: Managing agricultural lands to improve habitat values for special-status wildlife and other native species that depend on the Bay-Delta is important. Short-term objectives are to identify and acquire conservation easements on agricultural lands that affect nearby wetlands, riparian areas, or aquatic habitats or that are important habitats for special-status wildlife, waterfowl, or other birds. Longer-term objectives include preventing environmentally damaging urban development of farmland adjacent to natural areas or restored habitats and encouraging farming practices that favor wildlife and reduce the runoff of pollution to nearby waterways.

Fish Passage: Fisheries declines are associated with a wide variety of factors, including habitat destruction, alteration of instream flows, and natural or constructed barriers to upstream migration. In many cases, high quality aquatic habitat exists upstream of diversions on tributaries of the Sacramento and San Joaquin Rivers. Diversions and dams block fish passage and can adversely affect migration. In addition to removal of dams, other alternatives, such as consolidation of existing structures, can reduce the number of fish passage facilities and may provide more ecological benefits than retaining all structures with traditional fish ladder and screening solutions. Fish passage may include riffle modification and the augmentation of base flows (i.e., providing pulse flows at discrete times of adult migration).

A Fish Passage Improvement Program began in December 1999 as part of a coordinated CALFED Program called the Integrated Storage Investigations. Under DWR, this program will help the CALFED Program reach the goal of increasing the anadromous salmonids population in the Bay-Delta and its tributaries. The mission of the program is to improve migration passage and access to historic spawning and rearing habitat. This is a critical step towards improving riverine habitat conditions and ultimately increasing native fish populations. The Fish Passage Program will work with the ERP to evaluate the potential to modify or remove structures that impede migration to or from spawning and rearing areas within the historical range of anadromous fish species.

Strategic Goal 5: Non-native Invasive Species. Prevent the establishment of additional non-native species and reduce the negative biological and economic impacts of established non-native species in the Bay-Delta estuary and its watershed.

Non-native invasive species have had and continue to have a significant effect throughout the Bay-Delta ecosystem. Exactly how they affect Bay-Delta ecology, such as food web productivity, hydrological processes, and populations of native species is poorly understood. It is also unclear to what extent non-native species can be eradicated or controlled effectively and to what extent non-native species may preclude achieving restoration objectives. To minimize the risk of potentially massive ecological and biological disruptions associated with non-native species that could threaten to negate the benefits of restoration efforts, it is important to initiate an early program that meets the following immediate goals:

Goal 5. Non-native Invasive Species
- Non-native Invasive Species Life History Studies
- Non-native Vegetation Management

- Prevent new introductions and establishment of non-native invasive species into the ecosystems of the Bay-Delta, the Sacramento/San Joaquin rivers and their watersheds.
- Limit the spread or, when possible and appropriate, eliminate populations of non-native invasive species through management.
- Reduce the harmful ecological, economic, social, and public health impacts resulting from infestations of non-native invasive species through appropriate mitigation.
- Increase our understanding of the invasion process and the role of established non-native invasive species in ecosystems in the CALFED Program region through research and monitoring.

The CALFED Program established the Non-Native Invasive Species (NIS) program in 1998 and has funded a number of non-native invasive species projects which begin to address some of the numerous non-native invasive species issues. Projects have been funded largely to increase understanding of non-native invasive species such as Chinese mitten crab, introduced clams and effects of nonnative invasive species on estuarine systems. Projects also have been funded to better understand ballast water composition, to prevent introductions using outreach and education programs and to manage infestations of invasive plants species. Additionally, projects have been funded which focus on control and eradication of *Arundo donax*, nonnative *Spartina spp*., and purple loosestrife (*Lythrum salicaria*). These projects have all been large, cooperative efforts that included elements of outreach and education. Additionally, ERP has supported non-native invasive species outreach and education projects which have focused on addressing some of the pathways by which new introductions continue to arrive - such as pet releases or escapes, the escape of ornamental aquatic and terrestrial plants and ballast water dumping. This range of projects typifies the broad scope of the non-native invasive species problem and the various activities that will be necessary to implement an effective strategy to deal with the issues.

The above goals will not be reached unless there is an increase in the understanding of the invasion process and the role of established non-native invasive species in ecosystems in the CALFED Program region through research and monitoring. Life histories of key non-native species need to be better understood, especially differences between their life histories and environmental requirements relative to native species. Additionally, a better understanding of the negative impacts these species have on the ecosystem and native species (i.e., disruption of food webs and nutrient cycling, changes in contaminant accumulation/transfer, physical habitat and hydrological modifications and competition and/or predation pressures) is needed. Options are needed for reducing the negative impacts (i.e., appropriate eradication/control options, promoting colonization of natives over non-natives in restoration projects through informed management and monitoring activities).

Strategic Goal 6: Sediment and Water Quality: Improve and/or maintain water and sediment quality conditions that fully support healthy and diverse aquatic ecosystems in the Bay-Delta watershed and eliminate, to the extent possible, toxic impacts on organisms in the system, including humans.

The Bay-Delta ecosystem receives a large variety of potential toxicants (Gunther et al. 1987; Davis et al. 1992). These include significant quantities of selenium from agricultural practices, mercury from historical gold mining and refining activities, both new and historic pesticides from a variety of agricultural and home uses, polynuclear aromatic hydrocarbons from automobiles, and other metals from a variety of geochemical cycles accelerated by human activities. Moreover, there is a legacy of persistent chlorinated hydrocarbons whose effects appear to be as potentially as serious as those from any current practices. Synthetic compounds used in medicines, cosmetics, and as biocides are widespread in many aquatic environments and have been linked with effects on reproduction (endocrine disruption) elsewhere. Yet these substances have never been studied in the Bay-Delta. High exposures of aquatic organisms to some of these compounds differ seasonally, but often occurs when important aquatic species reproduce (Adams et al. 1996) and as well as where eggs, larvae and juveniles are the most susceptible stages to contaminants.

Strategic Goal 6. Water and Sediment Quality

- Dissolved Oxygen and Oxygen Depleting Substances
- Mercury
- Pesticides (including Organochlorine Pesticides)
- Selenium
- Other Pollutants
- Pollutant Effects
- Fine Sediment
- Toxicity of Unknown Origin

Many uncertainties remain about contamination, especially in the Delta. It is known that contaminants enter the Delta: selenium from the western San Joaquin Valley, pesticides from both the Sacramento and San Joaquin watersheds, mercury from mines and hydraulic mining debris, copper used as an algicide, PAHs, MTBE and perhaps TBT from heavy boat traffic, and metals from mining. Yet not one of these has been studied systematically or in detail in any Delta environment. Although the last several years have seen great advances in our understanding of the distribution and abundance of contaminants in the estuary (e.g., SFEI 1995), there has not been as much emphasis on defining contaminant exposures in the Sacramento and San Joaquin Rivers and the Delta. Moreover, there is no comprehensive understanding of the risk that contaminants might pose to the health of individuals and populations in the estuary or upstream of the tidal portion of the ecosystem. To improve our understanding, we must determine the degree of contaminant exposure to aquatic organisms, if there is link between exposure and sublethal and chronic toxicity, and then use the exposure-effect relationships to determine the risks to aquatic populations in the catchment of the Bay-Delta.

Contaminants can be directly toxic to reproductive tissues, disrupt endocrine function, or otherwise adversely impact sensitive life stages. Studies have shown that PAH and PCBs affect reproduction of starry flounder, silver and copper caused reproductive failure in resident bivalves, and selenium accumulation has affected bird reproduction. As a result of improvements in advanced waste treatment and source control, metal contamination has receded, and reproduction in the clams has returned to successful levels. Evidence from North Bay also suggests that cadmium and silver might chemically interfere with reproduction in resident fauna. Effects of metals on reproduction of animals are indicated by both studies, but have not been adequately studied. In addition, studies of physiological processes impairment (e.g., growth and reproduction) and establishing if there is a relationship to contaminant exposure in the organisms are needed. This would include further investigation of apparent toxicity of unknown origin in the ecosystem.

Research will be necessary to understand the links between contaminant cycling or effects and wetlands restoration. Does wetland restoration in locations contaminated with mercury-laden sediments or hydraulic mining debris accelerate mercury methylation? Do Delta and Suisun Bay wetlands near sources of selenium input (e.g., influenced by water from the San Joaquin River) trap this element and increase threats to resource species? What pre-restoration studies or methodologies are necessary to be sure that wetlands are not restored in contaminated environments or do not result in exposure or accentuation of historic contamination?

There appears to be a growing selenium problem in the Central Valley that could impede ecosystem restoration. Historical analyses suggest that selenium can be a cause of the disappearance of native fish species and inhibition of their recovery in an aquatic ecosystem (Hamilton 1999). Selenium threatens reproduction in important resource species of the Bay-Delta. The most threatened species include sturgeon, starry flounder, splittail, dungeness crab and some migratory birds. The issues surrounding selenium contamination are changing. There are proposals to dispose of selenium from saline soils of the western San Joaquin Valley directly into the Bay. As a result of changes in water management, selenium-laden San Joaquin River inflows to the Delta and Bay are already increasing or could increase. Selenium concentrations in bivalves are presently higher than they were in the late 1980's, despite reductions in refinery inputs of the element. The cause of the higher bivalve contamination is not fully known. The full implications of future agricultural selenium discharges to the Bay need to be better studied. The processes that will determine the selenium impacts must be better investigated (e.g., transformation of selenium in the forms that occur in agricultural drainage; selenium movement through the food web). The effects of selenium on reproduction in at-risk species need to be better understood. Most important, perhaps, is to better understand selenium fate, effects and transport in and through the Delta as well as the links between the Delta and Suisun Bay.

Additional information is needed about copper, which is used extensively as an herbicide in this system. A few available analyses suggest extensive copper contamination in indicator organisms. Pesticide pulses enter the Delta and superimpose their stress on populations of animals potentially stressed by local herbicide use. The joint effects of this contaminant remain uninvestigated, despite their potential to affect the success of restoration projects.

The sources of water to the Bay, the sinks for particulate material in the Bay and Delta, sedimentation regimes in the Bay, and water movement through the Delta all depend upon flows and management of flows. Important links exist between these processes and contaminants. Transport of selenium through the Delta, movement of copper out of the Delta, deposition of historic mining debris in the Delta, uncovering historically contaminated sediments by extensive erosion in the Bay and creation of contaminant hot spots by modern inputs from the river to the Delta all could affect restoration; but none of these are well known. All depend upon better understanding links of contaminants with water movement and sediment movement into and through the Delta.

Metal contamination from mining operations has been identified in the upper Sacramento River. Concentrations of cadmium are sufficient to raise questions about effects on benthic community diversity and salmonids in this system. Sediment bioassays from several studies and programs have documented that toxicity occurs frequently in Bay-Delta sediments. The causes of the observed toxicity are poorly understood, although the cumulative effects of mixtures of contaminants have been implicated in the Bay (Thompson, et al. 1996). The interactive effects of numerous sediment-associated contaminants require further study, particularly in combination with dissolved pesticides. Similarly, the relationships between sediment toxicity and other natural stressors (e.g., salinity, flow, elevated suspended sediments) need to be studied.

Work is needed to better understand what causes fish mortality, especially in the Central Delta, and general effects of contaminants on the food webs that lead to fish and birds in the Bay-Delta. Suites of biomarker techniques offer the potential to point toward causes of stress in the field, especially when accompanied by high quality chemical studies and studies of population processes. Yet, biomarker studies are a major gap in the existing database for the Bay-Delta rivers.

Environmental Education

Increased public understanding of the resource issues that led to the development of the Ecosystem Restoration Program and CALFED Bay-Delta Program will increase awareness and facilitate creative solutions to environmental problems. Actions should increase public awareness, knowledge, and appreciation of natural resources and ecosystem restoration activities, foster active participation in conservation, restoration and monitoring programs, or encourage individuals to wisely use natural resources. Education programs should focus on resource issues and activities that foster the goals of the Ecosystem Restoration Program. Where possible, education programs should work with existing educational resources and be coordinated with watershed stewardship groups and other local efforts. ERP environmental education programs may include support for programs for all age groups in rural and/or urban areas.

6.0 MULTI-REGIONAL BAY-DELTA PRIORITIES

Multi-region Description

Many of the projects selected for funding through the ERP in previous years encompassed more that one region. Some projects have applicability to all the regions while others were linked to at least two regions. This section covers those broad activities that span the ERP geographic scope (Attachment 5). For example, studies and education programs often have results that have multi-region application. Actions that are specific to a region are covered in the regional sections (Section 7 – 10).

CALFED ERP Expenditures and Highlights

The ERP has funded over 50 projects that have application throughout the Bay-Delta watershed and its tributaries. These projects include a number of water quality studies such as determining the effect of toxins or projects aimed at reducing the use of pesticide; environmental education projects such as traveling film festivals; non-native invasive species projects such as purple loosestrife prevention, detection and control; and fishery assessments on several at-risk species.

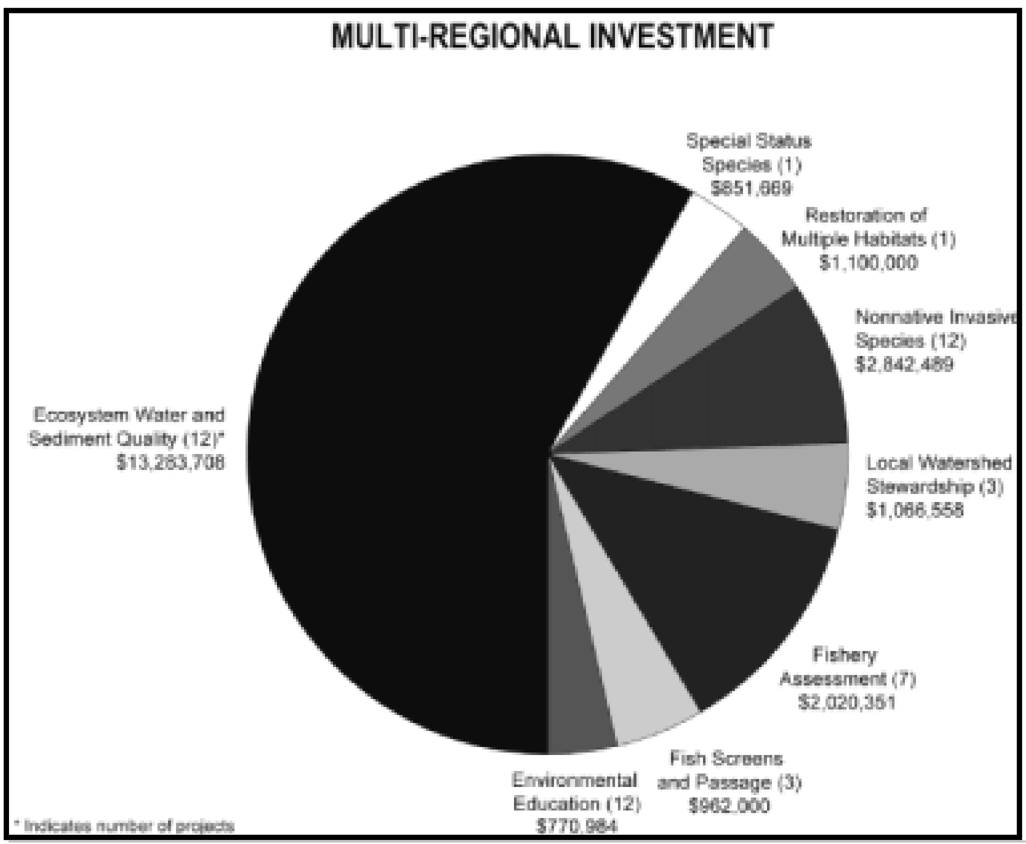

Figure 2. Multi-Region ERP Restoration Investment

Restoration Priorities for Multi-Regional Bay-Delta Areas

1. Prevent the establishment of additional non-native species and reduce the negative biological, economic, and social impacts of established nonnative species in the Bay-Delta estuary and its watersheds.
2. Develop programs for Wildlife-Friendly Agriculture and conduct studies to better understand relationships between farming and wildlife habitat.
3. Implement environmental education actions throughout the geographic scope.
4. Ensure restoration and water management action through all regions can be sustained under future climatic conditions.
5. Ensure that restoration is not threatened by degraded environmental water quality.
6. Ensure recovery of at-risk species by developing conceptual understanding and models of processes that cross multiple regions.

MULTI-REGIONAL PRIORITIES

1.) Prevent the establishment of additional non-native species and reduce the negative biological, economic, and social impacts of established nonnative species in the Bay-Delta estuary and its watersheds.

- *Prevention*. Preventing the introduction of additional non-native invasive species into the Bay-Delta and its watersheds is identified as the top priority in the CALFED Strategic Plan for Managing Nonnative Invasive Species. Of the ten NIS objectives identified in the CALFED ERP Strategic Plan, eight specifically address preventing the introduction of new NIS. The continued introduction of NIS into the natural areas of California causes negative environmental, socioeconomic and public health impacts whose severity is often not widely known or recognized. This lack of understanding and documentation hinders our ability to respond rapidly and effectively to new invasions and limits the vision and the opportunity to prevent new introductions. This leaves California with NIS management problems that are economically costly, technically challenging and frequently irreversible.

  NIS introductions continue to come into California from many sources and pathways. Often seemingly harmless activities, such as releasing non-native fish or imported baits, has the potential to cause large-scale economic and/or ecological damage. Public outreach and education, industry collaboration and evaluating management and policy options must be pursued to the extent possible.

- *NIS control and eradication projects.* Priority actions include efforts to eradicate non-native invasive species from tidal marshes and wetlands of the Bay Region, and from the aquatic habitats and riparian areas throughout the Delta and Eastside Tributaries, Sacramento River and San Joaquin River Regions and their tributaries to benefit native species. Focus should be on the control and eradication of non-native invasive plants such as *Spartina spp*., *Arundo donax, Tamarix spp, Eichornia crassipes* (water hyacinth), *Egeria densa*, *Lepidium latifoium, Salsola sod*a and *Lythrum salicaria*. Once non-native vegetation has been removed information is needed about how to best colonize native species into those areas. Mechanistic understanding of how non-native species function, what determines their success in the Bay-Delta system and appropriate eradication strategies are critical to accomplishing of all eradication goals. It is equally important to assess alternative control strategies and their impacts on native species.

- *Reducing impacts.* For some NIS, there may not be control or eradication strategies readily available that are feasible and/or effective. In such cases, it is essential that the negative impacts resulting from these invasions be understood and opportunities be investigated to reduce the impacts or manipulate the populations in such a way as to still provide the highest benefit possible from ERP restoration actions. For example, *Potamocorbula amurensis* is negatively impacting the food web and accumulating selenium at elevated levels. These are serious concerns when developing and implementing restoration actions. Since it is not known how to reduce *P. amurensis* populations without significant ecological impacts, it is important to continue to investigate and document the situation and use the information obtained to inform attempts to mitigate for the negative impacts with creative and innovative approaches.

- *Non-native invasive species surveys and studies.* Conduct NIS research to provide mechanist understanding of NIS life histories, recruitment dynamics and responses to different restoration actions. Conduct NIS surveys to detect new populations and develop monitoring methodologies to monitor the spread of these species. Study the efficacy of management and control programs for NIS.

- *Initiate a comprehensive system-wide annual survey* to document the species present in the system. This survey is to integrate and cooperate with existing surveys.

- *Support a cost/benefit analysis of eradication* and control techniques for NIS aquatic vegetation that includes expertise in biology, contaminant bioaccumulation and hydrodynamics/hydrology. To be done at both spatial and temporal scales.

- *Supplement the on-going CDFA Hydrilla eradication program* by implementing a project to evaluate the ecological impacts of the program, efficacy of treatments and to monitor water quality impacts.

- *Support enhancement and expansion* of the CDFA/DFG zebra mussel detection program at the California borders to improve detection and treatment of infested vessels.

- *Building on the existing CALFED Purple Loosestrife mapping* and outreach project to further support the development and implementation of loosestrife control and eradication management plans.

- *Work with industry and stakeholders,* build on the current Reducing Invasives Distribution to develop plans and programs to reduce the releases of NIS through aquaria, pet, landscape/aquascape trade.

- *Develop cost/benefit/risk evaluations for biocontrol agents*.

- *Implement NIS detection, monitoring and control programs* to reduce the establishment and spread of NIS in these habitats that may be related to project implementation to improve the value of restoration projects to native fish and wildlife.

- *Investigate the use of multi-species assessment and mapping methods* to develop watershed-level species inventories. These inventories can be used to develop management strategies to maximize control and minimize the risks of reintroduction/reinvasion.

- *Assess NIS biology*, establishment criteria, competitive interactions with natives, and the effects on associated flora and fauna.

- *Develop and evaluate integrated methods of NIS control*, using physical, chemical and biological techniques.

- *Assess success and impacts of control efforts*.

- *Develop coordination and cooperation between federal/state regulators* to facilitate timely environmental compliance evaluations for NIS management efforts.

- *Develop aggressive public information program* to educate the public about the dangers of introducing nonnative organisms into natural areas.

- *Investigate the use of imported baits within the watershed*. Work with industry and stakeholders to develop a plan to reduce the use and release of imported baits.

- *Develop hands-on projects* and a traveling trunk of materials to promote K-12 NIS education.

2.) Develop programs for Wildlife-Friendly Agriculture and conduct studies to better understand relationships between farming and wildlife habitat.

- *Coordinator*. Hire a coordinator for the Wildlife-Friendly Agriculture Program to work with local interests in developing a framework for implementing the program.

- *Work with local interests.* Collaborate with local interests and landowners to develop good neighbor policies to address potential conflicts regarding Wildlife-Friendly Agricultue.

- *Wildlife-friendly agriculture incentive program.* Develop an incentive program for the use of farming methods and crops that are favorable to wildlife including pilot projects.

- *Compare effectiveness of different practices*. Improve knowledge of the relative effectiveness of different wildlife-friendly agricultural practices by systematic comparisons of existing projects or designing multiple projects as systematic adaptive management experiments.

- *Landscape implications.* Conduct studies to better understand waterfowl and wildlife distribution and abundance across the landscape as affected by restoration.

<u>3.) Implement environmental education actions throughout the geographic scope.</u>

- *Education programs*. Develop programs affiliated with conservation, restoration and monitoring efforts including curriculum development and hands-on educational activities for adults and K-12. Programs should emphasize methods to build collaborative networks incorporating student driven decision makers and community building project that actually perform research and restoration.

- *ERP Website Improvement:* Work on ERP website focused on educating the public about the ERP program, priority issues and solutions and ongoing activities. Examples of projects may include a ERP project or Bay-Delta virtual tour.

- *Bay-Delta Tributaries Fact Sheets*. Develop information sheets to be made available on the ERP website and in printed form summarizing restoration project status with links to appropriate watershed groups and regional planning efforts

- *ERP Quarterly Newsletter*. Develop publications to educate and inform the public about ERP sponsored activities including protection, conservation and restoration actions.

