CALFED Bay-Delta Program

Ecosystem Health

Category III Guidance Document

CALFED
BAY-DELTA
PROGRAM

The Category III Guidance Document was developed to facilitate coordination between the ecosystem health components of the CALFED Bay-Delta Program (long-term objectives) and the near-term objectives of the Category III program, which resulted from the Bay-Delta Accord.

This document attempts to develop a framework for determining priority project funding in the second round of Category III funding within the context of the long-term program. This guidance should identify types of actions which, if funded by the Category III program, will be most beneficial to achieving the ecosystem health objectives of the long-term program.

I. Introduction: Ecosystem Quality

The Bay-Delta system no longer provides a broad diversity of habitats nor the habitat quality necessary to maintain ecological functions and support healthy populations and communities of plants and animals. Much of the public focus on ecosystem problems has centered on fisheries, especially those populations which have been designated as threatened or endangered under Federal and State laws. Declining fish populations and endangered species designations have generated major conflicts among beneficial uses of water in the Bay-Delta system. The underlying problems, however, are much broader and more far-reaching than a decline in fish. The health of the Bay-Delta ecosystem has declined in response to a loss of habitat to support various life stages of aquatic and terrestrial biota and a reduction in habitat quality due to several factors.

The steady decline in habitat quantity, quality, and diversity results from many activities both in the Delta and upstream. The earliest major damaging event was the unrestricted use of hydraulic mining in the river drainages along the eastern edge of the Central Valley, which greatly increased the amount of sediment entering the river systems. The effect of hydraulic mining was twofold. First, habitat degradation occurred in Central Valley streams as channel beds and shallow areas filled with sediment. Then the reduced capacity of the sediment-filled channels resulted in an increase in frequency and extent of periodic flooding. This accelerated the need for flood control measures to protect adjacent agricultural lands. Levee construction to protect these lands eliminated fish access to shallow overflow areas, and dredging operations to construct levees eliminated tule bed habitat along the river channels. Since the 1850s, 700,000 acres of overflow and seasonally inundated land in the Delta have been converted to agriculture or urban uses. Many of the remaining stream sections have been dredged or channelized to improve navigation, increase stream conveyance during periods of flood, and facilitate water export.

Upstream water development, depletion of natural flows and the export of water from the Delta have changed seasonal patterns of inflow, reduced annual outflow and muted the natural variability of flows into and through the Delta. Facilities constructed to support water diversions cause straying or direct losses of fish (e.g. unscreened diversions) and increased unnatural predation (e.g. Delta cross channel and Clifton Court Forebay). Entrainment and export of substantial quantities of food web organisms, eggs, larvae and young fish further exacerbate the impacts from overall habitat decline.

Habitat alteration and water diversions are not the only factors that have caused ecosystem problems. Water quality degradation caused by pollutants and increased concentrations of substances such as selenium may also have contributed to the overall decline in the health and productivity of the Delta. In addition, undesirable introduced species compete for available space and food supplies, sometimes to the detriment of native or economically important introduced species.

The primary Program objective for ecosystem quality is to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta system to support sustainable populations of diverse and valuable plant and animal species. Important habitat types include shallow water, shaded riverine aquatic, tidal slough, brackish and freshwater marsh, and riparian woodland. These habitats provide essential areas for activities that include breeding, foraging, resting, avoiding predators, and overwintering.

The decline of species dependent on the Bay-Delta system for all or part of their life cycle now results in considerable conflict among beneficial uses of the Delta and highlights the urgent need for resolution and restoration. Key issues which affect ecosystem quality are water export, outflow, levee and channel maintenance, and other nonflow related issues. Ecosystem quality can be restored or improved through changes in export timing and the method(s) of export. Enhanced flexibility in diversion and export activities can contribute significantly to restoration of beneficial flow patterns. If additional water supplies are developed in an environmentally sensitive manner or water needs are reduced, more functional Delta outflow can be provided. Improvement in levee maintenance and stabilization can be achieved by incorporating habitat restoration on or in levees and channels into future actions. If the conflicts over levee maintenance versus habitat could be addressed, levees could be rebuilt or improved using sound levee stabilization techniques which incorporate waterside berms that provide habitat elements such as shaded riverine aquatic and riparian. Additional habitat restoration could also be accomplished during efforts to address Delta island subsidence.

II. Problem and Objective Statements

Problem Statements

Problems of the Bay-Delta System related to ecosystem quality are expressed primarily in terms of the inadequacy of aquatic and wetland habitats. This emphasis on habitat reflects an ecosystem approach to problem-solving. An ecosystem approach entails addressing the underlying causes of ecosystem degradation through protecting, enhancing, and restoring important habitats.

