CHAPTER 3 – DRAFT STAGE 1 PSP PRIORITIES FOR THE ECOSYSTEM RESTORATION PROGRAM

The Draft Stage 1 Implementation 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, we expect to continue refining the elements of the Draft Stage 1 Implementation Plan and will establish regional workshops during early 2002 as we improve and identify restoration and science priorities for 2003 and beyond. This process will establish the boundaries of actions and information-gathering efforts needed to conform to the regulatory commitments contained in the ROD during Stage 1.

3.1 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. CALFED Program 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 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 Ecosystem Restoration Program as described in CALFED's programmatic documents falls within the first four regions. Therefore, this Draft Stage 1 Implementation Plan focuses on the Sacramento, San Joaquin, Delta, and Bay regions.

3.2 PROCESS FOR 2002

The CALFED Agency/Stakeholder Ecosystem Team (ASET), ERP staff, CALFED Science Program staff and CVPIA staff have worked collaboratively to develop the Draft Stage 1 Implementation Plan. This included an analysis to identify which ERP actions and targets are identified in the ROD commitments and ERP/Multi-Species Conservation Strategy milestones. The group also assessed the projects funded to date and how they match up to these same categories. The Draft Stage 1 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. 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. As new information becomes available and conceptual models are tested and refined, priorities are anticipated to change and new issues or questions will emerge.

3.3 PRIORITIES FROM THE DRAFT STAGE 1 IMPLEMENTATION PLAN

The Draft Stage 1 Implementation Plan provides information regarding the priorities, potential projects or programs, the science needs for each of the four regions, and priorities for multi-regional issues and opportunities. This PSP is based on the priorities identified in the Draft Stage 1 Implementation Plan and potential applicants should carefully review the appropriate section in the implementation plan for guidance in developing proposals. Applicants should consider the following priorities as the basis for developing their proposals and to clearly identify the linkage of the proposed action to the priority. The priorities are presented as follows: (1) multi-regional, (2) Sacramento Region, (3) San Joaquin Region, (4) Delta and Eastside Tributaries Region, and (5) Bay Region.

The Draft Stage 1 Implementation Plan provides information regarding the priorities, potential projects or programs, the science needs for each of the four regions, and priorities for multi-regional issues and opportunities.

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 and Actions (MR = Multi-Regional)

MR-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 soda* 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.

MR-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 Agriculture.

- *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.

MR-3.) Implement environmental education actions throughout the geographic scope.

- *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.

MR-4.) Ensure restoration and water management actions through all regions can be sustained under future climatic conditions.

- *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.

MR-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.

MR-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 used for conceptual modes, describing existing and restored ecosystems in each stream.

- *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.

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 and Actions for the Sacramento Region (SR = Sacramento Region)

SR-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.

SR-2.) Restore fish habitat and fish passage particularly for spring-run chinook salmon and steelhead trout and conduct passage studies.

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).

SR-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).

- *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).

SR-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.

- *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).

SR-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).

SR-6.) Continue major fish screen projects and conduct studies to improve knowledge of implications of fish screens for fish populations.

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/Ranch Seco Pumping Plan.

- *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?

SR-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).

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 and Actions for the San Joaquin Region (SJ = San Joaquin Region)

SJ-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).

SJ-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).

- *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).

SJ-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.

SJ-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.

SJ-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).

SJ-6.) 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 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).

- *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).

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 and Action for the Delta and Eastside Tributaries Region (DR = Delta Region)

DR-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).

- *Acquire, protect, and restore habitat.* 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).

DR-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.* Restore or continue study of the values of restoring large seasonally flooded areas like the Yolo Bypass including projects that provide hydraulic impact information that allows for restoration projects to take place without jeopardizing conveyance (Strategic Goal 4, floodplains and bypasses as ecosystem tools).

DR-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).

DR-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).

DR-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).

DR-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).

DR-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?

DR-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.

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 and Action for the Bay Region (BR = Bay Region)

BR-1.) Restore Wetlands In Critical Areas Throughout The Bay, Either Via New Projects Or Improvements That Add To Or Help Sustain Existing Projects .

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).

BR-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).

BR-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).

BR-4.) Understand performance of wetlands restoration efforts on a local and regional scale.

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).

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

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).

BR-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).

BR-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).

BR-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).