<u>4.) Ensure restoration and water management actions through all regions can be sustained under future climatic conditions.</u>

- *Climate and hydrologic variability.* Advances in understanding the implications of climate patterns, trends and variability is critical to sustaining restoration, anticipating outcomes and interpreting results of restoration efforts throughout the watershed. Climate and hydrologic variability also will have immense effects on water management and the intersection of water management and restoration. Areas where immediate needs exist to accomplish this goal include:
  - Developing detailed case studies of conditions during one or more of the epic medieval droughts that occurred in the Bay-Delta watershed. Bringing together a range of paleoclimate indicators to better understand conditions, spatial extent, and persistence of these extreme events is important.
  - Case studies that closely consider the implications on different time scales (or progressive influences) of different intensity shifts toward a greater propensity toward drought or very wet periods, which seems to be the pattern whereby these epic-scale conditions were constructed.
  - Better understanding of the origins and hydrologic implications of decadal scale variability. Studies of origins that might ultimately lead to improved predictability of

climate patterns and/or related hydrologic implications are of special interest. Implications that relate to the buffers built into the existing water management system or the vulnerabilities and dependencies of proposed CALFED actions are also of interest.

- Development and/or application of watershed scale models that relate hydrologic variability to specific issues of concern in ecosystem restoration and water management are needed.

5. Ensure that restoration is not threatened by degraded environmental water quality.

Specific water quality issues are embedded in the restoration priorities for each region, but many aspects of this issue also have multi-region implications.

- *Dissolved Oxygen and Oxygen Depleting Substances*: Low dissolved oxygen concentrations and excessive anthropogenic oxygen depleting substances loads are ecological water quality concerns in certain water bodies and areas. The primary concerns are low dissolved oxygen (DO) conditions and eutrophication in the San Joaquin River around Stockton; generation of oxygen-consuming materials in the San Joaquin; inter-substrate low DO conditions in salmonid spawning and rearing habitat in the Tuolumne, Mokelumne, Cosumnes, Merced, and American Rivers; low DO conditions in Suisun Marsh due to influx of oxygen-depleted water and substances from human sources; and excessive oxygen depleting substances and nutrient discharges from concentrated animal feeding operations. Actions include assessing potential adverse ecological effects of low DO conditions and excessive anthropogenic oxygen depleting substances loads; determining causes and sources of these problems; and developing, testing, implementing, and evaluating management actions to minimize or eliminate adverse effects.

- *Mercury:* Historic mercury and gold mines are continuing sources of degraded water quality. Stage 1 actions include assessment of mercury sources, loadings, factors affecting transformation and bioaccumulation across the watershed. Studies that would characterize these problems and where they overlap with restoration activities are needed. In particular, it is important to understand and compare mercury methylation in restored wetlands and implications for loadings to the Bay and Delta. The Stage 1 actions also include fish consumption studies needed for the development of fish advisories for human health impacts of mercury, and evaluation and implementation of long-term cost-effective methods to remove or reduce mercury or trace metals at their source at inactive and abandoned mine sites. Data on the extent of the threat from specific sources is needed to evaluate the relative importance of different sources to support prioritization of remediation efforts.

- *Pesticides (including Organochlorine Pesticides):* Pesticide residues from agricultural applications and residential use can enter watercourses and cause toxicity to resident organisms, including those upon which other organisms must depend for food. Stage 1 includes actions to reduce impacts of current-use pesticides (including diazinon and chlorpyrifos) through developments and implementation of Best Management Practices, for both urban and agricultural uses. Actions include studies on current and new-use (pyrethroids) pesticides and education and assistance in implementing control strategies for pesticide users. Studies that increase knowledge of occurrence, status, trends, and processes that determine exposure and effects of pesticides are critical to achieving the actions. Sources, effects and trends must be better understood to best implement such actions, or decide where actions are appropriate. Sediment control can reduce inputs and will also protect topsoil and prevent costly maintenance of drainage systems.

- *Selenium:* The two major sources of selenium within the watershed are agricultural drainage water from the West Side of the San Joaquin Valley and refineries within the Bay-Delta. Both industries have taken strides to reduce selenium loads. Still, selenium concentrations in bivalves have reportedly increased since the 1980's. Stage 1 actions include studies to determine the fate and transformation of selenium within the food web or causes of selenium impacts and trends within the San Joaquin River basin, the Delta and the Bay. Identifying impacts and sources of selenium accompanied by development of technologies to reduce selenium inputs, will aid management decisions, and will direct the program towards source control and regulatory actions that will identify appropriate levels of protection.

- *Other Pollutants:* Potential effects of metals on restoration processes in the Delta could stem invasive plant removal (where copper-based pesticides are often used). Metal mining (other than mercury) was also common in watersheds of the Sierra Nevada, and some of those watersheds are undergoing restoration. Such mine wastes can prevent the success of some species. PAH's and components of urban runoff (e.g. some metals) can have important effects on food webs and ecosystem processes. Chemicals such as cosmetics, pharmaceuticals and estrogens can have significant impacts on animal reproduction. Fate and effects of none of these chemicals are adequately known in the system.

- *Pollutant effects***.** Insufficient study of pollutant effects exist anywhere in the watershed. The studies most needed are those that evaluate effects expected within the context of the contaminated environment. For example, work is needed to better understand what causes fish mortality in the Central Delta; or if ecosystem processes or populations of species of concern, in areas undergoing restoration, are affected by pollutants. The Science Conference Summary noted the need for understanding contaminant effects, in an ecological/hydrologic context, as a large gap in knowledge about threats to restoration. General implications of contaminants for food webs is a special need. Linkages between contaminant exposure and physiological processes, reproduction and biomarker (biochemical) responses are needed for all pollutants.

- *Fine Sediment (Sedimentation):* Fine sediment loads from human activities can and have degraded stream and river habitat in the Sacramento River, San Joaquin River, and San Pablo Bay watersheds. Implementation priorities are to assess potential adverse ecological effects of anthropogenic fine sediment loads in selected streams; then, where appropriate, determine anthropogenic sources and magnitudes of loads; and, develop, test, implement, and evaluate management actions to reduce fine sediment loads from human activities. The Tuolumne, Merced, Stanislaus, Cosumnes, Napa, and Petaluma Rivers, and Sonoma Creek are the focal streams for Stage 1 actions addressing this issue.

- *Toxicity of Unknown Origin:* Toxicity tests conducted on water and sediment samples from the Sacramento and San Joaquin Rivers and the Delta show significant toxicity to test species. In many cases the toxicity has not been linked to specific chemicals and source control actions cannot be proposed until a toxicant is identified. Stage 1 actions include studies to demonstrate the link between contaminants and impacts to aquatic ecosystems, including the evaluation of aquatic toxicity. Identifying the toxic substances responsible for toxic effects is the first step towards correction of the problem. Understanding of these toxicity observations within the context of local hydrology and ecology, and understanding their implications for populations is critical.

6. Ensure recovery of at-risk species by developing conceptual understanding and models that cross multiple regions.

Many at-risk species have life histories that involve habitat use and migration across multiple regions. Knowledge of the integrated life history demands of these species is essential to successful restoration. Actions in a single region may be inadequate if bottlenecks to success occur in other regions. For example, salmonid studies and life history conceptual models should be integrated to consider the animals' use of widely varying habitats, from the upper rivers through the Delta, into the oceans and back to the rivers.

- *Salmonids Studies integrated across the system.* Salmonid studies and conceptual models should be integrated to consider the animals' use of widely varying habitats, from the upper rivers through the Delta, into the oceans and back to the rivers. Studies of ocean cycles, harvest implications and trends, interconnections to different Bay habitats and effects on different life stages in the Delta, and movement throughout the whole system, need to be better documented.

- *Knowledge for conceptual models that illustrate linkages within the systems.* A particular need exists to compare conceptual models and develop common restoration performance measures for tributary streams in the Sacramento and San Joaquin river basins. An important initial need is for studies that develop these integrated interdisciplinary knowledge that can be use for these conceptual modes, describing the existing and restored ecosystems in each of these streams.

- *Develop performance measures.* Develop performance measures that can be used to compare restoration progress across tributary streams. An important need is for systematic measures of restoration progress that can be compared across the tributaries of the Sacramento, the San Joaquin and the Delta. Integrated interdisciplinary studies, and conceptual models developed from such studies, are initially needed to describe the existing and restored ecosystems in each of these streams (e.g., models for fish communities, benthic/water column communities, stream usage by key species and groups of species). Studies should include the processes that support the communities and related ecosystem functions in each (e.g., flow, temperature, sediment transport, channel morphology, distribution and quality of in-channel and floodplain habitat, biological interactions, chemical quality and human disturbance and management of these processes). Performance measures could include environmental state variable, explanatory (mechanistic) measures, measures of success within a basin and measures comparable across basins.

7.0 REGIONAL IMPLEMENTATION – SACRAMENTO VALLEY REGION

Sacramento Valley Regional Description

Flowing for more than 300 miles from Lake Shasta to Collinsville in the Delta, where it joins the San Joaquin River, the Sacramento provides about 80 percent of the inflow to the Delta. It is the largest and most important riverine ecosystem in the State of California and is an essential spawning, rearing and migratory pathway for many anadromous fish populations, such as all runs of chinook salmon and steelhead. The river corridor encompasses more than 250,000 acres of natural, agricultural, and urban lands upstream of Sacramento. Various cropland habitats occur on flat and gently rolling terrain adjacent to most of this area. Irrigated crops are mostly rice, grains, alfalfa, and orchard crops. Most of this cropland is irrigated with water diverted from the Sacramento River or its tributaries. Five National Wildlife Refuges (Sacramento, Delevan, Colusa, Sacramento River and Sutter) are either adjacent to or within five miles of the Sacramento River.

Ecological factors having the greatest influence on the anadromous fish in the Sacramento River include streamflow, coarse sediment supply (including gravel for fish spawning and invertebrate production), stream channel dynamics (meander), and riparian and riverine aquatic habitat. Stressors that have affected the health of the anadromous fish populations, include dams, harvest, high water temperatures during salmon spawning and egg incubation, toxins from mine drainage, hatchery stocking, and unscreened or poorly screened diversions.

The Sacramento Region consists of the mainstem of the Sacramento River and its associated tributaries. The southern boundary is the southern end of the Yolo Basin west of the Sacramento River and the southern end of the American River watershed east of the Sacramento River. The following ERP ecological management zones are included in this region: Sacramento River, North Sacramento Valley, Cottonwood Creek, Colusa Basin, Butte Basin, Feather and Sutter Basin, Yolo Basin and American River Basin (Attachment 5). For this Plan, the portion of the Yolo Bypass in the Yolo Basin ecological management zone is not covered in the Sacramento River Valley section of this plan (Section 7.0); rather, it is covered in the Delta and Eastside Tributaries section (Section 9.0) with the rest of the Yolo Bypass.

Each of these ecological management zones has unique characteristics and stressors. Detailed descriptions and visions for each of these zones can be found in Volume II of the Ecosystem Restoration Program Plan.

CALFED ERP Expenditures and Highlights

The CALFED ERP has funded over 120 projects in the Sacramento River Valley Region for more than $130 million dollars (Figure 3). A majority of this money has supported fish screens and passage projects. Most of the major diversions on the mainstem of the Sacramento River have been or are in the process of being screened. In addition, numerous smaller diversions and barriers have been altered (consolidated, screened fish ladder improvements) or removed on the tributaries to improve fish passage in these areas. For example, almost 50 miles of habitat has or will be opened for migrating fish on Battle and Clear Creeks as a result of implementation of these activities.

Restoration along the mainstem Sacramento River and tributaries in collaboration with local groups has also been a focus for this region. The CALFED Program is working closely with the Sacramento River Conservation Area program (SB 1086) to ensure that riparian habitat management on the Sacramento mainstem addresses both the dynamics of riparian ecosystems as well as the realities of local agricultural issues and possible third-party impacts. With support from the CALFED Program and CVPIA, a coordinator supports a non-profit group which has a Board comprised of landowners and public interest appointees from the counties and agencies involved and a Technical Advisory Committee. These groups meet regularly to bring interested parties together and to discuss issues and proposed activities and to identify solutions to problems along the river.

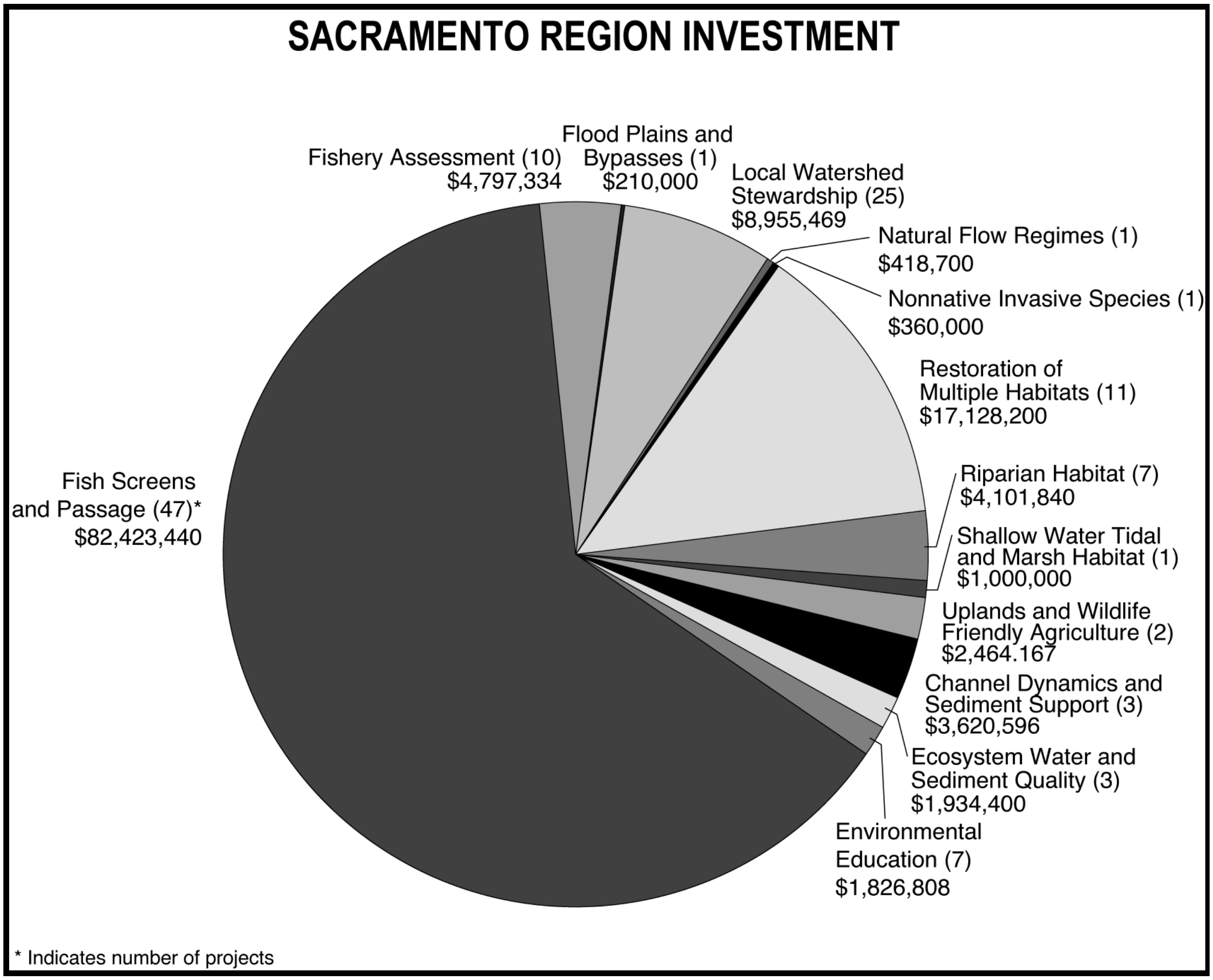

Figure 3. Sacramento Region ERP Restoration Investment

Numerous ongoing activities are occurring in this region, most of which are focused on working in collaboration with local watershed groups. More detail is provided for Butte Creek, Clear Creek and Battle Creek as examples of a few of the watersheds where progress is being made.

***Butte Creek Restoration*:** Butte Creek originates in Lassen National Forest on the western slope of the Sierra Nevada Mountains The creek is a tributary to the Sacramento River through two points: Butte Slough at Sacramento River Mile 139, and the Sutter Bypass and Sacramento Slough at Sacramento River Mile 80. The watershed ranges in elevation from 7,087 feet in the headwaters to approximately 150 feet at the Sacramento River and encompasses approximately 797 square miles (excluding the Sutter Bypass). Average annual unimpaired runoff is approximately 245,000 acre feet, while imports from the Feather River, Sacramento River, and Little Chico Creek exceed 550,000 acre-feet annually. The Butte Slough and Sutter Bypass reaches of Butte Creek serve as flood relief and convey all Sacramento River flows above approximately 25,000 cubic feet per second.

The vision for Butte Creek is to restore spring-run chinook salmon and steelhead populations by improving fish passage, increasing and improving streamflow, consolidating and screening diversions, and protecting and restoring the riparian corridor. These improvements will help to restore and maintain habitats needed to support a large population of spring-run chinook salmon and modest populations of fall-run and late-fall-run chinook salmon and steelhead trout. Screening will allow continued agricultural water diversion for the seasonal flooding of private wetlands and adjacent wildlife refuges. Restoring habitat in Butte Creek would allow the spring-run, fall-run, and late-fall-run chinook salmon and steelhead production to increase.

To achieve this vision, the strategy is to work with local entities directly and in coordination with the Butte Creek Watershed Conservancy and Lower Butte Creek Project stakeholders to plan, implement, and monitor projects.

Improving fish passage, improving instream flows, and developing and implementing a watershed management plan to reduce fine sediment input, protect and restore riparian habitat, and to reduce water temperatures are all identified as draft Stage 1 actions for Butte Creek in Appendix D of the Strategic Plan for Ecosystem Restoration. In addition, improving fish passage through modification or removal of diversion dams on Butte Creek is a commitment made in the ROD.

Prior to restoration efforts, there were nine diversion dams on Butte Creek upstream of the Butte Sink that impaired and delayed passage of migrating fish. Since 1992, five dams have been removed and the four remaining dams have been retrofitted with state-of-the-art fish ladders and screens. In addition to passage improvements, fishing regulations were revised and enforcement efforts increased, flows and flow monitoring were improved, and riparian habitat in areas key to chinook salmon holding, spawning, and rearing were restored and protected. Several evaluation and research projects are in progress or were completed that are guiding restoration project implementation and are providing a basis for assessing restoration project effectiveness.

Within the reach of Butte Creek beginning with the Butte Sink and below are more than 25 additional structures and diversions that impair passage of migrating fish. These are the focus of the Lower Butte Creek Project, which is structured to maximize the participation of local water user, resource agency and natural resource advocacy stakeholders in the process of designing and implementing fish passage and water delivery alternatives. Most of the planning is completed and the project has moved on to implementation. A key result of the ongoing evaluation and planning process was the finding that fish passage through the Butte Sink could not be confined to the main channel of Butte Creek. Frequent overflows from Butte Creek and the Sacramento River during key periods of fish exposure require the management of multiple routes including flows, through the Butte Sink and Sutter Bypass. To date, two key construction projects are completed: fish passage and flow management were improved at the Sanborn Slough Bifurcation and adult salmon and steelhead have been excluded from Drumheller Slough and White Mallard Duck Club outfall. Several additional projects to improve fish passage and flow management remain to be completed and several others require funding.

The primary focus of the completed and planned activities has been the restoration of spring-run chinook salmon. Natural production of spring-run chinook salmon on Butte Creek has increased since restoration efforts were initiated in 1993. For wildlife and fishery population, a cohort replacement rate greater than one indicates an increase in the number of fish surviving to reproduce in relation to the number of fish that produced them. The CDFG reported that the cohort replacement rate for spring-run chinook salmon on Butte Creek has exceeded 2.0 over the last three years, and was 6.5 in 2000 (CDFG 2001). Natural production of spring-run chinook salmon on Butte Creek is exceeding the production target established in the Restoration Plan for the AFRP (USFWS 2001). The ongoing life history study conducted by CDFG (Hill and Webber 1999, Ward and McReynolds 2001) has demonstrated that between November 1995 through April 2001, approximately 504,000 juvenile, primarily spring-run chinook salmon, were captured in the fish trap installed within the bypass of the Parrott-Phelan diversion fish screen. Thus, the average annual loss at the site would have been approximately 84,000 juvenile chinook salmon over the six-year period. Additionally, the life-history study demonstrated that juvenile salmon, primarily spring-run chinook that were captured and marked near Chico, reside and rear in the lower reaches of Butte Creek including the Sutter Bypass. Residence time averaged approximately two months prior to fish exiting into the Sacramento River near Verona. The study also produced a limited evaluation of growth, which suggested that the Butte Sink and Sutter Bypass are significant nursery areas. The limited evaluation showed that growth exceeded that found by other researchers for the mainstem Sacramento River and was equivalent to that for the Delta. Another result of the study was that during years with significant overflow from the Sacramento River, upper river juvenile salmon, including fall, late-fall, winter and spring-run enter and reside in Sutter Bypass reach of Butte Creek. Those nonnatal residents exhibit a similar residence time and growth to that found for natal Butte Creek fish.