Limitations in Delta habitat affect species in various ways. Some species reside in San Francisco Bay as adults and use Delta habitats for spawning and juvenile rearing (e.g. longfin smelt). Other species (e.g. salmonids) spawn upstream of the Delta and reside as adults in the Pacific Ocean but must travel through the Delta and Bay during juvenile outmigration and adult inmigration. The size and health species populations and species communities residing in the Bay-Delta system will be used as indicators to judge the success of the CALFED Bay-Delta Program in resolving habitat problems. If habitat problems are correctly identified and Program objectives are met, the result should be an increase in the size and health of species populations. For example, recovery of populations of resident species such as delta smelt and anadromous species such as chinook salmon that use the Delta would indicate that improvements to Delta habitats had been successful.

Many of the plant and animal species that use the Bay-Delta have experienced moderate to severe declines. The Bay-Delta ecosystem does not now contain the amount or quality of habitat needed to support a diverse assemblage of valuable plant and animal species. The major problems for the Bay-Delta's fish and wildlife and the aquatic and wetland habitats that support them are outlined below. Important species of fish, animals, plants, and other life-forms are identified in the problem statements as examples of the organisms adversely affected by the named habitat problems.

A. **Important Aquatic Habitats** are inadequate to support production and survival of native and other desirable estuarine and anadromous fish in the Bay-Delta system. Examples of fishes that have experienced declines related to changes in Delta habitat include delta smelt, longfin smelt, Sacramento splittail, chinook salmon, striped bass, and American shad. The problems for specific aquatic habitats include:

1. **Lack of Shallow Riverine Habitat** limits spawning success and early survival of many estuarine and anadromous fish in the estuary. Examples of affected species include Sacramento splittail, chinook salmon, striped bass, delta smelt, and American shad.

    a. **Lack of Riverine Edge Habitats** limits spawning success and survival of juveniles of many fish species that use such habitats for spawning and rearing (e.g. Sacramento splittail, delta smelt, largemouth bass, and chinook salmon).

b. **Lack of Shallow Shoal Habitat** within the main channels of the Delta and upper Bay limits shallow foraging habitat and protective cover for juveniles of many estuarine fish (e.g. Sacramento splittail, striped bass, delta smelt, longfin smelt, starry flounder, and white sturgeon).

2. **Lack of Shaded Riverine Habitat** limits growth and survival of estuarine resident and anadromous fish in the estuary (e.g. Sacramento splittail, chinook salmon, and tule perch).

   a. **Lack of Riparian Woodland** limits cover and terrestrial food production for Delta fish.

   b. **Lack of Large, Woody Debris** along Delta levees limits feeding and refuge habitat for juvenile and adult fish in the Delta.

   c. **Lack of Shaded Habitat** results in elevated water temperatures.

3. **Reduced Quality of Tidal Slough Habitat** limits the aquatic resource production capacity of the Delta (e.g. delta smelt, chinook salmon, striped bass, Sacramento splittail, tule perch, and copepods).

   a. **Degradation of Dead-End Slough Habitat** reduces areas available for spawning and rearing of some native resident fish species.

   b. **Abundant Water Hyacinth** may limit productivity of tidal slough habitats.

   c. **Primary Biological Production** during tidal cycling is limited by lack of tidal slough habitat.

4. **Springtime Upstream Relocation of Estuary Entrapment/Null Zone Habitat** by low Delta outflow limits the availability of suitable rearing habitat in the estuary (e.g. delta smelt, longfin smelt, and striped bass).

   a. **Saltwater Intrusion into Suisun Bay** reduces the bay's value as a low-salinity nursery area.

   b. **Low Salinity (less than 10 ppt) Habitat** is confined to deeper channels in the Western Delta where it is of limited value as compared to Suisun Bay.

   c. **Brackish Water (1 to 25 ppt) Habitat** occurs less frequently in San Pablo Bay with reductions in Delta outflow during the winter and spring which may limit production of bay species such as bay shrimp, starry flounder, Pacific herring, and dungeness crab.

5. **Reduced and Altered Transport Flows** hinder successful movement of larval and juvenile fish from spawning habitats to nursery habitats in the Delta and Bay (e.g. longfin smelt, striped bass, chinook salmon, and Sacramento splittail).

   a. **Reduced Transport of Young Fish from the Delta to Suisun Bay** nursery areas because of low Delta outflow reduces growth, survival, and abundance of important estuarine fish (e.g. striped bass and delta smelt).

   b. **Reduced Transport of Young Fish through the Delta** to the ocean limits survival and abundance of estuarine and anadromous fish (e.g. chinook salmon, steelhead, and American shad).

   c. **Increased Transport of Young Fish from North to South across the Delta** and direct entrainment of fish because of high export-to-inflow ratios reduces survival and abundance of estuarine and anadromous fish (e.g. chinook salmon, delta smelt, striped bass, steelhead, and American shad).

   d. **Local Structures** block and alter transport flows and increase predation rates (e.g. chinook salmon).

6. **Altered Migratory Cues** disrupt upstream and downstream movement of anadromous and estuarine fish (e.g. chinook salmon, steelhead, and white sturgeon).

   a. **Upstream Migration of Adult Salmonids through the Delta is Disrupted** by lack of olfactory cues caused by export of spawning-river water in and above the Delta.

   b. **Outmigration of Juvenile Fish through the Delta is Hindered** by net downstream flow cues toward South Delta export pumps (e.g. delta smelt, striped bass, American shad, and Sacramento splittail).

   c. **Upstream Migration of Adult Estuarine Fish into Delta and River Spawning Areas is Hindered** by altered net flow of water across the Delta.