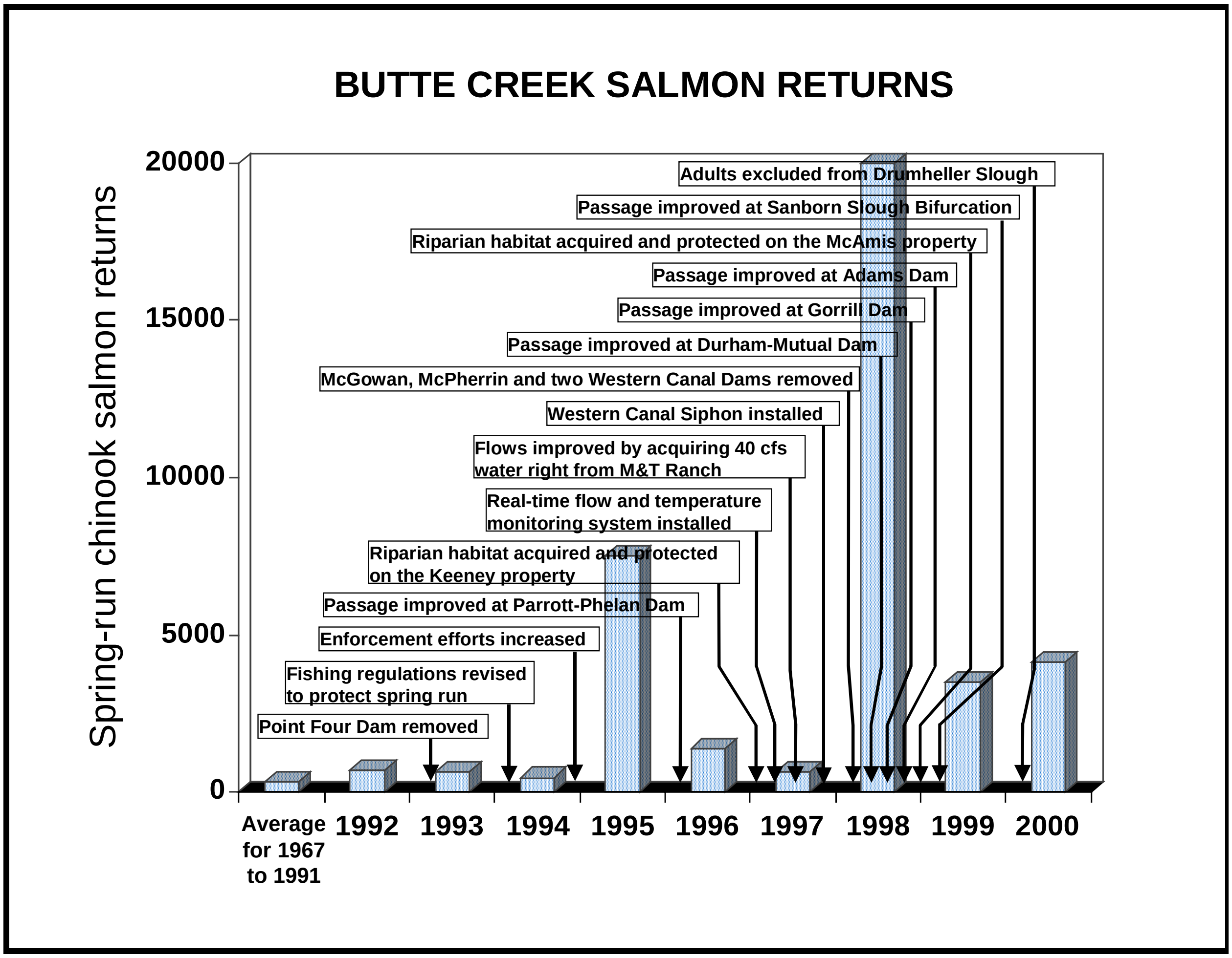

Figure 4. Spring-run chinook salmon returns and restoration actions on Butte Creek. First bar on the graph shows the average returns for 1967 through 1991.

These results suggest that spring-run chinook salmon are responding to restoration efforts on Butte Creek, although other factors such as weather and ocean conditions also play a role. Additional efforts are needed to build on this success by improving the numbers and condition of adult salmon and steelhead returning to Butte Creek as well as the survival and condition of juvenile salmon and steelhead rearing in the creek.

***Clear Creek Restoration*:** Clear Creek is a major tributary to the Sacramento River and drains approximately 238 square miles. It originates in the mountains east of Trinity Lake and flows into the Sacramento River near Redding. Whiskeytown Reservoir stores natural creek flows and water diverted from the Trinity River at Lewiston Dam through the Clear Creek Tunnel. Whiskeytown Dam, constructed in 1963, diverts more than 80 percentof Clear Creek's average natural flow to the Spring Creek Powerhouse at Keswick Reservoir on the Sacramento River.

The vision for Clear Creek to 1) increase water releases from Whiskeytown Dam; 2) allow successful upstream passage of chinook salmon and steelhead to historical habitat; 3) supplement gravel recruitment through the addition of spawning sized gravels; 4) restore sediment transport through proper sizing of stream geomorphology to flow conditions; 5) reduce fine sediment input into the stream from upland erosion; and 6) establish a clearly defined stream meander zone, with healthy functioning riparian and riverine aquatic plant communities.

To achieve this vision, the strategy is to develop an interdisciplinary team that works directly with local entities. The Clear Creek Coordinated Resource Management Planning group comprised of local landowners and stakeholders, and the Clear Creek Technical Team have met since 1995 to plan, implement, and monitor projects using a multi-disciplinary restoration approach to benefits anadromous salmonids and the ecosystems upon which they depend. Many of the projects are implemented by the Western Shasta Resource Conservation District with technical assistance from a dozen Federal, State and local agencies. The restoration groups are adopting an adaptive management approach to improve learning through active experimentation.

Stage 1 actions for Clear Creek include removing McCormick-Saeltzer diversion dam, augmenting the supply of spawning-sized gravel, filling instream and isolating floodplain mining pits, providing scouring flows, refining and implementing a watershed management plan to reduce the transport of fine sediment to the creek, and evaluating the need to augment flows. In addition, implementing large-scale restoration projects on Clear Creek and improving fish passage through removal of McCormick-Saeltzer diversion dam are ROD commitments. Through funding from both CALFED and CVPIA, a number of these actions have been accomplished or are underway.

Increased minimum flows during the winter are largely responsible for the average four-fold increase in fall chinook spawning escapement in Clear Creek over the baseline period. The benefit of increased summer flows for threatened spring chinook and steelhead were demonstrated in rotary screw trap catches and in snorkel counts of adult spawners and their redds. Spawning gravel augmentation has occurred on at least an annual basis at two or more locations since 1996. Spawning gravel introductions have created high density spawning areas in areas once bereft of spawning gravel. Three stream channel improvement projects were completed in 1998, 1999 and 2000. The success of riparian revegetation efforts have greatly exceeded expectations. McCormick-Saeltzer Dam was removed in November 2000 opening six miles of upstream habitat.

The current instream flow prescriptions for the creek, based on 1983 conditions, will be updated in the next few years to include temperature concerns, analysis of barriers to fish passage, recent developments in minimum flow setting methodology and changes in the stream channel that have been ongoing since Whiskeytown Dam was closed in 1963. Other ongoing monitoring and research studies involve juvenile salmonid use of restored habitats, fish stranding, juvenile salmonid out-migration, adult population estimates, redd mapping, neotropical migratory bird populations, riparian vegetation, wetlands, groundwater, stream flows, water temperatures, bedload movement, geomorphology, and spawning gravel quality.

One issue currently being studied is the use of gold mining tailings for restoration projects. This use may liberate mercury which could have negative impacts on the environment and human uses. Extensive gold mining in Clear Creek has produced tailings potentially contaminated with mercury. Two teams of interdisciplinary mercury experts will evaluate the potential risk of using the tailings in future restoration projects. The results of this effort may provide information useful on other tributaries throughout the region.

Battle Creek Restoration: Battle Creek is a tributary to the Sacramento River in northern California about 20 miles southeast of the city of Redding. The creek branches into a north and south fork, and the entire watershed encompasses approximately 360 square miles. PG&E operates a number of small hydroelectric facilities in the watershed. Battle Creek is unique as it may be the only tributary to the Sacramento River that supports four runs of chinook salmon (winter, spring, fall, and late-fall) and steelhead trout. Winter-run and spring-run populations are remnant populations; however, it appears that Battle Creek may play an important role in recovery of these two populations in the Sacramento Central Valley. As a result, the Battle Creek watershed is important to the CALFED ERP and the CVPIA Anadromous Fish Restoration Program (AFRP).

Many of the goals and objectives of both the CALFED ERP and CVPIA AFRP are being addressed by the Memorandum of Understanding (MOU) with PG&E. Implementation of MOU provisions will result in the removal of dams, construction of fish screens and ladders on other diversions, acquisition of in-stream flows to increase habitat for salmonids, and development and implementation of an adaptive management plan.

CALFED, PG&E, and others have substantial investments in implementing the provisions of the MOU. To date, designs and environmental documentation for restoration activities are nearly complete, a draft adaptive management plan for the restoration activities is being reviewed by the CALFED ERP Independent Science Board, and dam removals and ladder constructions are expected to begin in 2002.

The USFWS also manages Coleman National Fish Hatchery (CNFH) as part of mitigation for habitat lost due to construction of Shasta Dam. Fall-run chinook salmon and steelhead are propagated at CNFH and winter-run chinook salmon are reared at the Livingston Stone National Fish Hatchery (LSNFH), a satellite facility of CNFH at the base of Shasta Dam on the Sacramento River.

Compatibility of CNFH operation with Battle Creek watershed restoration is a major concern of stakeholders engaged in planning and implementing restoration activities in the Battle Creek watershed. Members of the Battle Creek Watershed Conservancy (Conservancy) as well participants of the Battle Creek Working Group (BCWG) meet monthly to discuss technical and policy issues relating to restoration in the watershed. Numerous working sessions have addressed upstream watershed concerns, hatchery and natural fish interaction, and other environmental and Endangered Species Act regulatory concerns and assurances. Continued collaboration and partnering with stakeholders is critical to implementing restoration on actions in the Battle Creek watershed.

As a result of stakeholder concern, hatchery management and operations at CNFH are currently being re-evaluated by a contractor to USFWS in order to ascertain options that would be most compatible with on-going and future restoration activities proposed in the Battle Creek

Watershed. Stakeholders meet monthly with agency representatives to discuss to policy and technical matters under the auspices of Battle Creek Work Group. Battle Creek offers an opportunity to employ adaptive management strategies to review impacts of hatcheries on restoration in the watershed.

Science Accomplishments: Fourteen science projects, for about $8 million, have been funded by CALFED in the Sacramento Region since 1997. Most of the projects have to do with developing better understanding of salmonids. This is primarily because of the high interest in these species, the threatened status of some runs and species, and because the region is so rich in opportunities for species restoration. Of the 268 restoration projects funded by the CALFED Program before 2001, 138 were designed to improve conditions for salmonids (Cheslak Sci. Conf. 2000). One important group of accomplishments reported at the CALFED Science Conference was advances in molecular genetic techniques used to type fish and to accurately assign individual chinook salmon by race. The latter technique enabled fish biologists to determine when winter run salmon are being salvaged at the diversion pumps in the Delta (Greene Sci. Conf. 2000). Length-at-age criteria have been used to determine when different runs of salmon enter and leave the lower Sacramento River. Adding genetic testing improves the certainty of actions designed to protect the most threatened runs. Other techniques, like analysis of ear bones (otoliths) can be used to determine where adult salmon have resided.

Explicit conceptual models were also proposed at the Science Conference as a way to aid selection of future restoration efforts and evaluate habitat requirements and specific successes of restoration effort. Population viability models are being developed for salmon and population models for splittail. Although such quantitative models are best used to develop testable questions rather than provide absolute answers, both salmon and splittail models have the potential to help evaluate such important uncertainties as probabilities for extinction under different scenarios. For example, Lindley (Sci. Conf.), using a population viability model, suggested Winter-run salmon had a very high probability of going extinct in the next 100 years under the existing range of conditions. But Kimmerer (Sci. Conf.) emphasized that more information is needed on all salmon related processes, both to guide restoration and to improve the credibility of models. Kimmerer advocated the importance of moving beyond enumerating fish abundance, to studies that were more mechanistic. Species-specific considerations are also important in salmonid restoration. For example, McEwan's (Sci. Conf.) work shows that restoration of steelhead will probably require different strategies than restoration of chinook salmon. Young steelhead have demanding requirements in streams, because they spend one or two years in freshwater, while most juvenile fall-run chinook salmon leave streams within a few weeks to months after hatching.

Studies also show that contamination is an important consideration for restoration in the Sacramento Region. Sixty-five percent of the bass in the Yuba and Bear River watersheds contain enough mercury (from hydraulic mining contamination) to pose a threat to humans who eat them (May, Sci Conf.). Contamination from historic copper mining remains a source of concern in the Upper Sacramento River (Cain, Sci. Conf.), and perhaps elsewhere. Organophosphate pesticides in Sacramento urban creeks were found at toxic concentrations 40% of the time (Russick, Sci. Conf.). Pesticide inputs to streams are determined by a combination of timing of application; timing, amount and location of rainfall; soil type; and hydrologic connection between fields and rivers (Kuivila, Sci. Conf.).

The findings from the CALFED Science Conference and from investments in CALFED science have had (and will continue to have) significant impacts on priorities chosen for study in the Sacramento River watershed.

Table 1. Scientific Projects Funded by the CALFED Program in the Sacramento Region

Year	Project Title	Amount Funded
1998	Genetic Comparison of Stocks Considered for Reestablishing Steelhead in Clear Creek	$45,493
	Spawning Areas of Green Sturgeon in the Upper Sacramento River	$60,801
	Monitoring Adult and Juvenile Spring and Winter Chinook Salmon and Steelhead in Battle Creek	$150,000
	Life History and Stock Composition of Steelhead Trout	$120,000
	Douglas/Long Canyon Paired Watershed Comparison	$83,000
1999	Central Valley Steelhead Genetic Evaluation	$70,636
2001	Influence of Flood Regime, Vegetative Structure and Geomorphic Structures on Restoration of Aquatic System	$2,521,236
	Real Time Flow Monitoring	$418,700
	Rainbow Trout Toxicity Monitoring: Contaminants Effects on Anadromous Fish	$530,000
	Estimate Abundance of Winter Run Chinook Salmon with Comparisons to Adult Escapement	$1,081,638
	Battle Creek Anadromous Salmonid Monitoring	$1,576,152
	Sac. River Winter Salmon Carcass Survey	$305,273
	Clear Creek Juvenile Salmonid Monitoring Project	$871,026
	Chinook Salmon & Steelhead Evaluation in Butte Creek, Big Chico Creek and Sutter Bypass	$280,951
	Total:	**$8,114,906**

Restoration Priorities for the Sacramento Region

1. Develop and implement habitat management and restoration actions in collaboration with local groups such as the Sacramento River Conservation Area Non-Profit Organization.
2. Restore fish habitat and fish passage, particularly for spring-run chinook salmon and steelhead trout and conduct passage studies.
3. Conduct adaptive management experiments in regard to natural and modified flow regimes to promote ecosystem functions or otherwise supports restoration actions.
4. Restore geomorphic processes in stream and riparian corridors.
5. Implement actions to prevent, control and reduce impacts of non-native invasive species in the region.
6. Continue major fish screen projects and conduct studies to improve knowledge of the implications of fish screens for fish populations.
7. Develop conceptual models to support restoration of river, stream and riparian habitat.

RESTORATION PRIORITIES FOR THE SACRAMENTO REGION

1.) Develop and implement habitat management and restoration actions in collaboration with local groups such as the Sacramento River Conservation Area Non-Profit Organization

Collaborative efforts to develop and implement habitat restoration actions are a priority in the Sacramento Region. Protecting and restoring Sacramento River meander processes and adjacent riparian forests constitute a significant collaborative effort between the Sacramento River Conservation Area and CALFED agencies. This conservation area provides habitat for fish passage, rearing and spawning, the stream banks can provide habitat for bank swallows and dense riparian forests can support the yellow-billed cuckoo and other neotropical migratory birds. Other opportunities include fisheries and floodplain interactions in the Sutter Bypass that may affect spring-run chinook, fall-run chinook, steelhead, and splittail.

- *Riparian habitat and channel meander.* Projects for riparian habitat restoration should focus on continued protection and restoration of stream meander corridors between Red Bluff and Colusa along the Sacramento River including continued coordination with the DWR/Corps Comprehensive Study actions. Priority tributaries include riparian habitat restoration on Battle, Clear, Cottonwood, Deer, Mill, Butte, Big Chico Creeks, and the Feather, Yuba, Bear, and American Rivers. Efforts should be designed and sized to provide multiple ecosystem benefits, including habitat for at-risk fish species, insects, reptiles and amphibians, riparian mammals, and migratory songbirds in the riparian zone (Strategic Goal 1 At-Risk Species, Strategic Goal 4, riparian habitat).

- *Sutter Bypass.* Projects are needed to establish a network of channels within the Sutter Bypass that effectively drains the flooded lands and provides connections with the Feather and Sacramento Rivers to allow juvenile anadromous and resident fish to move from rearing and migratory areas. Projects to study interconnections between floodplain habitat characteristics, ecosystem processes, water quality (particularly mercury and pesticides) and ecosystem processes and species populations are needed (Strategic Goal 4, Floodplains and Bypasses).

- *Protect and manage gabbro-soil chaparral habitat:* Protect and manage gabbro-soil chaparral habitat in El Dorado County to benefit federally-listed plant species and other at-risk plant species. (a CVPIA Habitat Restoration Program priority).

- *Evaluate restoration in the Sacramento River corridor.* Establish a program that systematically evaluates restoration performance among the mosaic of projects restoring ecosystems and wildlife on the Sacramento mainstem. The program should include monitoring performance measures and assessments or research that allow understanding of success or limits of different restoration practices.

<u>2.) Restore fish habitat and fish passage particularly for spring-run chinook salmon and steelhead trout and conduct passage studies.</u>

For the past several years, spring-run chinook salmon have been a species that influenced restoration priorities. More recently, steelhead trout have become a priority at-risk species as well. These species and others will benefit from actions to augment in-stream gravel supplies and gravel quality, actions to improve up and downstream fish passage. Although great progress has been made to improve fish passage in the Sacramento Region, additional information is needed to better assess remaining fish passage issues, evaluate and improve existing fish passage facilities, and develop larger scale views of climatic and hydrological patterns that influence fish passage.

- *Replenish spawning gravel.* Projects are needed to replenish spawning gravel and maintain gravel recruitment, especially in the Sacramento and American Rivers, monitor the movement of replenished gravels, and develop and implement techniques to assess fish use of replenished gravel (Strategic Goal 2, channel dynamics and sediment transport).

- *Monitor and reduce fine sediment loads:* Projects are needed to assess potential adverse ecological effects, particularly on salmonids, of anthropogenic fine sediment loads in spring-run chinook salmon streams. Where appropriate, determine anthropogenic sources and magnitudes of loads; as well as develop, test, implement, and evaluate actions to reduce fine sediment loads from human activities (Strategic Goal 2, channel dynamics and sediment transport).

- *Facilities improvements and fish passage programs.* Programs are needed to improve fish passage for salmonids by improving existing facilities or constructing new fish passage and protection facilities, exclusion barriers, repairing weirs, eliminating ponds, and removing physical barriers to upstream and downstream migration. Facilities improvements and fish passage programs are particularly needed in the Sacramento, Feather and Yuba Rivers, in lower Butte Creek and at Iron Canyon in Big Chico Creek and in the Colusa Basin drain and Sutter Bypass (Strategic Goal 4, fish passage).

- *Monitor passage flow.* Projects are needed that support "real-time" flow metering on spring-run chinook salmon streams to improve the ability to identify, manage, and maintain adequate flows (Strategic Goal 2, natural flow regimes).

- *Fish stranding studies.* Studied need to focus on developing programs to reduce or eliminate fish stranding in the active stream channels, floodplains, shallow ponds and borrow areas. Field surveys are needed to assess fish stranding under a range of flow conditions. Protocols are needed for ramping flow reductions to help minimize impacts on fish, wildlife, and associated habitats. (Strategic Goal 4, fish passage).

3.) Conduct adaptive management experiments in regard to natural and modified flow regimes to promote ecosystem functions or otherwise support restoration actions.

Efforts to address natural and modified flow regimes to promote ecosystem functions and favorable biological responses are important in the Sacramento Region. In particular, efforts are needed that augment or improve the scientific basis for flow-related actions and which improve our ability to effectively manipulate and supplement flows.

- *Mechanistic models as restoration tools.* Projects are needed to develop methods, including a combination of simulation models and physical measurements to evaluate flow, sediment transport and other fluvial processes. Develop ecologically-based plans and process understanding to aid restoration of conditions in the rivers, sloughs and floodplains (including bypasses) sufficient to support targets for restoring chinook salmon, steelhead, sturgeon, and splittail (Strategic Goal 2, natural flow regimes).

- *Instream flow programs.* Projects are needed to conduct instream flow studies to improve our understanding of the effects of flows and flow regimes on ecological and physical processes, especially their effects on fish populations in the Sacramento Valley. In particular, develop and test flow recommendations for Central Valley steelhead, spring-run, fall, and late-fall-run chinook salmon passage in the valley sections of Mill and Deer Creek watersheds and on the Yuba and Feather Rivers (Strategic Goal 2, natural flow regimes).

- *Streamflow management plans.* Projects are needed to design and implement ecologically based streamflow and temperature management plans including geomorphic and biological criteria for water acquisitions for Sacramento River Basin tributaries, specifically the Yuba and Bear Rivers, Butte, Big Chico, Deer, Mill, Antelope, Battle, Cottonwood, and Clear Creeks (Strategic Goal 2, natural flow regimes).

- *Effects of managed flow fluctuations.* Projects are needed to evaluate the effects of managed flow fluctuations on ecosystem processes and habitat conditions, especially effects of flow fluctuations on anadromous fish habitat below dams (Strategic Goal 2, natural flow regimes).

- *Environmental water acquisitions.* Programs are needed to: develop ecological and hydrodynamic modeling tools and conceptual models that describe ecological attributes, processes, habitats, and outflow/fish population relationships; develop ecological and biological criteria for water acquisitions; and evaluate previous water acquisition strategies and biological and ecological benefits (Strategic Goal 2, natural flow regimes).

4.) Restore geomorphic processes in stream and riparian corridors.

Physical processes in the Sacramento Region related to fluvial geomorphology and hydrology are extremely important in the restoration effort. This is an area in which we need to enhance the scientific understanding and basis for potential restoration actions. Many elements here are closely related to the natural flow regime topic. Understanding the relationships between fluvial processes and riparian regeneration will improve our immediate and future restoration efforts.

- *Tributary assessments.* Fluvial geomorphic assessments of coarse sediment supply needs and sources are needed to maintain, improve, or supplement gravel recruitment and natural sediment transport processes linked to stream channel maintenance, erosion and deposition, maintenance of fish spawning areas, and the regeneration of riparian vegetation (Strategic Goal 2, channel dynamics and sediment transport).

- *Intensive process and mechanistic studies*. The environmental implications of each of these approaches need to be better understood, in a long-term sense. Studies that compare implications across strategies are especially needed (Strategic Goal 2, channel dynamics and sediment transport).

- *Riparian vegetation research project.* Scientific studies are needed to determine appropriate conditions for the germination and establishment of riparian woody plants along the Sacramento River (Strategic Goal 2, natural flow regimes; Strategic Goal 4, riparian habitat).

- *Natural floodplains and flood processes.* Develop floodplain management plans, including feasibility studies to construct setback levees, to restore and improve opportunities for rivers to inundate their floodplain on a seasonal basis on tributaries within the Sacramento River basin. Study ecological implications of these actions (Strategic Goal 4, floodplains and bypasses as ecosystem tools).

5.) Implement actions to prevent, control and reduce impacts of non-native invasive species in the region.

Invasive species are problematic throughout the Sacramento Region. Actions that improve our knowledge of the distributions of these unwanted species are needed as well as actions to begin control or eradication.

- *Manage Arundo donax* and *Tamarix spp*. in upper Sacramento River tributaries to reduce the negative impacts to these areas and to protect beneficial uses of downstream areas at now at risk of invasion by these plants (Strategic Goal 5, non-native invasive species).

- *Support investigation and evaluation* of the use of natural enemies of some of the widespread non-native invasive species within the CALFED area of concern, such as *Arundo donax* and *Tamarix spp*. Explore the use of these agents in an integrated pest management approach, which also may include physical and chemical methods (Strategic Goal 5, non-native invasive species).

<u>6.) Continue major fish screen projects and conduct studies to improve knowledge of implications of fish screens for fish populations.</u>

CALFED and CVPIA have funded numerous fish screen projects in the Sacramento Valley and have screened most of the large diversions on the Sacramento River. The ERP alone has provided over $80 million for screen and passage projects. CALFED and CVPIA are now focused on completing ongoing projects and maintaining existing investments.

- *Continue and complete ongoing fish screen construction projects* and maintain existing investments currently supported by CALFED and/or CVPIA, including the following (Strategic Goal 1, At-risk species):
  - Screening Coleman National Fish Hatchery's intakes and installing a fish barrier at the Coleman Powerhouse tailrace on Battle Creek;
  - Screening the City of Sacramento's diversions from the American and Sacramento rivers;
  - Screening Sutter Mutual Water Company's diversions from the Sacramento River
  - Consolidating and screening Natomas Mutual Water Company's and other's diversions from the Sacramento River;
  - Screening Pleasant Grove-Verona Water Company's diversions from the Natomas Cross Canal and Sacramento River;
  - Screening Meridian Farms Water Company's diversions from the Sacramento River;
  - Consolidating and screening Reclamation District 108's diversions from the Sacramento River; and
  - Screening Reclamation District 2035's diversion from the Sacramento River.
  - Screening Princeton-Codora-Glenn/Provident Irrigation District diversion from the Sacramento River.
  - Screening Hallwood-Cordura on the Yuba River
  - M&T Ranch/Llano Seco Pumping Plant.

- *Comprehensive studies* of how effectively fish screens protect species are needed to better prioritize allocation of expenditures. Answers to the following basic questions are important to help design a more effective approach to selecting sites for future screen installations (Strategic Goal 1, At-risk species).

- *Cost Benefits:* From a cost/benefit perspective, do *all* diversions have to be screened? Or is there a point at which screening additional diversions no longer provides population-level benefits for the fish of interest?
- *Cumulative Benefits:* Are the cumulative benefits of screening projects known? Do we understand how screening affects fish *populations*, especially those of declining species?
- *Selection Criteria:* Is it more beneficial to screen some diversions than others, based on size, location, and mode of operation?
- *Alternatives to Screening:* Are there alternatives to fish screens for many diversions?
- *Adverse Consequences of Screening:* Are there detrimental effects of screening?

7.) Develop conceptual models to support restoration of river, stream and riparian habitat.

As noted earlier, the Sacramento Region has restoration activities in progress in all ecological management zones. A history of at least some fish monitoring exists in each basin and stream, and CALFED agencies, local agencies and stakeholder groups have reasonable knowledge of what activities are underway within most basins. But conceptual ecosystem models are not well developed for individual watersheds, nor can comparisons be effectively made of restoration success at the regional scale. To develop a regional measures of restoration success, important needs exist for more monitoring, better understanding of historic data, as well as greater knowledge of basic processes, populations and communities, stressors, and ecological implications of restoration actions.

- *Compare conceptual models and develop restoration performance measures for tributary streams and rivers*. An important need exists for systematic knowledge of restoration activities and accomplishments across Battle, Clear, Cottonwood, Deer, Mill, Butte, Big Chico, and Antelope Creeks. An important initial need is to develop integrated interdisciplinary conceptual models describing the existing and restored ecosystems in each of these streams (including fish communities, benthic and water column communities, stream usage by key species and groups of species). These models should include the processes that support the communities and related ecosystem functions in each (e.g., flow, temperature, sediment transport, channel morphology, distribution and quality of in-channel and floodplain habitat, biological interactions, chemical quality and human disturbance and management of these processes). Additionally, conceptual model development of salmonid stressors and their effects is needed on rivers. This has begun on the American River. Comparative conceptual models and ecosystem and process characterization is also needed for the Feather, Yuba and Bear Rivers (Strategic Goal 4, Habitats).

- *Annual population estimates*. Annual estimates of fish populations on the Sacramento River are a key ingredient in management actions to protect fish in the Delta. A strong need exists to understand and reduce the uncertainties in those estimates via more field studies, and data analysis as well as applying advanced field methodologies and modeling capabilities. Models and basic studies that might allow better connection of management actions and specific stressors to population responses of key species of native fish are critical to managing fish protection and water supplies (Strategic Goal 1, At-risk Species Assessments).

- *Understand and compare salmon/steelhead life histories, needs and responses to restoration.* The CALFED Science Conference summary noted that significant differences exist in chinook salmon and steelhead life histories and environmental requirements. Efforts to better understand these differences and their mechanistic causes and implications are needed. Salmonid studies and conceptual models are incomplete if they are limited to tributaries and the main-stem Sacramento. Sacramento watershed models are needed that integrate the animals' life history, migration and use of widely varying habitats, from the upper rivers through the delta, into the ocean and back to the rivers (Strategic Goal 1, At-Risk Species Assessments).

- *Genetic assessments.* On-going development of molecular genetic techniques to type fish (salmonids, splittail,etc.) from the Sacramento Basin are critical to understanding restoration needs, managing water to protect fish and to decisions about the status of fish populations (Strategic Goal 1, At-Risk Species Assessments).

- *Juvenile life history requirements.* There is a generic need to understand juvenile life history requirements of salmonids, splittail and delta smelt in the Sacramento River and tributaries (Strategic Goal 1, At-Risk Species Assessments).

- *Implications of mine wastes for restoration.* One essentially unstudied potential impediment to restoring native communities in the Sacramento Region is the occurrence of mine wastes in areas undergoing restoration. Researchers from the CALFED directed action mercury study found that during certain months the Sacramento River is the predominant source of methylmercury to the Delta. Mercury and other metal mines are common in the Sacramento watershed, and in a few cases contamination at significant levels has been documented. Contaminated sediments can be transported far downstream from these historic activities, and can have both toxicity and environmental justice implications. Transformations of mine wastes products such as mercury can have implications for the delta as well. Contaminated sediments have the potential to stall restoration efforts, or prevent full recovery of sensitive species. Mitigation of such effects can be possible, but prioritization (what to mitigate, where), relative to other needs, requires understanding and comparing the concentrations, distribution, fate and effects of contaminated sediments in and among the tributary rivers and streams of the Sacramento. Further work, particularly in the tributaries, is needed to identify sources of bioavailable mercury (Strategic Goal 6, Water and Sediment Quality).

  Other Stage 1 actions include:
  - Conduct the necessary research to determine to determine no adverse ecological/biological effects threshold concentrations for mercury in sediments and key organisms in the Sacramento River watershed (Strategic Goal 6, mercury).

  - Mercury evaluation and abatement work in the Sacramento River and tributaries is needed to determine and inventory sources of high levels of bioavailable mercury; refine mercury models; participate in remedial activities (Strategic Goal 6, mercury).

  - Mercury evaluation and abatement work in the Cache Creek watershed is needed to support development and implementation of Total Maximum Daily Load (TMDL) for mercury; determine bioaccumulation effects in Cache Creek; source, transport, inventory, mapping and speciation of mercury; participate in Stage 1 remediation (drainage control) of mercury mines as appropriate; determine sources of high levels of bioavailable mercury (Strategic Goal 6, mercury).

- *Pilot projects for mine waste source control.* Proposition 13 provides funds for restoration and source control of mine wastes at abandoned mine sites. New information on treatment, and remediation techniques are needed. Pilot-scale and demonstration projects designed to test such techniques are also needed, as well as studies to evaluate the efficacy of restoration and remediation approaches (Strategic Goal 6, Water and Sediment Quality).

- *Pesticides.* Toxicity testing shows that pesticide toxicity could be an important impediment to survival of some species in the tributaries of the Sacramento. Greater understanding of pesticide occurrence, distribution, and effects under conditions typical of Sacramento stream and river environments is a critical need for addressing this threat (Strategic Goal 6, pesticides).

- *Develop research and pilot/demonstration* projects that test and evaluate restoration and management practices that reduce contaminants and other stressors (fine sediments, pesticides, and nutrients) from agricultural lands (Strategic Goal 6, Water and Sediment Quality).

- *Green Sturgeon.* Green sturgeon are an at-risk species native to the Sacramento River, yet little is known about the habitat needs of this species and its responses to restoration. Evaluating green sturgeon habitat, including barriers, diversions, flows and temperatures, especially on the Feather River, is a high priority (Strategic Goal 1, At-risk Species Assessments).

- *Analyze historic data.* An important need exists for further analysis and publication of existing historic data within basins to identify trends, habitat use and factors affecting trends in salmonids, splittail, and native and non-native fishes. Significant data sets exist for streams like Battle Creek, the Feather River, and Butte Creek. These and other data sets need to be exploited to better understand trends and limiting factors for species key to the region (Strategic Goal 1, At-risk Species Assessments).

8.0 REGIONAL IMPLEMENTATION – SAN JOAQUIN REGION

San Joaquin Regional Description

The San Joaquin River and its tributaries are the second significant contributor to flows of the Bay-Delta system. Much of the natural flows has been diverted and stream flow is discontinuous along the river, with significant sections being dry or extremely low during much of the year. The mid-portion of the river receives significant inputs from the Sacramento River, acting as a conduit for water that is then diverted to Southern California. It is important to rehabilitate the ecological integrity of the San Joaquin River below Friant Dam to improve the health of the Bay-Delta system. Rehabilitating the current system below the mouth of the Friant Dam is particularly important for improving conditions for the anadromous fish that annually migrate into and out of the Stanislaus, Tuolumne, and Merced Rivers and potentially could utilize the upper mainstem.

The 290-mile-long San Joaquin Valley occupies the southern half of the Central Valley and has an average width of 130 miles. The San Joaquin River basin is bounded on the west by the Coast Ranges and on the east by the Sierra Nevada. The San Joaquin River flows west from the Sierra Nevada turns sharply north at the center of the valley floor, and flows north through the valley into the Sacramento-San Joaquin River Delta.

On the arid westside of the basin, relatively small intermittent streams drain the eastern slopes of the Coast Ranges but rarely reach the San Joaquin River. Historically, under more natural conditions, Ingram, Del Puerto, and Orestimba Creeks reached the San Joaquin. Natural runoff from westside sloughs is augmented by contaminated agricultural drainage and spill flows. On the eastside, many streams and three major rivers drain from the west slope of the Sierra Nevada and flow into the San Joaquin River. The major eastside tributaries south of the Delta are the Stanislaus, Tuolumne, and Merced rivers. Secondary streams south of the Merced River include Bear Creek and the Chowchilla and Fresno rivers and the upper San Joaquin River.

The Stanislaus, Tuolumne, and Merced Rivers flow through extensive and biologically valuable grassland and vernal pool complexes in eastern Stanislaus and Merced Counties. Two important National Wildlife Refuges (NWR) are in this zone: Merced NWR and San Joaquin River NWR. In addition to the overall ecological values, the Stanislaus, Tuolumne and Merced Rivers provide habitat for many fish, wildlife, and plant species. They are particularly important as spawning and rearing areas for chinook salmon. Other at-risk species in the San Joaquin Region include riparian brush rabbit, San Joaquin Valley woodrat, neotropical migratory birds, and western yellow-billed cuckoo. Important ecological processes for this area are streamflow, stream meander, floodplain processes, coarse sediment supply including gravel recruitment, transport, and cleansing, and water temperature.

The Stanislaus River is the northernmost major tributary in the San Joaquin River basin. The river flows westward into the Central Valley, draining approximately 1,100 square miles in the Sierra Nevada. The average unimpaired runoff in the basin is about 1.2 million acre-feet (AF).

Significant changes have been made in the hydrological conditions of the basin since agricultural development began in the 1850s. New Melones Dam, completed by the U.S. Army Corps of Engineers (Corps) in 1978 and approved for filling in 1981, is now the largest storage reservoir in the Stanislaus basin, with a gross capacity of 2.4 million AF. The U.S. Bureau of Reclamation (Bureau) operates the project as part of the Federal Central Valley Project (CVP). Downstream of the New Melones Dam, Tulloch Reservoir, with a gross storage capacity of 68,400 af, regulates water releases from the New Melones Dam. Goodwin Dam, downstream, regulates releases from Tulloch Reservoir and diverts water for power and irrigation to South San Joaquin Irrigation District and Oakdale Irrigation District.

The Tuolumne River is the largest tributary in the San Joaquin River basin, with an average annual runoff of 1.95 million AF and a drainage area of approximately 1,900 square miles, including the northern half of Yosemite National Park. The lower Tuolumne River below La Grange Dam is divided into two geomorphic zones based largely on channel slope and bedload material (McBain & Trush 1998). The lowermost area, the sand-bedded zone, extends from the mouth upstream for 24 miles. The upper area, the gravel-bedded zone, extends from river miles 24 to 52.

The Merced River is the southernmost stream used by chinook salmon in the San Joaquin River basin and in California. The river flows westward into the valley, draining approximately 1,275 square miles in the Sierra Nevada and foothills, including the southern half of Yosemite National Park. The average unimpaired runoff in the basin is approximately 1.02 million AF, similar to the Stanislaus River drainage.

In 1999, the Friant Water Users and the Natural Resources Defense Council coalition of environmental and fish organizations agreed to develop a restoration plan for the San Joaquin River below Friant Dam. The restoration plan will identify the key biological, ecological, and hydrological needs to accomplish restoration. The purpose is to expeditiously evaluate instream and related measure that will restore natural ecological functions and hydrologic and geomorphic processes to a level that restores and maintains fish populations in good condition including but not limited to naturally reproducing, self-sustaining population of chinook salmon.

On these three tributaries, stream-flow and available natural spawning habitat limits salmon production. Physical habitat for salmon spawning and rearing has been lost or degraded because of channel changes caused by many years of low-flow releases. These changes include siltation of spawning gravel; lack of spawning gravel recruitment below the reservoirs; removal of bankside riparian vegetation, reducing stream shading and bank stability; and in-channel mining, which has removed spawning gravel, altered the migration corridor, and created excellent salmon predator habitat.

Water quality is a significant concern in the main stem of the San Joaquin River, because flows can be low and because of inputs of agricultural drainage with high salt and contaminant (primarily selenium) concentrations. Contamination and salinization are important issues in the San Joaquin Valley. They stem from a combination of irrigation, geology and high evaporation rates. Salt build-up could inevitably impede agricultural potential. Salinization can be alleviated by draining soils into buried perforated pipe, collecting drain waters, and disposing of those contaminated waters. However, the waters draining from the saline soils are especially high in selenium. When drainage is halted, selenium can accumulate in the internal reservoir of ground water, which will eventually impede beneficial use of this resource. Where drainage water is collected, its release can result in increases in selenium contamination of surface water resources, exceedance of water quality criteria, contamination of food webs and possible effects on ecological integrity. No feasible engineering solutions have yet been demonstrated for treating irrigation drainage to remove selenium, at least at the scale necessary to alleviate the problem of waste disposal. A thorough, balanced, systematic program is needed to understand the irrigation drainage problem and potential solutions in the San Joaquin Region.

CALFED ERP Expenditures and Highlights

Since 1995, the CALFED ERP has funded 42 projects in the San Joaquin Region at a total cost of about $59,500,000 (Figure 5). The San Joaquin River below Friant Dam has been one of the areas of emphasis for restoration. The seventeen projects funded along the San Joaquin River include fish screens, habitat restoration, ecosystem water quality, environmental education and fishery assessments. Another area of significant investment has been the Tuolumne River where CALFED has funded projects that emphasize channel dynamics, sediment transport and riparian restoration (10 projects), floodplains and bypasses (2 projects), riparian habitat (1 project) and environmental education (1 project). Six projects were implemented in the Merced River, 3 on

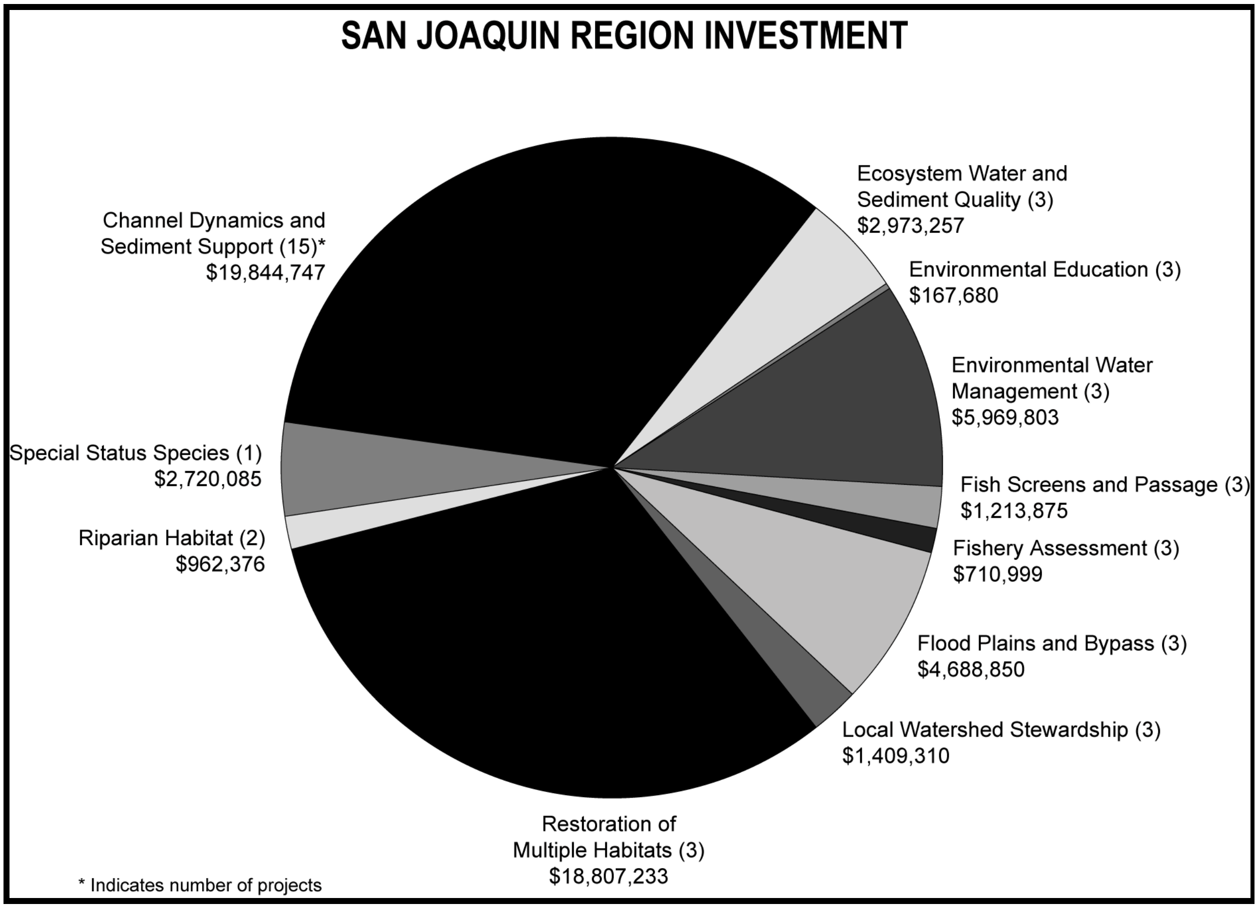

Figure 5. San Joaquin Region ERP Restoration Investment

the Stanislaus River, and 2 within the West San Joaquin Ecological Management Zone. The Tuolumne River projects will be described in more detail as an example of the work that is ongoing in this region.

***Tuolumne River Planning and Restoration*:** Restoration planning and implementation have been emphasized on the Tuolumne River, which is a demonstration stream for the ERP. The overall objective of the planning effort has been to integrate, then evaluate, the many biological and geomorphic watershed processes affecting river ecosystem health and creating salmonid habitat, and to assess the river's reasonable and feasible restoration potential and guide design and prioritization of river-wide restoration projects.

The effort on the Tuolumne River is spearheaded by a Tuolumne River Technical Advisory Team (TRTAC). The TRTAC includes representatives from: USFWS, DFG, Turlock and Modesto Irrigation Districts (TID/MID), City and County of San Francisco (CCSF), Tuolumne River Preservation Trust and others. Collectively, they have developed a shared vision for restoration of the a river corridor.

The river corridor restoration plan provides an integrated and long-term restoration strategy for the lower Tuolumne River to maximize anadromous fish habitat improvements, minimize channel restoration project costs, and streamline project evaluation and monitoring. Five products are being developed as part of this process: (1) identifying general types of inventoried preservation and restoration sites; (2) evaluating fluvial geomorphic processes; (3) evaluating geomorphic-salmonid relationships and develop restoration strategy; 4) finalizing restoration site list and designs; and 5) developing an integrated and comprehensive river corridor habitat restoration plan.

This effort on the Tuolumne River is related to the anadromous salmonid populations in the lower river and the required ecosystem health to achieve and sustain their potential productivity. Restoring and maintaining dynamic geomorphic processes are crucial for ensuring healthy river ecosystems with naturally productive salmonid populations. When complete restoration of a river ecosystem is infeasible, as for alluvial rivers regulated by dams, stressors must be identified and prioritized based on a scientific rationale in order to develop and implement actions that would best improve the ecosystem, particularly salmonid habitat.

The final Habitat Restoration Plan for the Lower Tuolumne River was completed and approved by the TRTAC in early summer 2000.

Science accomplishments: Five science projects, for about $3 million have been funded by CALFED in the San Joaquin Region since 1997 (Table 2). These projects deal mainly with water quality problems that are a serious concern in the basin (selenium from irrigation drainage, pesticides and dissolved oxygen depletion). The science investment here is smaller than in other regions, because most of the projects that are developing a better understanding of salmonid fishes (listed in Sacramento Region) are also of relevance in the San Joaquin Region. In addition to projects listed in the table, advances were reported at the CALFED Science Conference about improved understanding of interrelationships between dams, stream flow dynamics, streambed alterations, sediment transport and channel migration, in the San Joaquin River tributaries.

Table 2. Scientific Projects Funded by the CALFED Program in the San Joaquin Region		
Year	Project Title	Amount Funded
1997	Bacterial Treatment of Selenium in the Panoche Drainage	$500,000
	Evaluation of Alternative Pesticide Use Reduction Practices	$957,781
	Adult Fall-Run Chinook Salmon Movement in the Lower San Joaquin River and South Delta	$285,000
1999	Causes of Dissolved Oxygen Depletion in the San Joaquin	$866,408
	Total:	**$2,609,189**

Priorities for the San Joaquin Region

1. Continue habitat restoration actions including channel-floodplain reconstruction projects and habitat restoration studies in collaboration with local groups.
2. Restore geomorphic processes in stream and riparian corridors.
3. Improve rearing and spawning habitat and downstream fish passage on tributary streams and the main stem San Joaquin River, particularly for chinook salmon, steelhead trout and splittail.
4. Implement actions to improve understanding of at-risk species in the region.
5. Develop understanding and technologies to reduce the impacts of irrigation drainage on the San Joaquin River and reduce transport of contaminant (selenium) loads carried by the San Joaquin to the Delta and the Bay.
6. Conduct adaptive management experiments in regard to natural and modified flow regimes to promote ecosystem functions or otherwise support restoration actions.

RESTORATION PRIORITIES FOR THE SAN JOAQUIN REGION

1.) Continue habitat restoration actions including channel-floodplain reconstruction projects and habitat restoration studies in collaboration with local groups.

Physical processes in the San Joaquin Region related to fluvial geomorphology and hydrology are extremely important in restoration efforts in this region. Riparian habitat research and restoration is closely linked to channel dynamics and sediment transport processes and flow regimes. Primary stressors affecting channel-floodplain function and riparian habitats within the San Joaquin Region include: channel straightening and clearing; levee construction and bank hardening; instream gravel mining; flow modifications affecting sediment transport and spring germination; and loss of sediment and bedload from watershed sources upstream of dams.

- *Channel-floodplain reconstruction projects.* Proposed channel-floodplain reconstruction projects should clearly articulate a conceptual model explaining how the proposed channel-floodplain geometry will restore ecosystem function within the context of the regulated flow regime, existing habitat, sediment routing, and companion restoration strategies such as gravel augmentation. Potential projects could include preparation of channel reaches for high flows, such as removing bank protection, removing encroached trees, setting back levees, or re-grading banks that artificially narrowed due to lack of flood scour. Proposed actions may also include the evaluation of existing channel floodplain reconstruction projects for measurement of hydraulic conditions and channel form before and after high flows, and evaluation of project performance as a basis for informing future projects. In addition to direct experiments, explicit quantitative mechanistic and process studies are needed to understand how these actions affect environmental processes, ecosystem processes and life histories of at-risk species. Studies that compare such effects among restoration strategies are critical for future prioritization of CALFED activities. (Strategic Goal 2, Channel Dynamics and Sediment Transport)

- *Gravel Augmentation Projects.* Gravel augmentation projects to restore salmon spawning habitat should explicitly describe how the scale of the proposed augmentation project fits within the context of sediment deficit caused by the dam or gravel mining activities. Projects should place the scale of the augmentation project within the context of the sediment transport capacity of the current, regulated flow regime and include the placement and monitoring of tracer gravel to help develop an understanding of bed mobility thresholds. Gravel augmentation projects could also deliberately vary the scale, rate, depth, method, and location of gravel injections and monitor gravel movement, habitat conditions (such as intragravel permeability), aquatic invertebrate production, and fish spawning and rearing preferences to help develop a better understanding of the mechanisms underlying population responses to habitat changes. Proposed actions may also include the evaluation of existing salmon spawning gravel enhancement projects for measurement of hydraulic conditions and channel form before and after high flows, and evaluation of project performance as a basis for informing future projects. In addition to direct experiments, explicit quantitative mechanistic and process studies are needed to understand how these actions affect environmental processes, ecosystem processes and life histories of critical species. Studies that compare such effects among restoration strategies are critical for future prioritization of CALFED activities. (Strategic Goal 2, Channel Dynamics and Sediment Transport)

- *Non-native Invasive Species.* Projects are needed to implement an eradication program for purple loosestrife (*Lythrum salicaria*) along the Tuolumne River.

- *Riparian and riverine aquatic habitat restoration and research.* Efforts should be designed and sized to provide multiple ecosystem benefits, including habitat for at-risk species, such as riparian brush rabbit and riparian woodrat, and migratory songbirds in the riparian zone. Scientific studies to determine appropriate conditions for the germination and establishment of riparian woody plants along the San Joaquin River are also needed. (Strategic Goal 1, At-risk species and Strategic Goal 4, Riparian Habitat).

2.) Restore geomorphic processes in stream and riparian corridors.

Success in restoring riparian communities will depend on how well the physical processes that maintain dynamic stream channels are understood. There is a need to enhance the scientific understanding and basis for potential restoration actions. Understanding the relationships between fluvial processes and riparian regeneration will improve the success of immediate and future restoration efforts.

- *Hydrologic and sediment transport models as restoration tools for the main stem San Joaquin River and its tributaries below Friant Dam.* A focus of these efforts should be to assess the potential ecological effects of the anthropogenic fine sediment loads, especially on priority at-risk species. These efforts may also include implementing sediment management actions, but a strong component of these actions should be to monitor their effects (Strategic Goal 2, Channel Dynamics and Sediment Transport).

- *Tributary assessments.* Baseline assessments are needed of the attributes of river ecosystem integrity such as morphology, flow patterns, substrate composition and distribution, floodplain extent, riparian corridor, groundwater table, and frequency of channel migration or avulsion (Strategic Goal 2, Channel Dynamics and Sediment Transport).

- *San Joaquin floodplain evaluation.* Develop floodplain management plans, including feasibility studies to construct setback levees, to restore and improve opportunities for rivers to inundate their floodplain on a seasonal basis on tributaries within the San Joaquin River. Work in close coordination with the DWR/Corps Comprehensive Study actions. (Strategic Goal 4, Floodplains and Bypasses as Ecosystem Tools).

- *Biological value of floodplain habitats.* Additional information is needed to better understand the role of natural and managed floodplains to the food web and in the survival and growth of young fish (Strategic Goal 4, Floodplains and Bypasses as Ecosystem Tools).

3.) Improve rearing and spawning habitat and downstream fish passage on tributary streams and the main stem San Joaquin River, particularly for chinook salmon steelhead trout and splittail.

The San Joaquin River and its tributaries are the southernmost spawning populations of chinook salmon in the Central Valley and have been the focus of restoration for decades. A variety of stressors have been identified in the San Joaquin that are detrimental to the survival of juvenile and adult fish. Efforts to improve our understanding of these stressors and actions to abate the problems are needed.

- *Facilities improvements and fish passage programs.* Projects should improve fish passage by improving existing facilities or constructing new fish passage and protection facilities, exclusion barriers, repairing weirs, eliminating ponds and removing physical barriers to upstream and downstream migration (Strategic Goal 1, At Risk Species Assessments).

- *Fish screens.* Projects should continue and complete ongoing fish screen construction projects currently supported by CALFED and/or CVPIA including screening the Bant-Carbona Irrigation District and City of Patterson diversions.

4.) Implement actions to improve understanding of at-risk species in the region.

Additional actions and information is needed for numerous at-risk species in this region.

- *Resource assessment and monitoring programs.* Efforts are needed which, through the use of existing, expanded, and new programs, monitor adult anadromous salmonid returns to each watershed. Efforts are also needed to improve standardization among researchers and watersheds of monitoring techniques, data compilation and analysis, and reporting (Strategic Goal 1, At Risk Species Assessments).

- *Salmonid Life-history studies.* Projects should ontinue to identify Central Valley salmonids life history and habitat associations and requirements especially in relation to existing and restored habitats in all three San Joaquin River tributaries and on the mainstem San Joaquin River. A priority focus for these effort should be to build knowledge of the status and needs of steelhead in the San Joaquin Region (Strategic Goal 1, At Risk Species Assessments).

- *Protect and better understand at risk species in the region.* Preserve grassland, alkali sink, and alkali scrub habitat in the Central Valley, especially in the Tulare Basin, to protect and restore habitat and habitat linkages for San Joaquin kit fox and other species that depend on this habitat complex. Developing wildlife-friendly farming practices to improve habitat for kit fox and other species that depend on these habitats, i.e., blunt-nosed leopard lizard, kangaroo rat, etc (a CVPIA Habitat Restoration Program priority) is another emphasis.

- *Other at-risk species life history studies.* Preserve existing habitat and restore additional habitat to benefit riparian brush rabbit, riparian woodrat, valley elderberry longhorn beetle, giant garter snake and vernal pool species. Study distribution, abundance, threats to populations, and potential opportunities for reintroduction of these species.

5.) Develop understanding and technologies to reduce the impacts of irrigation drainage on the San Joaquin River and reduce transport of contaminant (selenium) loads carried by the San Joaquin to the Delta and the Bay

- *Dissolved oxygen.* The CALFED Record of Decision specifically identifies the issue of improving dissolved oxygen conditions in the San Joaquin River near Stockton. Additionally, the Water Bond of 1999 (Proposition 13) authorizes CALFED to fund construction of facilities to control waste discharges that contribute to low dissolved oxygen in the lower San Joaquin River and the south Delta. An important contributing factor to dissolved oxygen deficits at Stockton Deep Water Ship Channel could be the production of oxygen consuming substances. These substances are carbonaceous and nitrogenous BOD, algae, and algal nutrients that develop into algae in the transport from their source to the Deep Water Ship Channel. There is a need to develop management techniques, including the assessment of their efficacy and cost-effectiveness for reduction and control of oxygen demanding substances in the San Joaquin River Deep Water Ship Channel.

- *Reduce the impacts of irrigation drainage on the San Joaquin River habitats and reduce transport of contamination (selenium) loads carried by the San Joaquin to the Delta and the Bay.* Although selenium contamination is well known in San Francisco Bay, and studies of selenium in the Delta are beginning, only scattered studies of the selenium problem at its source have been conducted. A program of study in the San Joaquin River itself is needed. This work should be conducted in collaboration with and as a complement to the studies and monitoring of the Bureau of Reclamation and the Fish and Wildlife Service. Specific needs are (Strategic Goal 6, water and sediment quality):
    1. Collect data and develop mass balance models at appropriate time and space scales to understand and monitor inputs from all sources of selenium, and the fate of selenium in the San Joaquin River.
    2. Determine selenium dynamics and concentrations on suspended particulates, since this is a primary source of bioavailable selenium.
    3. Determine biogeochemical transformation of selenium in the river, sloughs and wetlands both near and far from the drainage inputs.
    4. Develop knowledge for conceptual models of ecosystem processes, stressors and food webs of the river, sloughs and wetlands, from field study.
    5. Develop bioindicator performance measures, and begin long-term monitoring to track progress in selenium clean-up in the river.
    6. Describe and develop models of selenium dynamics within species and within the food webs.
    7. Develop technologies for removing selenium from drainage and strategies for employing such technologies so that significant improvements in releases to the ecosystems can be made.

- *Pesticides and other contaminants.* High genetic damage, possibly from pesticides, has been reported in the California sucker in the San Joaquin River (Anderson, 2000). Better understanding is needed of pesticide and other contaminant dynamics, inputs, fate and biological effects in the system (Strategic Goal 6, water and sediment quality).

- *New technologies to prevent pollutant inputs.* Develop research and pilot/demonstration projects to that test, and evaluate new solutions and/or BMPs to reduce "pollutant" (especially oxygen depleting substances, pesticides, selenium, fine sediment, and nutrients) discharges from agricultural lands stressors (Strategic Goal 6, water and sediment quality).
- *Real-time Monitoring.* Continue to expand San Joaquin River water quality real-time monitoring program.

<u>6.) Conduct adaptive management experiments in regard to natural and modified flow regimes to promote ecosystem functions or otherwise support restoration actions.</u>

Efforts to address natural and modified flow regimes to promote ecosystem functions and favorable biological responses are important in the San Joaquin Region. In particular, efforts are needed that augment or improve the scientific basis for flow-related actions and which improve our ability to effectively manipulate and supplement flows.

- *Mechanistic models as restoration tools.* Develop methods, including a combination of simulation models and physical measurements, to evaluate flow, sediment transport and other fluvial processes. Develop ecologically based plans and process understanding to aid restoration of conditions in the rivers, sloughs and floodplains (including bypasses) sufficient to support targets for the restoration of chinook salmon, steelhead, sturgeon, and splittail (Strategic Goal 2, natural flow regimes).

- *Instream flow programs.* Conduct instream flow studies to improve our understanding of the effects of flows and flow regimes on ecological and physical processes, especially their effects on fish populations in the San Joaquin Valley. (Strategic Goal 2, natural flow regimes).

- *Streamflow management plans.* Projects should design and implement ecologically based streamflow and temperature management plans including geomorphic and biological criteria for water acquisitions for the San Joaquin, Stanislaus, Merced, and Tuolumne Rivers (Strategic Goal 2, natural flow regimes).

- *Effects of managed flow fluctuations.* Projects are needed to evaluate the effects of managed flow fluctuations on ecosystem processes and habitat conditions, especially effects of flow fluctuations on anadromous fish habitat below dams (Strategic Goal 2, natural flow regimes).

- *Environmental water acquisitions.* Projects should develop ecological and hydrodynamic modeling tools and conceptual models that describe ecological attributes, processes, habitats, and outflow/fish population relationships. Develop ecological and biological criteria for water acquisitions. Evaluate previous water acquisition strategies and biological and ecological benefits (Strategic Goal 2, natural flow regimes).

9.0 REGIONAL IMPLEMENTATION -- DELTA AND EASTSIDE TRIBUTARIES

Delta and Eastside Tributaries Regional Description

The Sacramento-San Joaquin River Delta (Delta) is the tidal confluence of the Sacramento and San Joaquin rivers. The CALFED Delta Ecological Management Zone is defined by the legal boundary of the Delta that includes the areas that historically were intertidal, along with supratidal portions of the floodplains of the Sacramento and San Joaquin Rivers (Attachment 5). Today's legal Delta extends between the upper extent of the tidewater (i.e., near the city of Sacramento on the Sacramento River and Mossdale on the San Joaquin River) and Chipps Island to the west, and encompasses the lower portions of the Sacramento and San Joaquin River floodplain systems as well as those of some lesser tributaries (e.g., Mokelume River and Calaveras River). Once a vast maze of interconnected wetlands, ponds, sloughs, channels, marshes, and extensive riparian strips, the Delta is now islands of reclaimed farmland protected from flooding by hundreds of miles of levees. Remnants of the tule marshes are found on small "channel" islands or shorelines of remaining sloughs and channels.

The Delta is a mosaic of habitats that support the system's fish, wildlife and plant resources. Instream and surrounding topographic features influence ecological processes and function and are major determinants of aquatic community potential. Currently, much of the remaining natural habitats consist of small, scattered, and degraded parcels. More common wildlife habitats on agricultural lands are at risk of loss because of levee failures. Important aquatic habitats are severely limited by levees and flood control systems.

Ecological factors having the greatest influence on Delta fish and wildlife include freshwater inflow from rivers, water quality, water temperature, channel configuration and hydraulics, wetlands, riparian vegetation, and diversity of aquatic habitat. Stressors include water diversions, channelization, levee maintenance, flood protection, placement of rock for shoreline protection, poor water quality, contaminants, legal and illegal harvest, wave and wake erosion, agricultural practices, conversions of agricultural land to vineyards, urban development and habitat loss, pollution, and introductions of non-native plant and animal species.

The Delta is home to many species of native and non-native fish, waterfowl, shorebirds, and wildlife. All anadromous fish of the Central Valley either migrate through the Delta or spawn in, rear in, or are dependent on the Delta for some critical part of their life cycle. Many of the Pacific Flyway's waterfowl and shorebirds pass through or winter in the Delta. Many migratory songbirds and raptors migrate through the Delta or depend on it for nesting or wintering habitat. Despite many changes, the Delta remains a productive nursery grounds and migratory route for many species. Four runs of chinook salmon, steelhead, white sturgeon, green sturgeon, lamprey, striped bass, and American shad migrate through the Delta on their journey between the Pacific Ocean and Central Valley spawning rivers. Native resident fish including delta smelt and splittail spend most of their lives within the Delta. Considerable areas of waterfowl and wildlife habitat occur along the channels and sloughs and within the leveed agricultural lands. The Delta also supports many plants with restricted distribution and some important plants include Mason's lilaeopsis, Rose-mallow, eel-grass pondweed, delta tule pea, and delta mudwort. A more complete description of the Delta and the vision for the Delta can be found in the ERPP Volume II pages 68 – 120.

The Eastside Delta Tributaries include the three major tributaries entering the Sacramento-San Joaquin Delta on its east side; the Cosumnes, Mokelumne, and Calaveras Rivers. Important ecological processes within the Eastside Delta Tributaries include stream-flow, stream meander, gravel recruitment and cleansing, sediment transport, flood and floodplain process, and water temperature. Disturbance from historic mining practices is a consideration. Important habitats include seasonal wetlands, floodplain, and riparian and shaded riverine aquatic (SRA) habitat.

Fish and wildlife resources in the basin include fall-run chinook salmon, steelhead, splittail, other native resident fish, and waterfowl. Fall-run chinook salmon and steelhead populations are generally unhealthy due to poor habitat conditions. Achieving healthy status for these salmonid populations, as well as for splittail, will depend on actions implemented in this region and on complementary restoration actions in the Sacramento-San Joaquin Delta. The confluence of the Mokelumne, Cosumnes, and Calaveras Rivers, as they enter the Delta, are important backwater floodplain areas that support excellent riparian habitats. These areas provide important habitat for juvenile chinook salmon, delta smelt, splittail, giant garter snake, and sandhill crane. A more complete description of the East Side Delta Tributaries and the vision for this area can be found in the ERPP Volume II pages 328 - 352.

Key to implementation of ERP actions in the Delta will be collaboration with the Delta Protection Commission. The Delta Protection Commission is a State agency and includes the directors (or designee) of Department of Parks and Recreation, State Lands Commission, Department of Water Resources, Boating and Waterways, Department of Fish and Game, and Department of Food and Agriculture. Also on the Commission are: one supervisor from each of the five counties in the planning area, three city representatives; and five reclamation district representatives. The Commission is charged with preparation of a regional plan for the "heart" of the Delta. The plan addresses land uses and resource management for the Delta region. Key land uses are identified in the legislation and include: agriculture, wildlife habitat and recreation. The ERP will work closely with the Delta Protection Commission as the regional strategy for ecosystem restoration is further developed and refined.

CALFED ERP Expenditures Highlights

To date, the CALFED Program has funded 70 projects within the Delta Region for approximately $106 million (Figure 6). Types of projects funded have included protection and restoration of tidal wetland, shallow water, riparian, and upland habitats, fish screen evaluations, evaluations of water quality and nonnative invasive species impacts on Delta resources, and environmental education. Additional focused research projects have been designed to provide information that will improve future restoration efforts. In implementing these projects, the CALFED Program works very closely with local groups in the Delta Region. In particular, the Delta Protection Commission is a state agency that focuses on activities within the Delta. A few projects will be highlighted to give a sense of projects funded in this region. The CALFED Program has also supported a number of scientific investigations to support restoration in the

Delta. Those funded via the competitive proposal process are listed in Table 3. Examples of restoration and science accomplishments follow.

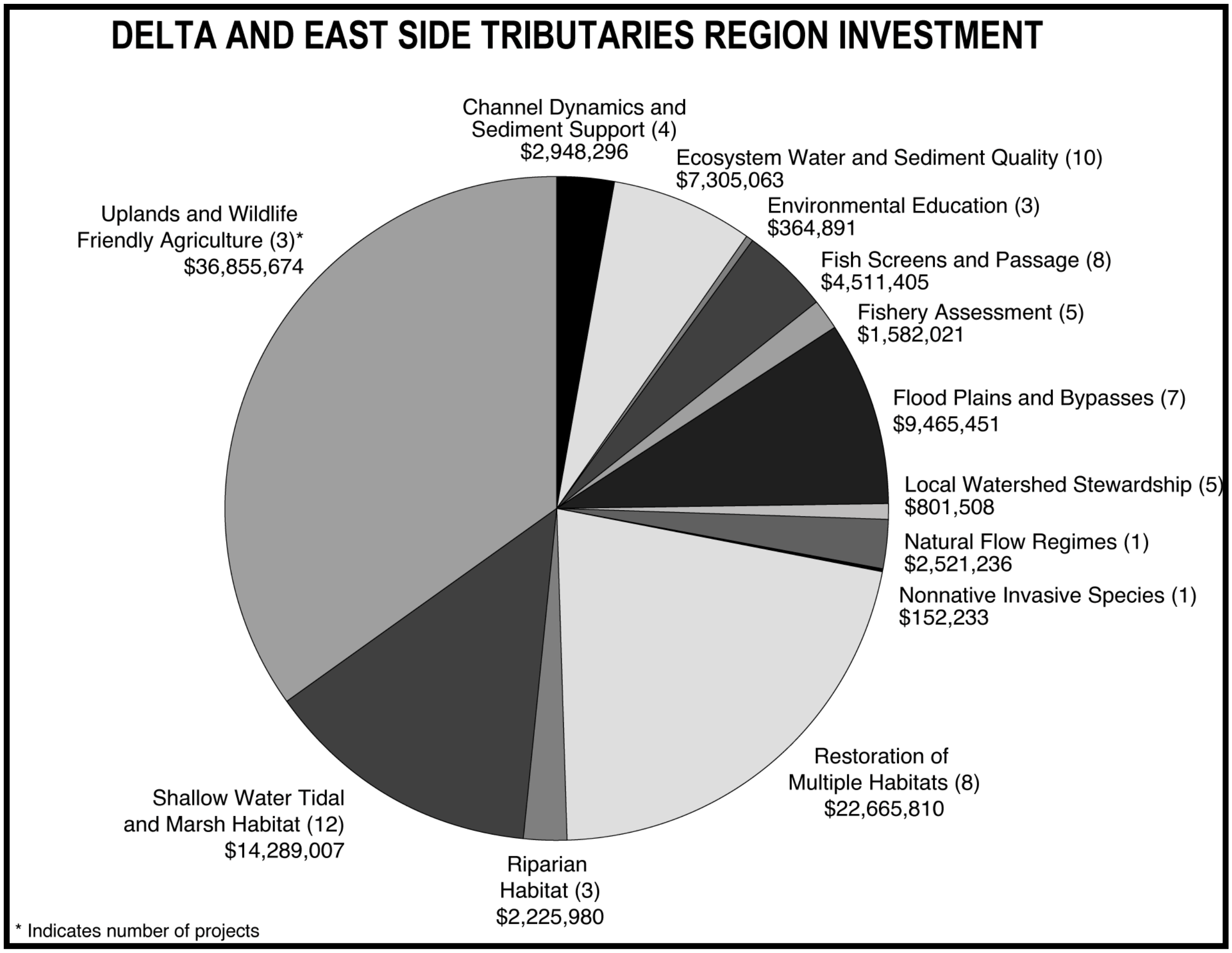

Figure 6. Delta and Eastside Tributaries ERP Restoration Investment. (Note: the $36.8 million investment in Uplands and Wildlife-Friendly Agriculture included the acquisition of Staten Island for $35 million.)

Table 3. Scientific Projects Funded by the CALFED Program in the Delta Region.		
Year	Project Title	Amount Funded
1997	Effects of Wetlands Restoration on Methyl Hg Levels (D274)	$530,617
	Sedimentation Movement and Availability and Monitoring in the Delta	$1,046,200
	Contaminant Effects on Smelt (E6)	$437,000
	Culture of Delta Smelt	$194,870
	Assessment of Organic Matter in the Habitat and its Relationship to the Food Chain	$1,400,000
	Hydrogeomorphological Models Supporting Restoration in the Cosumnes	$1,546,000
1998	Biological Assessment of Green Sturgeon in the Sacramento-San Joaquin Watershed	$241,000
1999	Toxicity of Contaminants to Sacramento Splittail	$673,684
	Pesticide Effects on Fish in the Delta	$1,875,561
	Dissolved Organic Carbon Release from Delta Wetlands	$1,392,669
	Impact of Chinese Mitten Crab in the Delta	$147,799
	Effects of Introduced Species on Zooplankton and Clams	$726,930
2000	Culture of Delta Smelt, Phase II	$431,606
	Biological Assessment of Green Sturgeon	$205,013
	Dissolved Organic Carbon Release in Delta Wetlands	$1,000,000
2001	Transport, Transformation and Effects of Selenium in the Delta	$2,600,000
	Food Resources for Zooplankton in the Bay Watershed	$576,422
	Juvenile Salmon Migratory Behavior in the Delta	$210,000
	Total:	**$15,235,371**

Cosumnes River. Recovery of native species, rehabilitating natural processes and restoring functional habitat types are all goals of the ERP. These goals converge in floodplains, which were once a dominant functional type of habitat in the system. Because the Cosumnes River is the last free-flowing river on the western slope of the Sierra Nevada, it was designated as a high priority area for restoration and study of functional floodplain. The Cosumnes River provides unique opportunities for research and restoration. The Cosumnes River Preserve, located at the east edge of the Delta, is saving crucial habitat on a large scale within the rapidly growing urban areas of Sacramento and Stockton. Habitats protected include seasonal and permanent wetlands, riparian forests, vernal pools, grasslands, and valley oak woodlands. Restoration of natural floodplains is a priority at the Cosumnes River Preserve. Natural floodplains have many important ecological benefits, such as providing spawning habitat for native fish, and contributing to the aquatic food web. Floodplains also help to minimize flood damage. Floodplain restoration reduces flood damage by reducing flood stages and velocities and providing a wide area for overbank flow. Restoration of natural floodplains, such as those found on the Cosumnes River Preserve are an important step toward a healthy Bay-Delta ecosystem.

Many partners have helped to protect and restore the important resources of the Cosumnes River Preserve. Protection is achieved with environmentally sensitive management practices, conservation easements, and property acquisition. Five ERP projects, to date, have been in support of the Cosumnes River Preserve effort. For the most part, these CALFED–funded projects have been land acquisitions more than 7,000 acres. One of the more visible acquired properties is the Valensin Ranch, also supported by CVPIA. This parcel is located primarily on the south side of the Cosumnes River, and straddles Highway 99.

Scientific studies are underway to support restoration, aid prioritization of efforts and evaluate progress. A few of the results to date show that floodplains are critical in the life history of juvenile salmon and adult splittail in this area. Native fish dominate the upper and middle basins, but non-natives comprise almost the entire assemblage in the lower basin. Adults of native fish species used primarily shallow floodplain areas whereas adults of invasive fish species preferred deeper sloughs and ponds within the floodplain; arrival and departure time from the floodplain also differed between native and non-native species. Restoring floodplains is critical strategy in the Cosumnes River, but the differences in needs, distribution and life history between native and non-native species must be considered if restoration is to favor recovery of native species.

One way to evaluate the success of floodplain restoration is to compare areas breached at different times or in different ways. Initial studies following this strategy showed that after three years of flooding an intentional breach, the beginning signs of geomorphologic evolution toward a more natural state were evident. The necessary ingredients for Cosumnes River breaches to be successful appear to include: (a) a natural flood hydrograph; (b) breaches at downstream ends of the outside of meander bends; (c) an aquatic link to the river until the floodplain drains completely.

Addressing Low Dissolved Oxygen Levels in the San Joaquin River near Stockton. Ror the last 15 years, dissolved oxygen (DO) concentrations below the State water quality standard have occurred in the San Joaquin River Deep Water Ship Channel from the Port of Stockton to Disappointment Slough and Columbia Cut in the Delta. Low DO levels may create a migration barrier for fall-run chinook salmon. Furthermore, low DO can also negatively impact the San Joaquin River benthic and water column biotic communities and ecological processes. It is hypothesized that local and upstream anthropogenic inputs of oxygen depleting substances, algal blooms, and human flow and channel geometry manipulations contribute to causing the low DO levels.

The CALFED Program, through the ERP, is committed to help solve this important water quality problem, and thus eliminate any adverse ecological effects it. To date, the ERP has funded two integrated field and modeling, totaling over 2.4 million dollars, to generate the scientific and engineering information needed to develop and implement management actions to eliminate low DO concentrations in the San Joaquin River Deep Water Ship Channel. Peer review of the study outcomes and design is an on-going process. A major recommendation from the most recent review is that comparisons of multiple approaches to modeling transport of oxygen consuming materials and hydrodynamics in the region, built around data from the field studies, is necessary for cost-effective management decisions.

Mercury Project (Directed Action). CALFED is currently funding a study initiated in September, 2000, that consists of collaboration among 12 scientists on the issue of mercury. There are two main study areas; the Sacramento-San Joaquin Delta that receives flow from the Sacramento-San Joaquin watershed; and Cache Creek, a tributary to the Delta containing several major mercury mines. Research efforts include mass loading, bioaccumulation, effects, and mercury speciation. The project's main goal is to reduce mercury concentrations is fish tissue to levels that do not post a human or wildlife health hazard**.** There are currently health advisories for fish consumption in thirteen water bodies in Northern California including San Francisco Bay and the Sacramento-San Joaquin Delta. In this study, bioaccumulation data was obtained in for striped bass, large mouth bass, and catfish and from another study for clams and silversides. The data indicate that mercury levels in some species in the Delta have not declined over the past 30 years.

Ecological response to island inundation in the Delta: Lessons for Restoration. The CALFED Program placed a high priority on understanding ecological responses to island inundation in the Delta, because this is a primary approach to restoration in that area. Such understanding is critical to optimizing restoration strategies and evaluating factors limiting restoration. The Pacific Division of the American Fisheries Society sponsored a session at its annual meeting that summarized many of the findings (in addition studies were presented at the annual CALFED Science Conference). Several conclusions important to restoration have been drawn from this work: (1) Integrated field studies that include historical analysis, hydrodynamic modeling, field ecological experiments, and laboratory experiments are required to yield insight into Delta food web processes. The past emphasis on largely independent and isolated scientific investigations has not yielded insights at the rate needed to impact restoration strategies (Cloern). (2) Providing a diversity of habitats should be the underlying theme of Delta restoration, given the diversity of needs by different species and the very different nature of the environments being rehabilitated. (Grimaldo). (3) A second goal should be restoration of reproductive habitat and rearing habitat for key species, as these often seem to be the bottlenecks (Moyle). (4) Fundamental differences in ecology and life history offer the potential to design restoration strategies that would favor native species rather than non-natives. For example, natives spawn earlier in the year in general than non-natives, so system manipulations could be developed to favor the former (Moyle). (5) Some implicit assumptions accompany the strategy of inundating Delta Islands (Simenstad), (breaching will recover critical processes, recruits and raw materials will be there to recover system, and processes that created the original marshes are still at work.) (6) Deficiencies in the above assumptions impose contingencies on restoring certain types of habitats. Overcoming these contingencies in by selection of restoration sites, manipulation of the system and engineering are probably necessary (many islands are subsided, and continue to subside at faster rates than sediment will deposit, if they are flooded, sediment sources are depleted by reservoirs; sedimentation rates are slow; and re-suspension in larger lakes raises questions about the permanence of artificially augmenting sediment deposition. Other raw materials for restoration (e.g., bioavailable organic material) may also be deficient in some systems, although the controls on things like carbon availability are not yet fully understood. Recruitment sources of native animals and plants may be limited in this disturbed system. Issues like exotic species and contaminants must be considered and monitored in every action, because it is possible to make circumstances worse for restoration. The net effect of any restoration will be to lose some wildlife and gain others. Knowledge will make it more likely that informed choices can be made. (7) While monitoring fish abundance and escapement provides a valuable baseline of information about trends in the system, it is not adequate as a knowledge base for restoration. Process studies and interdisciplinary, integrated science both must be added to the traditional monitoring strategies. (8) Adaptive management should be better built into restoration actions. This means that there should be some control over the action, the action must begin with hypotheses, we must expect we can change the action if the data point toward that, and data must be collected (multi-discipline study) as restoration proceeds. Scientific study of outcomes is as important as engineering and construction.

Restoration Priorities for the Delta and Eastside Tributaries Region

1. Restore habitat corridors in the North Delta, East Delta and San Joaquin River.
2. Restore and rehabilitate floodplain habitat in eastside tributaries and the lower Sacramento and San Joaquin rivers.
3. Restore upland wildlife habitat and support wildlife-friendly agriculture.
4. Restore habitat that would specifically benefit one or more at-risk species; improve knowledge of optimal strategies for these species.
5. Implement actions to prevent, control and reduce impacts of non-native invasive species in the Delta.
6. Restore shallow water habitats in the delta for the benefit of at-risk species while minimizing potential adverse effects of contaminants.
7. Protect at-risk species in the Delta using water management and regulatory approaches.
8. Ensure restoration and water management actions in the Delta can be maintained under future climate conditions.

RESTORATION PRIORITIES FOR THE DELTA AND EASTSIDE TRIBUTARIES REGION

1.) Restore habitat corridors in the North Delta, East Delta and San Joaquin River.

Delta habitat corridor restoration is a priority. Projects restoring Delta wetland, aquatic, riparian, and associated habitats are needed that that will contribute to creating the following habitat corridors that connect the Delta with upstream areas:

- *North Delta habitat corridor*. Provide contiguous habitat connecting the mosaic of marsh, aquatic, and associated floodplain and riparian habitat types in Prospect Island, Liberty Island, Little Holland Tract, Steamboat Slough, Cache Slough Complex, and Yolo Bypass (Strategic Goal 4, shallow water, tidal and marsh habitat).

- *East Delta habitat corridor*: Restore a contiguous corridor containing a mosaic of marsh, aquatic, and associated floodplain and riparian habitat types in the area of Georgiana, Snodgrass, and other east Delta sloughs, the lower Cosumnes River, and the South Fork of the Mokelumne River (Strategic Goal 4, shallow water, tidal and marsh habitat).

- *San Joaquin River* - Delta habitat corridor, providing a contiguous corridor containing a mosaic of aquatic, wetland, and associated riparian and floodplain habitat types (Strategic Goal 4, shallow water, tidal and marsh habitat and floodplains and bypasses as ecosystem tools).

Actions that restore natural and managed seasonal or permanent wetlands are also a priority; including actions that contribute to connectivity between aquatic, wetland and riparian habitats. The goal is to protect or restore lands already under government ownership, ultimately resulting in mosaics of seasonal and permanent tidal wetlands, riparian zones, and associated upland habitats. Such actions should include monitoring programs and be designed as adaptive management experiments to better contribute (or evaluate if and how they contribute) to recovery and restoration of native species and biotic communities. Additional priorities are:

- *Restore tidal marsh and mid-channel island littoral zone (shoreline marsh and shallow water) habitats in the central and west Delta.* Develop, test, and assess techniques to restore and protect shoreline marsh and shallow water habitats around midchannel islands (Strategic Goal 4, shallow water, tidal and marsh habitat).

- *Protect, and restore habitat for at-risk species.* Habitat should to benefit giant garter snake, greater sandhill cranes, Swainson's hawk and waterfowl. Incorporate intensive studies of physical, chemical and ecological process changes as these sites are developed (Strategic Goal 1, at-risk species and Strategic Goal 4, habitats).

- *Restore inland dune scrub habitat.* Habitat should benefit the Antioch Dunes evening primrose, Contra Costa wall flower, Lange's metalmark butterfly (Strategic Goal 1, at-risk species and Strategic Goal 4, habitats).

2.) Restore and rehabilitate floodplain habitat in eastside tributaries and the lower Sacramento and San Joaquin rivers

Many species native to the Delta and the Eastside tributaries are adapted to the large floodplains that were frequently flooded in the original system. Rehabilitating and restoring this functional habitat and the species that reproduce on or otherwise use floodplains (Sacramento splittail, delta smelt and chinook salmon) are important goals. Projects are requested to improve floodplain habitat, complete or sustain existing restoration projects, or restore new areas of such habitat.

- *Improve floodplain habitat*. Establish restoration projects that improve slough and creek channels, or develop networks of channels to effectively drain flooded lands and provide connections with the Delta or Eastside tributaries (Goal 4, floodplains and bypasses as ecosystem tools).

- *Floodplain management plans and actions.* Evaluate setback levees, or restored areas where rivers inundate their floodplain on a seasonal basis on the Cosumnes and Mokelumne Rivers as well as the lower San Joaquin and the lower Sacramento Rivers (Strategic Goal 4, floodplains and bypasses as ecosystem tools).

- *Yolo Bypass.* Support locally-led efforts to protect and restore at-risk species dependent on the Yolo Bypass that balance the needs of local agricultural communities and local governments with restored habitats. Provide resources to conduct hydrologic modeling that allows for restoration projects to take place without jeopardizing conveyance capacity (Strategic Goal 4, floodplains and bypasses as ecosystem tools).

3.) Restore upland wildlife habitat and support wildlife-friendly agriculture.

Encouraging farming practices that improve agricultural lands' value as habitat for at-risk wildlife and other species dependent on the Delta and Eastside Tributaries Region and that minimize polluted run-off into nearby waterways is an important goal. In addition to specific habitat improvements, efforts are encouraged that:

- *Develop agricultural incentive programs*. Programs should describe crops, farming methods, and marketing programs that favor wildlife (Strategic Goal 4, uplands and wildlife-friendly agriculture).

- *Comparative analysis.* Compare across existing projects, or use new projects to compare, the effectiveness of the different approaches to promoting wildlife-friendly agriculture (Strategic Goal 4, uplands and wildlife-friendly agriculture).

4.) Restore habitat that would specifically benefit one or more at-risk species; improve knowledge of optimal restoration strategies for these species.

- *Adaptive experimentation with species-specific restoration approaches.* Adaptive management restoration experiments that test the effectiveness of alternative restoration strategies for one or more at-risk fish, bird, or riparian species (or communities that include these species) in the Delta or eastside tributaries are a priority. Investigations and monitoring efforts are also a priority to better understand existing Delta restoration environments or newly designed restoration experiments (Strategic Goal 4, habitat).

- *Restoration of Sacramento splittail and delta smelt.* Restoration projects or investigations designed around the priorities defined by the Sacramento Splittail Workshop for restoring this species will receive priority. Adaptive restoration experiments designed to increase Delta smelt abundance (including monitoring that evaluates changes in abundance) are also needed as well as projects to restore delta smelt habitat. Studies are encouraged that would contribute to understanding the life history of these species, factors controlling its migrations through and distribution (space and time) in the Delta, and development of population models (Strategic Goal 1, at-risk species assessments; Strategic Goal 4, habitats).

- *Life histories and restoration or habitat requirements of at-risk species.* Workshops, white papers, or pilot scale monitoring and survey programs that might summarize or better the state of knowledge about poorly known riparian or wetland species or groups of species that inhabit the Delta, especially where such studies can lead to population models (Strategic Goal 1, at-risk species assessments).

- *Changes in species abundances on a landscape basis.* Understanding gains and losses of specific species and communities on a landscape basis as a cumulative result of establishing corridors of restored habitat (Strategic Goal 1, at-risk species assessments, Strategic Goal 4, habitats).

5.) Implement actions to prevent, control and reduce impacts of non-native invasive species.

Non-native invasive species are especially problematic in the Delta. Actions that improve knowledge of the distributions of these unwanted species are needed as well as actions to begin control or eradication.

- *Support the formation of a Delta-wide multi-county interagency coordinating council* to identify and organize implementation of non-native invasive species management in the Delta (Strategic Goal 5, non-native invasive species).

- *Develop pilot projects* in marsh habitats to develop successful approaches to control of *Lepidium latifolium* (pepperweed), *Salsola soda* and other non-native invasive plants (Strategic Goal 5, non-native invasive species).

- *Research* the relationships between inundation, salinity and non-native invasive species needs in tidal wetlands to expose the hydrologic regimes less favorable to the non-natives (Strategic Goal 5, non-native invasive species).

- *Document the distribution and abundance* of *Corbicula fluminea,* as well as the trophic impacts of their populations in fresh, shallow water habitat, which may be targeted for restoration work. Initial investigation indicates that this species may be the fresh water counterpart to *Potamocorbula amurensis* and may seriously impact our attempts to restore shallow water habitat (Strategic Goal 5, non-native invasive species).

- Evaluate the relationship between DO and *Egeria densa*, as well as the DO impacts of implementing a control program for *Egeria densa* (Strategic Goal 5, non-native invasive species)

- Evaluate the relationships/interactions between nonnative organisms and *Egeria densa* in areas of possible delta smelt spawning (Strategic Goal 5, non-native invasive species).

High priority is given to surveys, studies, eradication efforts and monitoring efforts for non-native species in the Delta, because non-native species represent one of the greatest threats to successful restoration of native populations. Eradication actions that are accompanied by assessments of effects on non-target species will be a priority. In particular, priorities will be given to developing better knowledge of:

- *Responses* of striped bass, centrarchid predators, zooplanktons, non-native bivalves, mitten crabs or aquatic macroflora to different restoration actions (Strategic Goal 5, non-native invasive species).

- *Methods* for comprehensive mapping, system-wide surveys and/or on-going monitoring of specific invasive species actions (Strategic Goal 5, non-native invasive species).

- *Education* efforts to help the public better understand the non-native species threat actions (Strategic Goal 5, non-native invasive species).

- *Mechanistic understanding* of the life histories of key non-native species actions (Strategic Goal 5, non-native invasive species).

6.) Restore shallow water habitats in the Delta for the benefit of at-risk species while minimizing potential adverse effects of contaminants.

Results from the CALFED Science Conference showed that the ecological outcomes of habitat restoration projects in the Delta can differ widely, but the reasons for those differences are not fully understood. Understanding the factors that shape or constrain the outcomes of different habitat restoration scenarios is needed. Better understanding is sought of the comparative outcomes of existing projects, under different conditions or where different strategies have been employed. Additional priorities include:

- *Performance measures*. Conduct pilot tests of performance measures of restoration outcomes, on inundated islands undergoing restoration. Retrofit common monitoring protocols across restoration actions that are underway, including older flooded islands

(Strategic Goal 1, at-risk species, Strategic Goal 2; ecosystem processes and biotic communities; Strategic Goal 4, habitats).

- *Finding solutions to the constraints to restoring ecosystems of inundated islands by advancing process understanding of Delta ecosystems.* Some examples of important processes include:

  - Effect of subsidence, sediment deposition, sediment availability and re-suspension on time to achieve or sustainability of restoration (Strategic Goal 2).
  - Reactions of restoration efforts to other disturbances in the system (Strategic Goals 1-6).
  - Factors that determine recruitment of desired species vs. undesired species in breached systems with different geomorphology or elevation (Strategic Goal 1, Strategic Goal 5).
  - Interconnections between inflow regimes, tidally-driven hydrodynamics, sediment processes, channel form and elevation in inundated islands and channels and how they affect the ecological outcomes. Priorities include furthering applications of multi-dimensional hydrodynamic modeling and/or modeling coupled with physical measurements that address interconnections between ecology and physics; as well as models that can be used to address how ecological attributes, processes, habitats, and/or fish populations respond to flow regimes (Strategic Goal 2).
  - Effect of restoration on contamination problems or effect of contaminants on restoration outcomes (Strategic Goal 6).
  - Nature of native and non-native biological communities in different Delta environments (Strategic Goal 1 and Strategic Goal 5).

- *Restoration and monitoring strategies for riparian zones.* Improve understanding of appropriate conditions for the germination and establishment of riparian woody plants in the Delta, including addressing questions about the effectiveness of different restoration efforts in the riparian habitat zone (Strategic Goal 4, riparian habitat).

- *Better understand net effects of multiple restoration projects on waterfowl and wildlife distribution and abundance across the landscape.* Priorities include actions that develop methods for determining landscape distributions of different species or new approaches to monitoring (Strategic Goal 1, at-risk species assessment, Strategic Goal 3, harvestable species)

Water and sediment quality also threaten the success of restoration, but many of these issues are not adequately understood to set priorities for regulation or elimination of problems. High priority is thus given to advancing understanding of the importance of water quality issues and bettering the regulatory basis relative to other issues. To that end, the following are the highest priorities:

- *Effects of contaminants*. Studies should consider effects under the specific environmental conditions and exposures typical of the Delta, so as to prioritize effects on populations and restoration outcomes compared to other stressors (Strategic Goal 6, water and sediment quality).

- *Sediment Contamination* and effects of dredging in contaminated areas or disposing of marginally contaminated sediment (Strategic Goal 6, water and sediment quality).

- *Fish survival in the Central and South Delta.* Projects are needed to evaluate variables that might explain poor fish survival in the Delta and if or how it relates to water diversion (using new studies or existing data). Development of relevant biomarker techniques could be especially important (Strategic Goal 6, water and sediment quality).

- *Mercury.* Better understand processes that determine mercury methylation in the Delta and tributaries, particularly how it is affected by restoration in different settings. Yolo Bypass, Cache Creek and the Cosumnes River are of particular interest (Strategic Goal 6, water and sediment quality).

- *Selenium.* Understand transport of selenium from the San Joaquin River to and through the Delta. Advance understanding of selenium trapping in Delta shallow water/wetlands and accumulation/effects in the Delta food webs (Strategic Goal 6, water and sediment quality).

- *Transport of nutrients and current-use pesticides.* Projects are needed to develop models for processes that mobilize contaminants or nutrients from the watershed and transport them into the Delta and other waterways. Illuminate distributions of contamination through the Delta and effects of flow regimes on fate and transport within and through the Delta (Strategic Goal 6, water and sediment quality).

- *Emerging chemicals: Pyrethroids.* Baseline techniques for studying pyrethroids, and study pyrethroid occurrence, fate and toxic effects in eastside tributary floodplains, inundated Delta Islands, and tidal wetland ecosystems (Strategic Goal 6, water and sediment quality).

7.) Protect at-risk species in the Delta using water management and regulatory approaches.

Long-term management of the water-use system to protect fish is important to accomplishing the goals of ecosystem restoration. Therefore it is essential to begin now to improve the scientific underpinning of regulatory activities and manipulations of water management to protect species of concern. New, creative solutions to water management dilemmas can also result from better scientific knowledge of environmental processes in the Delta, fish behavior and biology, and the influences of water management. Priority will be given to studies of processes relevant to the interconnections of water management, regulation and fish protection. Priority will be given to studies that address processes relevant to, or that directly address the following topics:

Minimize effect of diversions on fish: Projects are needed that address the following questions about diversion effects on fish (Strategic Goal 1, At-risk species):

- What is the relationship between screening water diversions and protecting individual fish, populations and ecosystems?
- What are the full, economic or non-economic, cost-benefit implications of current water use, water management and fish protection strategies? Priority will also be given to studies that consider the limits of such analyses.
- Can models or statistical relationships be used to improve knowledge of the relationships between management actions and their influences on fish populations?
- What are the implications and environmental tradeoffs associated with the environmental water account?

Optimize use of Delta Cross Channel: Projects are needed that address the following question regarding Delta Cross Channel Operations (Strategic Goal 1, At-risk species).

- How do operational manipulations of the Delta Cross Channel, the export pumps or barriers, independently or in combination, affect water movement, water chemistry, transport of pollutants, fate of oxygen consuming materials, sediment deposition, or fish distributions/behavior? What is the net effect, or the cumulative effect, of such actions and changes on the Delta ecosystems or on restoration projects?

Optimize regulatory strategies to protect fish and develop temporal regimes for water movement that minimize adverse effect on fisheries: Projects are needed that support temporal management regimes for water movements in the Delta (Strategic Goal 1, At-risk species).

- What are the ecological characteristics of shallow water habitat in the Delta and how should those characteristics affect the definition used for management and restoration purposes?
- During what windows of time (and space) do species such as delta smelt, longfin smelt, Sacramento splittail and salmon occupy the Delta? Can work windows in the Delta be refined to more precisely direct variability in time and space when these species are present?
- What habitats in the legal Delta are critical for the delta smelt and other species considered in water management decisions. Does habitat use by these species vary in time and space (new projects or interpretations of existing data)?
- What processes influence the interconnections between levee protection techniques, water quality, biological community characteristics and attainment of ecosystem restoration goals?

8.) Understand the implications for Delta water issues of climate and hydrologic variability.

It is self-evident that climate has enormous implications for water management in California. Although the CALFED Program cannot engineer climate, or control its variability, actions across all programs (ERP, Drinking Water Quality, etc.) must operate within the constraints imposed by climate. It is difficult to imagine successfully managing water issues in California for the next decades in the absence of a better understanding long-term and short-term patterns and trends in climate and the implications of those patterns and trends for hydrology and issues linked to hydrology.

- *Studies to better understanding climate variability.* Studies of climate variability should include controlling factors and linkages to issues throughout the watershed that are especially critical for the Delta. Climate variability is a confounding factor in interpreting the success of CALFED Program actions, therefore, understanding interactions between climate change, hydrologic variability and the issues that will affect the CALFED Program success are important.

10.0 REGIONAL IMPLEMENTATION --BAY

Bay Regional Description

The Bay Region, or the Suisun Marsh/North San Francisco Bay Ecological Management Zone, includes the northern San Francisco Bay area, Suisun Bay and Marsh, San Pablo Bay, and the Napa River, Petaluma River and Sonoma Creek watersheds (CALFED ERPP Vol. II, 2000). The Ecological Management Zone does not include the Central and South bays. This region is the westernmost zone of the ERP. The eastern boundary is near Collinsville and the western boundary is the northwestern end of San Pablo Bay. The northern boundary follows the ridge tops of the Coast Ranges and the southern boundary is the San Rafael/Richmond Bridge (Attachment 5).

This region once contained extensive tidal marshes, but bayland alterations have reduced these marshes to a fraction of their historical extent, approximately 30 percent of North Bay tidal marshes and 21 percent of Suisun Region's tidal marshes remain (Goals Project 1999). The largest remaining tidal marshes are in the Petaluma River, Napa-Sonoma Marsh and Suisun Marsh. Many of the tidal marshes have been reclaimed for agriculture, salt production, duck clubs and managed freshwater marshes, mostly protected from flooding by hundreds of miles of levees. Consequently, the configuration of habitats in the Suisun and North Bay regions has largely shifted from arteries of highly branched tidal sloughs and creeks with complex marshplains, to a matrix of diked nontidal baylands with minimally branched and narrowed (infilled) tidal sloughs, and highly simplified fringing tidal marshes. Remnant tidal marshes are frequently so small that much of the community diversity distributed among marsh types, and especially terrestrial ecotones associated with marshes in the region, has been eliminated.

The Central and South bay areas are within the more expansive CALFED Program solution area and, if appropriate, projects may be considered if they clearly contribute to CALFED Program goals or to ERP Strategic Goals and the recovery of at-risk species identified in the ERP and MSCS. South and Central Bay are interconnected with the Suisun Marsh/North San Francisco Bay Ecological Management Zone by migration of anadromous fish (both into small streams throughout the watershed and through Central Bay as they move into the larger watershed). Overlapping territories of brackish water organisms, transport of sediments and circulation of waters also connect all the sub-systems in the Bay-Delta. For example, ecological disturbances in South or Central Bay could counter progress made in restoration efforts in the Suisun Marsh/North San Francisco Bay Ecological Management Zone. Water quality and availability decisions in the Delta affect South Bay water supplies and demand in South Bay could affect supplies for other localities.

The important habitat types in this region are tidal perennial aquatic habitat, tidal brackish and salt marshes, seasonal wetland, perennial grassland, riparian habitat and agricultural land. This region supports a host of native and non-native species of fish, waterfowl, shorebirds and other wildlife, including many native plant communities housing rare or endangered plants that are dependent on wetland processes. Additionally, all Central Valley anadromous fish migrate through the Bay Region and depend on its open water and marshes for some critical part of their life cycle. Many Pacific Flyway waterfowl and shorebirds pass through or winter in the Bay Region and feed in this highly productive estuary. The Bay Region and its adjacent marshes are important nursery grounds for many marine, estuarine and anadromous fish species. Some of the species of concern include chinook salmon, delta smelt, splitttail, salt marsh harvest mouse, California clapper rail, and numerous sensitive plant species.

Ecological factors having the greatest influence on this region include freshwater inflow from rivers and creeks; tidal action and climate (precipitation, evaporation, wind and barometic pressure); wetland distribution, abundance and quality; structure and distribution of riparian vegetation and the pattern or diversity of shallow aquatic habitats. Stressors include water diversions, poor water quality, legal and illegal harvest, wave and wake erosion, urbanization, and invasive non-native plant and animal species. Stressors to Bay Region tidal marshes also include alterations of tidal inundation regimes and seasonal salinity patterns, cattle grazing, and replacement of gradual ecological gradients with steep levee slopes. For a more detailed description of this region and the vision for this region, refer to the Ecosystem Restoration Program Plan, Volume II pages 123 - 155.

More in-depth descriptions and highlights on restoration efforts are discussed below for the Suisun Marsh and Bay and the North Bay (San Pablo Bay and its tributaries) units. Though these areas are contiguous and share many features, regional implementation plans, jurisdictional differences, and watershed characteristics tend to divide these areas into two discreet zones, hence they are discussed separately

Suisun Marsh and Bay: Suisun Marsh is in southern Solano County, , west of the Sacramento-San Joaquin Delta and north of Suisun Bay (Attachment 5). This intricate land-water area of tidal wetlands, diked seasonal ponds, sloughs, and upland grasslands comprises over 10 percent of the remaining wetlands in California, and is an important part of the San Francisco Bay-Delta Estuary. Suisun Marsh provides habitat for many species of plants, fish, and wildlife, in addition to wintering and nesting habitat for waterfowl on the Pacific Flyway. Suisun Marsh is a brackish marsh due to the combined influences of saline ocean water from Suisun Bay and fresh water from the Sacramento-San Joaquin Delta. Suisun Marsh was originally formed by the deposition of silt particles from floodwaters of Suisun Slough, Montezuma Slough, and the Sacramento-San Joaquin river network. Suisun Marsh soils are mixtures of hydrophytic plant remains and mineral sediments. As the Suisun Marsh formed, plant detritus slowly accumulated, compressing the saturated underlying base material. Mineral sediments were added to the organic material by tidal action and during floods. Generally, mineral deposition decreased with distance from the sloughs and channels (Miller and others 1975).

In its original state, Suisun Marsh consisted of islands separated by a network of tidal sloughs. Large portions of these islands were submerged daily by the high tides, while larger tracts of land were submerged during seasonal high tides and winter flood events. The salinity of the water in the sloughs of Suisun Marsh varied considerably with season and from year to year. The area was also distinctive from much of the Bay Region, but similar to the Delta in that it historically had a very thick organic peat marsh substrate, making it prone to subsidence. All the soils are saline and poorly drained. When allowed to dry, these hydric soils tend to subside, thus lowering the elevation of the pond bottoms. The native vegetation of Suisun Marsh consisted of aquatic plants such as tules *(Scirpus* sp.), cattails *(Typha* sp.), and rushes *(Juncus* spp.) in the areas of continuous flooding; salt grass *(Distichlis spicata*) on the higher ground not usually flooded; and pickleweed *(Salicornia virginic*a) in isolated areas of poor drainage. Salt grass was the predominant vegetation of most of the marsh.

Today Suisun Marsh is a mosaic of fragmented and disconnected habitats including diked wetlands, unmanaged tidal wetlands, bays and sloughs, and upland grasslands. Approximately 52,000 acres of the marsh are contained within levee systems and water control structures and are managed as seasonal wetlands, most of which are managed for waterfowl hunting. Acreage devoted to grazing and agriculture is very small. Tidal marsh areas are limited to about 6,300 acres in Suisun Marsh and 13,562 acres of tidal marsh for the Suisun Region as a whole. Larger tidal marsh areas are found along Hill, Peytonia, Montezuma, Suisun and Cutoff sloughs and First and Second Mallard Branch, and along the edge of Grizzly Bay. While most of the naturally tidally inundated marsh is gone, seasonal wetland habitat has increased in area. In Suisun Marsh, seasonal wetlands are managed primarily by deliberate temporary flooding of tidal water through tidegates, and subsequent drainage after a period of ponding. There are hundreds of tidegate intakes in Suisun, and the vast majority are unscreened. This practice and its effect on fisheries are largely unknown.

The southern edge of Suisun Bay is primarily urban, with several cities, industrial plants, and a military facility on or near the shoreline. There are a number of small, isolated marshes along the southern shoreline and several restoration projects have been implemented or planned. With the exception of the Port Chicago Navel Weapons Station and some parkland, the upland areas are developed.

Suisun Bay is generally the site where the seasonally variable null zone/entrapment zone and "X2" exists, and as such it is an area of high productivity and importance to a wide range of aquatic bay species. Nearly all of the historic marshes and sloughs adjacent to the null zone/X2 are bounded by dikes, so these potentially important shallow water systems are cut off from this important source of productivity. The Suisun Bay is also an important migration corridor for anadromous species (all Central Valley stocks), and an important nursery area for many species, including white sturgeon, striped bass, American shad, starry flounder, bay shrimp, and the listed delta smelt and splittail. Also, it provides open water habitat for waterfowl, and there is a least tern colony near Pittsburg.

North Bay: The North Bay is composed of the Napa River, Sonoma Creek, Petaluma River, and San Pablo Bay Ecological Management Units (ERP Vol. II, 2000). It extends through 5 counties, including Solano, Napa, Sonoma, and Marin, all west of Suisun Marsh and Bay (Attachment 5). Evolutionary history, varied topography, unusual soils and geology, wide differences in local climate, and the estuarine influence created a diverse array of habitats ranging from aquatic to xeric terrestrial types. These habitats form a mosaic pattern across the landscape and include tidal, brackish and seasonal freshwater wetlands and sloughs, diked seasonal ponds, upland grasslands and riparian/riverine corridors. San Pablo Bay provides habitat for many species of plants, fish, and wildlife, in addition to wintering and nesting habitat for waterfowl on the Pacific Flyway.

Much of the tidal marsh that originally flanked the northern border of San Pablo Bay has been diked and drained. Tributaries to the Bay suffer from reduced and impaired flows and the fragmentation of riparian corridors. Despite this, there is significant potential for restoring diked historic baylands to tidal influence and for reestablishing floodplain and upstream riparian habitat along many portions of the tributaries. Rapid urbanization and conversion to vineyards makes restoration an urgent priority for many parts of the watershed. The Baylands Goals report (SFEI 1999) calls for increasing the area of tidal marsh in the North Bay from 16,000 acres to over 38,000 acres, a potential increase to approximately 70 percent of the estimated area of historical marsh.

CALFED ERP Expenditures and Highlights

The funding allocated for the entire Bay Region including Suisun Marsh and Bay, North Bay and Central and South San Francisco bays is approximately $18.5 million for 41 projects (Figure 7). The CALFED ERP Program has funded 17 projects in the North Bay, including the Napa River, Sonoma Creek and Petaluma River, for an amount totaling $13.4 million, approximately 72 percent of total Bay Region's project expenditures. The projects include seasonal wetland, tidal brackish and saline wetland, and riparian restoration planning, acquisition and implementation, invasive species control (*Spartina alterniflora*), environmentally responsible vineyard management practices and watershed stewardship. In the South Bay, there has been limited funding with the emphasis on projects that have significant impacts on the entire North Bay, Suisun Bay, and Delta such as improvements in fish passage and research on steelhead and chinook salmon and non-native invasive species (Chinese mitten crab and *Spartina alterniflora).* Other Bay-Delta wide projects with beneficial impacts for the North Bay include anadromous fish protection, enhancement and research projects, research on control of invasive species (*Arundo donax,* purple loosestrife, ballast water treatment) and education programs.

CALFED ERP implementation is still in its early stages and it will be some time before most projects demonstrate measurable effects. Despite this, certain projects have already had significant positive impacts. The following projects have numerous partners, but were chosen largely to highlight projects supported by CALFED ERP funds. It should be noted that these projects are not necessarily the largest and most noteworthy projects as they build on previous efforts and are small in size. Other projects, such as Sonoma Baylands, Muzzi Marsh, and the Sonoma Land Trust Marsh, are completed efforts that have helped inform current restoration efforts. The Napa Salt Pond restoration effort, currently in the planning stage, has the potential to restore 9,850 acres of muted or fully tidal marsh west of the Napa River and north of Highway 37.

The Baylands Ecosystem Habitat Goals Project: This was a multi-agency interdisciplinary planning effort whose main objective was to identify the kinds, amounts and distribution of wetlands and related habitats needed to sustain diverse and healthy communities of fish and wildlife resources in the San Francisco Bay area. The Project presented its final recommendations in March 1999 in the form of the *Baylands Ecosystem Habitat Goals* report and later completed the *Community and Species Profiles* report.

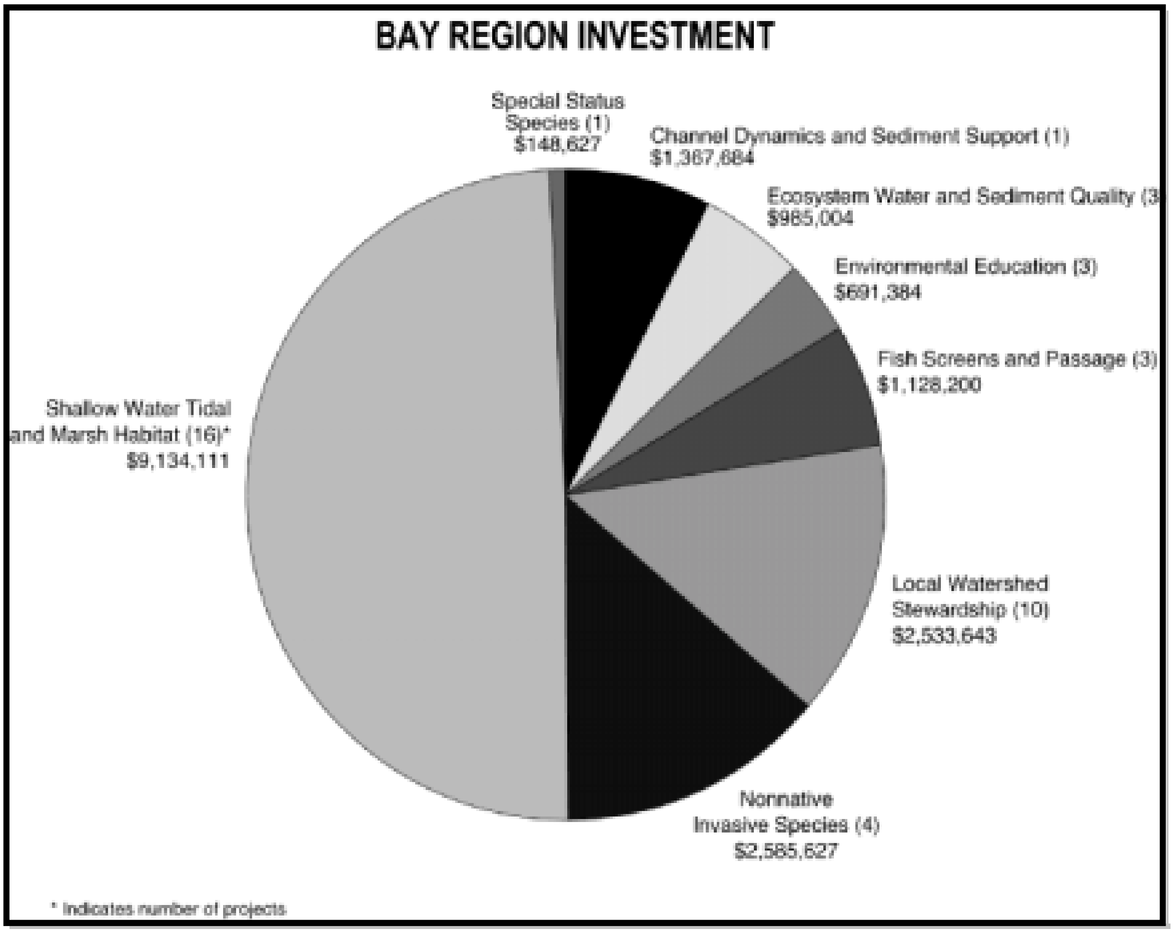

Figure 7. Bay Region ERP Restoration Investment

Suisun Marsh and Bay: Suisun Marsh currently receives significant attention by a number of State, federal, and county agencies. The Suisun Marsh Preservation Agreement was signed in 1987 by DWR, DFG, Bureau, and Suisun Resource Conservation District (SRCD) to mitigate for effects on Suisun Marsh salinity from the CVP, SWP and other upstream diversions. The agencies together with the USFWS have developed a Suisun Marsh Charter for the Development of an Implementation Plan for Suisun Marsh Wildlife Habitat Management and Preservation. They are now actively working on the development of a Suisun Marsh Implementation Plan that balances implementation of the Suisun Marsh Preservation Agreement, the CALFED program, and other management and restoration programs in the marsh. This plan will incorporate integrated solutions to meet Marsh needs including the protection of existing uses and endangered species recovery.

CALFED has funded 14 projects in the Suisun Marsh and Bay that cover a variety of topics. The projects funded to date include: shoreline restoration, seasonal wetland, tidal brackish and saline wetland restoration, acquisition and implementation, water quality improvements, environmental contaminants, endangered plant restoration, three fish screen projects, and educational programs. A few of these projects are discussed in more detail.

Hill Slough West Tidal Restoration Project. A CALFED funded project to restore tidal action to approximately 200 acres of seasonal and permanent wetlands in the northeastern Suisun Marsh on the DFG Hill Slough Wildlife Area. The project is a collaborative effort to restore a transition from perennial aquatic habitat to tidal saline emergent wetlands habitat and perennial grasslands. It is significant as the first tidal restoration project in Suisun Marsh. Potential benefits of the project include: reduced entrainment of fish into unscreened diversions, reversal of physical isolation of marsh plain, restored ecological functions and processes, and restored habitat for restoration of rare plant communities. To date a topographic survey, hydrologic evaluation, engineering level plan, and refined cost estimate have been completed. Forthcoming phases will cover environmental documentation, restoration and implementation, and reestablishment of rare plant communities, monitoring, and interpretive program implementation.

Suisun Marsh Vegetation Mapping Project. Vegetation mapping of Suisun Marsh was conducted in the summer of 1999 and 2000 and a vegetation map of the Marsh was completed in December 2000. The mapping was conducted by DFG and funded by DWR and the Bureau through the Suisun Marsh Preservation Agreement. The mapping project blended ground-based classification, aerial photo interpretation, and GIS editing and processing for 69,323 acres. Although not a CALFED Program funded project, this mapping effort provides important baseline information on vegetation for anyone conducting studies or planning restoration in Suisun Marsh.

North Bay: In the North Bay there are several ongoing regional restoration planning efforts and numerous agencies actively involved in restoration. Much of the infrastructure to implement the vision for this region is available; however, to achieve these goals will require significant effort to support and integrate existing planning efforts with CALFED Program implementation funds and to ensure that projects with the most significant positive ecological impacts are funded. Actions in the area will be stronger if they seek to integrate existing efforts and illustrate how projects build on locally driven but scientifically supported goals. For example, the Baylands Ecosystem Goals project provided an important foundation - an overview of historical conditions and wetland ecosystem goals. Other ongoing regional planning efforts such as the San Pablo Bay Watershed Restoration Framework (www.bay.org) and the San Francisco Joint Venture (www.sfbayjv.org) encompass broader geographic areas and seek to build on this approach by documenting ecological conditions, present issues and stressors, the outcome of past restoration projects and identifying restoration opportunities ripe for funding. Two areas in the North Bay, Tolay Creek and Cullinan Ranch are highlighted below.

Tolay Creek: The Tolay Creek restoration project was designed to return tidal flows to lower Tolay Creek and restore 435 acres of diked baylands to tidal marsh and creek floodplain. The USFWS (specifically the San Pablo Bay National Wildlife Refuge) and DFG jointly own and manage the marsh. The lower lagoon has been gradually filling with sediment and *Spartina* is emerging. The project illustrates the use of dredging and levee modification to restore a historic floodplain and associated marsh.

Cullinan Ranch: Cullinan Ranch, near Vallejo, is a 1500 acre ranch purchased by USFWS in 1991. The land was used as a hayfield and during the wet season, rainwater accumulated on the site. In 1993 the pumping was stopped in order to allow water to inundate the wetland and allow the area to restore passively to a seasonal wetland. USFWS is working with Ducks Unlimited to complete the first phase of tidal marsh restoration and with the U.S. Geological Survey-Biological Resources Division, San Francisco Bay Estuary Field Station. USGS is leading most of the biological research, which is being supported by CALFED ERP funds.

Scientific Studies in the Bay: CALFED Funding was also provided for five scientific studies for approximately $5 million. In addition, two large programs (>$1 million each) related to CALFED are underway in the Bay Area: the USGS's Integrated Science Place-Based studies are studying linkages between physical processes, sediments and ecosystems in Suisun Bay and Napa Marsh; the San Francisco Estuary Institute's Regional Monitoring Program monitors contaminants throughout the Bay system, including numerous sites in Suisun.

Table 4. Scientific Projects Funded by the CALFED Program in the Bay Region.

Year	Project Title	Amount Funded
1997	Evaluation of Se Sources, Levels and Consequences	$1,588,709
	Preventing Exotic Introductions from Ballast Water	$222,830
1998	Biological Restoration and Monitoring in the Suisun Marsh/North San Francisco Bay Ecological Zone	$772,667
1999	Understanding Tidal Marsh Processes and Patterns	$1,042,246
2001	Sedimentation in Delta and Suisun Bay	$1,367,684
	Total:	**$4,994,136**

The scientific findings of some of these studies were included in the ecosystem description of Suisun Marsh and Bay included above. An additional issue in the Suisun Marsh is contamination and poor environmental water quality, resulting from agricultural, industrial and urban waste inputs. A national classification of estuaries, conducted in late 1980s listed Suisun as one of the nations estuaries most vulnerable to adverse effects from water quality, primarily because of potential industrial, agricultural and urban pollutant inputs relative to the size and circulation patterns of the system (Biggs et al, 1990). CALFED and other agencies have since funded studies and regulatory actions related to sources of contamination. One of the contaminants of greatest concern in the area is selenium (because small increases in selenium contamination can have large impacts of wildlife). Selenium contamination of North Bay was found in the 1980's and was related to inputs from refineries surrounding Carquinez Straits. Recent studies (Cutter, CALFED Science Conference 2000) show that the selenium in water has declined in Carquinez Straits since refineries reduced their discharges of the element in 1998. Concentrations in suspended sediment, sediment and bivalves in the area had not yet declined, however, by 1999. Robin Stewart (CALFED Science Conference 2000) found within Grizzly Bay, that the Asian clam had the highest concentrations of selenium compared to other invertebrates. Among fish, white sturgeon bioaccumulated the highest levels of selenium. Concentrations in sturgeon were above the thresholds for potential reproductive toxicity. Splittail are another species that concentrate selenium, especially during that stage of their life cycle (adults) when they reside in selenium-contaminated Suisun Bay and eat bivalves. Striped bass had lower concentrations than sturgeon and splittail. This appears to be because crustaceans, at the base of the striped bass food web, do not strongly concentrate the element. Separate studies by Schlekat and Lee (CALFED Science Conference 2000) showed that both bivalves and crustaceans take up selenium efficiently from their food, but that crustaceans (including copepods, mysids and amphipods) also lose the element rapidly while bivalves retain selenium efficiently. The effect is less bioaccumulation by crustaceans than by bivalves, and less selenium threat to fish like striped bass than to bivalve-feeding fish like sturgeon. Because of their high trophic level, striped bass accumulate high concentrations of mercury however.

A potential source of selenium input to Suisun Marsh, with changing water management strategies, is irrigation drainage from the western San Joaquin Valley. A recent USGS study identified the most likely selenium loads that would be carried outside the San Joaquin Valley, if a drainage conveyance to Suisun were completed. The authors developed a model to forecast selenium concentrations and forms in the Bay-Delta from those loads, then used those concentrations to model selenium exposures of invertebrates, like clams. Transfer from clams to predators was also estimated, and selenium effects on wildlife were then forecast. The methodology could aid comprehensive consideration of the impacts of various drainage disposal options. The report also illustrates many specific needs for better data. The authors concluded that most options that fully meet existing demand for drainage disposal by an out-of-valley conveyance system appear to pose strong risks to the reproduction and survival of sensitive birds and fish in the Bay. Threats to reproduction and survival of birds and fish are particularly severe during periods of low river flow.

Restoration Priorities for the Bay Region

1. Restore wetlands in critical areas throughout the Bay, either via new projects or improvements that add to or help sustain existing projects.
2. Restore uplands in key areas of Susuin Marsh and San Pablo Bay
3. Implement actions to prevent, control and reduce impacts of non-native invasive species.
4. Understand performance of wetlands restoration efforts on a local and regional scale
5. Restore shallow water, local stream and riparian habitats for the benefit of at-risk species while minimizing potential constraints to successful restoration.
6. Protect at-risk species in the Bay using water management and regulatory approaches.
7. Improve scientific understanding of the linkages between populations of at-risk species and inflows, especially relative to regulatory measures like “X2”.
8. Use monitoring, evaluations of existing monitoring data, and new investigations to develop improved strategies for restoring Bay fish populations and at-risk species

RESTORATION PRIORITIES FOR THE BAY REGION

1. **<u>Restore wetlands in critical areas throughout the Bay, either via new projects or improvements that add to or help sustain existing projects</u> .**

Tidal marsh restoration is a key strategy in the Suisun Marsh and North San Francisco Bay area. The following types of projects are needed.

- *Protect existing tidal marsh* and restore tidal marsh in diked baylands and shoreline along San Pablo Bay and the Napa and Petaluma rivers and Sonoma Creek, especially in the Napa-Sonoma Marsh and Petaluma River marshes (Strategic Goal 4, shallow water, tidal and marsh habitat).

- *Restore marshes* along the northern and southern sides of Suisun Bay, Grizzly Bay and Honker Bay, ultimately to provide a continuous band of restored tidal marsh. In Suisun Marsh, restore a continuous band from the confluence of Montezuma Slough and the Sacramento/San Joaquin rivers to the Marsh's western edge (Goals 1999). (Strategic Goal 4, shallow water, tidal and marsh habitat).

- *Tidally muted marsh and seasonal wetland habitat*. Projects should create and/or enhance managed muted marsh and seasonal habitat on diked baylands in areas where full tidal inundation is not possible or as a first step toward full tidal action; especially where muted tidal marsh habitat provides direct benefits for waterfowl guilds and indirect benefits for some endangered marsh species (Strategic Goal 4, shallow water, tidal and marsh habitat).

- *Enhance managed waterfowl wetlands.* Demonstration/research and adaptive management projects to enhance existing managed waterfowl wetlands by converting seasonal pond management to muted tidal pond management. These demonstration projects must be accompanied by research to determine how tidally muted marshes can be managed such that they are beneficial to waterfowl and fishes, particularly at-risk species. Landscape analysis of which species benefit and what species would be lost (net ecological implications) by broad scale restoration strategies are also needed (Strategic Goal 4, shallow water, tidal and marsh habitat).

- *Retrofit historic dikes to more natural configuration. D*emonstration projects to retrofit historic dikes to a configuration that provides a gradient that more closely mimics the natural high marsh/terrestrial ecotone. Proposed configurations include lowering the dike crest elevation and reducing the landward slope (Strategic Goal 4, shallow water, tidal and marsh habitat).

- *Riparian and riverine aquatic habitat restoration.* Riparian and aquatic habitat restoration efforts in Suisun Marsh and tributaries to the San Pablo Bay may include the use of tools such as conservation easements, purchases and restoration of riparian corridors. Restoration Efforts should be designed and sized to provide multiple ecosystem benefits, including habitat for at-risk fishes, riparian mammals, and migratory songbirds in the riparian zone. Efforts might include studies analogous to those detailed for marshes (Strategic Goal 4, riparian habitat).

- *Update existing outdated Individual Ownership Management Plans* to provide landowners with multiple management strategies to protect, conserve, and sustain brackish marsh diversity, waterfowl, and wildlife values within the managed wetlands (Strategic Goal 4, shallow water, tidal and marsh habitat).

2. Restore Uplands in key areas of Suisun Marsh and San Pablo Bay

- *Acquire, protect, and restore vernal pool habitats and perennial grasslands* north and east of the Suisun Marsh and in key areas of the San Pablo Bay watershed to benefit endemic plants and animals specific to these habitats (see Attachments 1 and 3 for CALFED designated species) (Strategic Goal 4, uplands and wildlife-friendly agriculture).

3.) Implement actions to prevent, control and reduce impacts of non-native invasive species.

- *Develop pilot projects* in the marsh habitats to develop successful approaches to understanding invasion rates, ecological impacts and control strategies of *Lepidium latifolium* (pepperweed), *Salsola soda* and other NIS plants (Strategic Goal 5, non-native invasive species).

- *Research* the relationships between inundation, salinity and NIS needs in tidal wetlands to identify the hydrologic regimes less favorable to the non-natives (Strategic Goal 5, non-native invasive species).

- *Consequences of Non-native Invasive Species.* Marsh slumping and pillaring in South Bay and in upstream marshes due to Chinese mitten crab and isopod burrowing (combined with erosion) is becoming quite serious. Evaluate the function of various effects, such as flows, wind waves, sediment types, sediment porosity, and burrow density with an interdisciplinary team of biologists, sedimentologists and geologists (Strategic Goal 5, non-native invasive species).

- *Consequences of Non-native Invasive Species.* Bank slumping and erosion due to Chinese mitten crab burrowing has also recently become much more apparent in upstream areas in tributaries to the Bay. It is important to investigate and document the negative impacts of this activity as a means of developing methods and projects that may reduce these impacts (Strategic Goal 5, non-native invasive species).

- *Improve knowledge base and eradication strategies for controlling non-native species with potential for major ecological impacts.* Priorities include studies, surveys, and monitoring to better understand trends, life histories, distributions and potential means for controlling the overbite clam (*Potamocorbula amurensis*), mitten crabs, and the eastern cordgrass *Spartina alterniflora* (and its hybrids). Methodologies to monitor invasive species at the scale of the Bay Region are a special priority (Strategic Goal 5, non-native vegetation management).

4.) <u>Understand performance of wetlands restoration efforts on a local and regional scale.</u>

To date, land purchases and restoration in the Bay have not been accompanied by substantial efforts to document the accomplishments of the investments.

- *Retrofit monitoring to existing restoration projects.* Multi-site monitoring/assessment projects and programs (including performance measures) are needed from South Bay through Suisun Bay. Pilot monitoring/assessment programs, and pilot scale testing of performance measures are needed at several scales to document performance of wetland habitat restoration, advance understanding of optimal restoration approaches and coordinate restoration at the regional scale (Strategic Goal 4, habitats).

- *Enhance interpretations of existing aquatic system monitoring information from the Bay.* Fisheries and water quality monitoring data has been conducted in the Bay for over 20 years. Priority will be given to efforts that derive questions important to status of species, communities and species recovery, and propose to use the existing data to begin to frame answers to those questions (Strategic Goal 1, at-risk species).

<u>5. Restore shallow water, local stream and riparian habitats for the benefit of at-risk species while minimizing potential constraints to successful restoration efforts.</u>

Hydrology, water/sediment quality and invasive species are major limitations to effectively restoring populations and ecosystems in the Bay and to sustaining restoration efforts. Better understanding of the relative importance of the most important limiting factors, especially relative to some specific restoration efforts, is important.

- *Modeling and physical measurement studies that detail how freshwater and brackish water interact in Suisun Marsh.* Better understand how those interactions are affected by natural tidal processes, levee breaks, and how managing levees in the marsh might influence water quality and supplies of high quality water elsewhere in the Delta (Strategic Goal 2, ecosystem processes; Strategic Goal 6, water and sediment quality).

- *Mercury inputs from Yolo Bypass and their implications in Suisun Marsh and Grizzly Bay.* Potential contaminant inputs from local dredge fill projects also need to be better understood (Strategic Goal 6, water and sediment quality).

- *Effects of hydraulic mining debris and other mercury sources on wetlands development and production of methylmercury.* Locate where hydraulic mining debris deposits and other types of mercury deposits interconnect with proposed and on-going restoration. Understand implications of restoring mercury contaminated sediments for regional and local methyl mercury production and food web accumulation (including environmental justice implications of the latter) (Strategic Goal 6, water and sediment quality).

- *Spatial and temporal variability of structure and dynamics of tidal wetland plant communities*. Determine the relationship of vegetation pattern to depth and duration of flooding, soil salinity, soil redox potential, soil pH and channel water salinity (Strategic Goal 2, ecosystem processes, Strategic Goal 4, habitats).

- *Critical life stages and range of edaphic requirements of sensitive plant species*, including listed species and species recognized to be in decline, which could become further endangered by management actions (Strategic Goal 1, at-risk species assessments).

- *Track the distribution of rare plants, listed species and species diversity in different tidal and managed environments.* Needs and processes are important; Suisun Marsh, San Pablo marshes and South Bay are all of interest, as are comparisons of regions (Strategic Goal 1, at-risk species assessments).

- *Demonstration projects to evaluate the potential use of dredge material to restore deeply subsided areas to tidal marsh*. Projects must include monitoring and assessment targeting processes that can affect sustainability, like dredge material erodability, grain-size distribution, transport, formation of dendritic channels, and contaminant release. Retrofit studies to on-going experiments (Strategic Goal 4, habitats; and Strategic Goal 6, water and sediment quality).

- *Fine sediment loadings.* Support actions to assess the level of, determine the ecological impacts of, and reduce fine sediment loading to streams, especially in the Napa and Petaluma rivers and Sonoma Creek. Understand interactions with sediment inputs to restoration projects (Strategic Goal 6, fine sediment).

- *Understand implications of contamination problems for local restoration projects and regional restoration strategies.*

  --Understand contributions of sediment deposits (historic legacy) to regional scale problems (as compared to local inputs) (Strategic Goal 6, fine sediment).

  --Selenium cycling, trends and effects in Suisun/San Pablo Bay (Strategic Goal 6, selenium).

  --Implications to wetlands and the aquatic environment of pesticide inputs from urban sources. Improve understanding of the effects that pesticide inputs from urban and agricultural sources have on wetlands. Include study of the toxicity inputs in local streams and pesticide inputs implications at their intersection with the Bay (Strategic Goal 6, pesticides).

--Begin studies of "emerging" chemicals, including pharmaceuticals, cosmetic products and estrogens that have apparent impacts on animal reproduction elsewhere. Clarification of distributions (time and space) and potential effects on local fauna/flora are needed (Strategic Goal 6, other pollutants).

--Understand implications for specific restoration projects of PAH's, other components of urban runoff, and PCB's (Strategic Goal 6, other pollutants).

6. Protect at-risk species in the Bay using water management and regulatory approaches.

Availability of organic carbon could be an important limitation to restoration of critical fish populations in the Bay. Restoration actions in the watershed might influence estuarine food web productivity by affecting the carbon and nutrient loads delivered to the estuary through bypasses and rivers. Internal production of organic material may also be affected if restoration projects result in increased production of bioavailable organic material. Exotic species may also play a role in redistributing the flow of carbon. Finally, many food webs in the Bay are poorly understood, as are the factors that control their structure, function and productivity.

- *Better understand primary and secondary productivity* within Suisun Bay, North Bay, and South Bay and linkages among internal and external inputs (Strategic Goal 2, decline in productivity).

- *Better understand linkages between North and South Bay* that might affect restoration or productivity in either; and understand implications of engineering projects for such linkages (Strategic Goal 2, decline in productivity).

- *Understand linkages* between tidal marshes and adjacent habitat, in creation and transfer of bioavailable organic material (Strategic Goal 2, decline in productivity).

- *Understand poorly known aspects of the food webs* of Grizzly Bay, San Pablo Bay and South Bay. Establish pilot efforts and field experiments to demonstrate techniques for effectively monitoring food web structure and function (Strategic Goal 2, decline in productivity).

7. Improve scientific understanding of the linkages between populations of at-risk species and inflows, especially relative to regulatory measures like "X2".

Flow and physical structure are important determinants of the positioning of the freshwater-seawater interface in the Bay; which in turn seems to be related to success of some species. The mechanistic basis for these relationships are not well known, however. Better understanding of the physical, biogeochemical and ecological processes related to X2 and this zone is critical. A related question is whether tidal wetlands restoration near this zone is an overall benefit more-so than other sites.

- *Hydrologic/sediment transport models as restoration tools.* Develop methodologies, including a combination of simulation models and physical measurements, to evaluate flow, sediment transport and hydrodynamic patterns in the Suisun Marsh, Grizzly Bay, the Sacramento River-Montezuma Slough complex, Napa-Sonoma Marsh and tributaries to the San Pablo Bay, related to the freshwater-seawater interface. Apply such approaches to understand how engineering changes in the Delta and actions in the Bay (including restoration) might affect X2, water quality and ecosystem processes (Strategic Goal 2 X2 relationship).

- *Improve understanding of how physical processes* affect ecological processes in the sloughs, bays, tidal flats and associated marsh plains (Strategic Goal 2, channel dynamics).

- *Understand short-term to long-term sediment deposition patterns* throughout the Bay, especially as they relate to sustainability of sediment deposition at restoration sites (Strategic Goal 2, sediment transport).

8. Use monitoring, evaluations of existing monitoring data and new investigations to develop improved strategies for restoring Bay fish populations and at-risk species

Priorities include:

- Effects of open water and tidal marsh food web interactions on fish population dynamics.

- Examine how trends in chlorophyll a, zooplankton and pollutants impact different fish species locally (in Suisun Marsh) and across the Bay region landscape (interconnections between Bay segments) (Strategic Goal 2, decline in productivity).

- Develop pilot programs for monitoring of zooplankton from tidal marshes to open water (Strategic Goal 2, decline in productivity).

- *Monitor and improve understanding of zooplankton and juvenile fish distribution and abundance* (species composition, density, size distribution, condition factor) in the Bay proper and various types of shallow water habitats, including marsh plain channels and larger order sloughs of tidal marshes and riparian floodplains in San Pablo Bay tributaries (Strategic Goal 2, decline in productivity).

- *Understand anadromous and estuarine fish use of North Bay and South Bay tributaries* (include steelhead, chinook salmon, and splittail as priorities) and potential of restoration projects in small streams vs. larger areas in the Delta and watershed (Strategic Goal 1,at-risk species assessments).

- *Interpret existing region-specific monitoring data on fishes, aquatic ecosystems, wetland communities and water quality for North Bay, Central Bay and South Bay. Develop new data and monitoring approaches.* Understand fish, wetland and mammal communities, and their interconnections with the rest of the Bay, especially relative to large engineering projects and restoration proposed (Strategic Goals 1-6).

- *Better understand the Bay waterfowl community*, including surveys of distributions (time and space; local to landscape), analyzing trends from existing data, life histories in the Bay region, environmental requirements and effects of pollutants (Strategic Goal 1 and Strategic Goal 6).

- *Determine the extent of intermarsh movements by at-risk species* within marshes in the San Francisco estuary and how dispersal and colonization movements are related to marsh size, shape, position, habitat characteristics, and population dynamics (Strategic Goal 1 and Strategic Goal 6).

11.0 PROJECT SOLICITATIONS AND DIRECTED ACTIONS FOR THE ERP

The ERP uses several processes to fund actions and implement ecosystem restoration activities. One method that has been in use for the last four years is to fund projects through a Proposal Solicitation Package (PSP). The PSP process allows for an open solicitation, rigorous technical review and public input in identifying and funding ecosystem restoration actions. This process consists of a call for proposals and a multi-step proposal review. Projects are initially selected by a Selection Panel and final selection occurs after a multi-step public comment and approval process. The 2002 PSP is being released at the same time as this Draft Implementation Plan. Refer to the 2002 PSP for full details of the PSP process and instructions on how to submit a proposal.

The Proposal Solicitation Process (PSP) will always be an important aspect of how the CALFED Program funds projects. However, it has become apparent that for all CALFED Programs, a PSP process alone will not be sufficient. The proposals are unlikely to always include all the specific investigations necessary to resolve critical uncertainties, or scientific actions necessary to meet critical or time-dependent objectives. Given the scope and complexity of some of the issues facing CALFED, it may be necessary to supplement the annual calls for proposals with support for additional (sometimes sustained) commitments of effort. Addressing critical information needs may require specifically soliciting specific study approaches or projects that fill gaps of strategic need.

Gaps are subject areas and projects called for in implementation plans and PSP priority designations, for which an inadequate number of high quality proposals were received. In addition, it may be necessary to solicit types of projects that are not commonly submitted via the PSP process, including interdisciplinary studies coordinated among investigators, experimental studies organized across a range of appropriate spatial and temporal scales, studies that cut across program issues, studies that take advantage of specific adaptive management opportunities, opportunities to coordinate monitoring efforts or develop new monitoring protocols, development of analytical and numerical models of critical ecosystem functions and responses to management actions. Achieving a critical restoration action, for example, may require developing a team of specific individuals or institutions to undertake or complete the desired action.

In such cases, CALFED may wish to contract with specific individuals or institutions, because of recognized expertise, accomplishment and past responsiveness, to carry out a program of strategic study or action that is not adequately accommodated in the year-to-year PSP process. The following protocol defines how special projects are selected for such contracting.

CALFED ERP DIRECTED PROPOSAL PROCESS

Identification of Restoration or Information Needs

The critical restoration or information needs and actions will be identified in the ERP Draft Stage 1 Implementation Plan. To identify those needs, the ERP will continue to solicit input from the

Lead Scientist, the ERP's Agency and Stakeholder Ecosystem Team (ASET), the ERP's Independent Science Board, regional workshops and workshops in specific subject areas.

The directed priorities will be identified after the PSP proposals are reviewed and preliminary projects selected, by identifying gaps left unfunded or inadequately funded by the PSP. Thus, the directed efforts are justified by addressing those identified needs left inadequately supported by the PSP process. The program, in collaboration with the ASET and the Independent Science Board will designate the level of funding and identify specific projects with consideration for:

- Immediacy of the need (more immediate needs get highest priority, immediate can include immediate need to begin a long-term study because of importance or lack of knowledge).

- Availability of at least some investigators known to be interested and qualified to do work (i.e., talent is available to meet the need).

Soliciting Needs

Where possible, the above entities will identify individuals, groups or institutions from which proposals might be solicited. The potential applicants might be people who submitted proposals that were not accepted in prior competitions, but who had ideas that might result in suitable proposals if modified as suggested by reviewers. They might also be specialists identified by the program or its advisors as especially qualified to do the needed work.

It is desirable that the strategic needs be broadcast to a wider audience than just those solicited (although, in most cases, the priorities would have already been advertised via the PSP). For this purpose, the description of gaps and needs will be placed on the CALFED Program website, so if others can respond and enough money is available, opportunities are open to people not yet identified by the above entities. This solicitation will be held open until the designated funding is expended.

Proposal Format

Applicants (invited and contributed) can submit one page pre-proposals, although full proposals without pre-proposal will also be accepted. Pre-proposals will be screened and the program will reply to applicants as to whether the subject area is of interest. Pre-proposals will not be used to guide proponents through developing full proposal (to avoid favoritism). Pre-proposals are simply a way for applicants to verify the CALFED Program interest. CALFED Program staff review and replies will be brief and will either solicit a full proposal or suggest submission to the PSP process.

The individual/entity will develop a proposal, using the format described in the most recent PSP. Full proposal must include:

- Suggestions for referees, with one sentence justification for suggestion. The program is not obliged to use these referees.

- Enough detail to evaluate both the idea and the approach: ~10 – 15 pages should include

- Broad questions;

- Clearly stated objectives and testable hypotheses;

- Relevance to ERP and CALFED Program;

- Justification, including conceptual model, relevance to adaptive management and citation of studies that support idea and approach ;

- Detailed discussion of experimental design, approach, statistical methods, methodologies (including monitoring methodologies if appropriate), as well as why the approach is novel and why it will work.

- Expected products, publications and oral presentations including milestones indicative of success;

- Qualifications, facilities, and history of accomplishment of principle investigators and co-investigators.

Review Process

It is critical that proposals submitted under the Strategic Directed Study Program be subject to deliberate and objective technical and management review, with grants being made on the basis of technical merit as well as CALFED Program need. Carrying out such a review will require instituting an objective process for the anonymous peer evaluation of proposals that is efficient and achieves broadest acceptance of the process within the CALFED community. It is critical that all proposals are peer reviewed before funding is granted.

The overall review process is comprised of a two-tiered system:

- Peer evaluation of the scientific merit and reasonableness of the proposed work, and qualifications of the principle investigator(s), and

- Technical and programmatic evaluation of the appropriateness of the proposed work under the Directed Studies Program

Selection

The Review Panel will transmit its findings, priority rankings, and recommendations to the appropriate stakeholder oversight bodies (Management Team, Ecosystem Roundtable, Policy Group). Selection conclusions and reviews will be posted on the web, along with the abstract of proposal.

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To be completed.

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