7. **Reduced Food Web Productivity** in aquatic habitats limits forage availability for fish species (e.g. delta smelt, longfin smelt, Sacramento splittail, chinook salmon, striped bass, starry flounder, bay shrimp, and neomysis).

   a. **Entrainment of Food Productivity** by diversions limits habitat suitability for desirable fish species.

b. **High Concentrations of Toxicants** in the water column and in sediments reduces production and survival of aquatic plants and invertebrates.

c. **Introduced Species** compete for food and habitat space with desirable species.

d. **Reduced Residence Time of Water** in Delta channels limits plankton blooms.

e. **Reduction in Nutrient Inputs** from wetland and riparian habitats limits aquatic productivity.

f. **High Salinity Levels** in Delta aquatic habitats limit seasonal productivity patterns of estuarine food-chain organisms.

g. **Reduction and Seasonal Shift of Freshwater Inflow to the Delta** directly limits primary and secondary productivity of the estuary during critical periods.

8. **Excessive Concentrations of Toxic Constituents and their Bioaccumulation** directly limits survival and growth of desirable fish, wildlife, and other species (e.g. delta smelt, longfin smelt, Sacramento splittail, chinook salmon, striped bass, starry flounder, rails, avocets, grebes).

a. **Excessive Pesticide Residues** directly affect some fish and wildlife species.

b. **Excessive Hydrocarbons, Heavy Metals, and other Pollutants** directly harm some fish and wildlife species.

B. **Important Wetland Habitats** are inadequate to support production and survival of wildlife species in the Bay-Delta system. The problems for the specific wetland habitats include:

1. **Lack of Brackish Tidal Marsh Habitats** of high quality limits supportable populations of wildlife species that inhabit them (e.g. Suisun Slough thistle, Suisun song sparrow, and snowy egret).

a. **Altered Vegetation Composition** in brackish marshes caused by changes in salinity levels limits habitat suitability for some species.

b. **Reduced Areal Extent and Patchiness** of brackish marsh limits wildlife populations and genetic exchange.

c. **Disconnection of Supporting Habitats** such as aquatic habitats and riparian woodlands and adjacent uplands limits productivity in brackish marshes.

2. **Lack of Freshwater Habitats** of high quality limits supportable populations of native plant and wildlife species (e.g. giant garter snake, tri-colored blackbird, and Mason's lilaeopsis).

   a. **Inappropriate Increased Salinity Levels** do not support desirable vegetation composition and thereby limit habitat suitability for some species.

   b. **Reduced Areal Extent** of high quality freshwater marsh habitats does not support sustainable populations sizes of some wildlife species.

   c. **Lack of connection between** freshwater marsh habitats does not provide corridors for population movement and genetic exchange.

   d. **Vulnerability of Delta Islands to Levee Failure** threatens sustainability of existing freshwater marshes.

3. **Limited Riparian Woodland Habitats** of high quality in the Delta reduce diversity and sizes of supportable native wildlife populations (e.g. Swainson's hawk, riparian brush rabbit, western yellow-billed cuckoo, neotropical migrant songbirds, and northern California black walnut).

   a. **Lack of Riparian Habitat Structure** near foraging areas limits nesting opportunities for some native bird species.

   b. **Fragmentation** of riparian habitat does not provide corridors for population movement and genetic exchange.

   c. **Limited Areal Extent** of riparian habitats prevents use by some native bird species.

   d. **Disconnection of Supporting Habitats** such as aquatic habitats and brackish marshes limits productivity in riparian woodlands.

4. **Reduced Breeding Waterfowl Habitats** limit production of desired populations of dabbling ducks (e.g. mallard, cinnamon teal, and wood duck).

   a. **Lack of Brood Habitat** of high quality near nesting habitat limits dabbling duck production.

b. **Lack of Nesting Habitat** of high quality near brood habitat limits dabbling duck production.

5. **Reduction in Wintering Wildlife Habitats** for foraging and resting limits desired populations of wintering waterfowl (e.g. Aleutian Canada goose, mallard, tundra swan, white-fronted goose and shore birds).

   a. **Decreasing Waste Grain** on agricultural lands limits availability of wildlife forage.

   b. **Lack of Resting Areas** near foraging areas limits wintering wildlife populations that can be supported in the Delta.

   c. **Reduction in Historical Foraging Habitats** (e.g. freshwater marsh and brackish water marsh) limits availability of high quality foraging areas for wintering wildlife.

   d. **Vulnerability of Delta Islands to Levee Failure** threatens sustainability of some wintering wildlife habitats.

6. **Lack of Managed Permanent Pasture Habitat** limits wintering crane populations (e.g. lesser sandhill crane, greater sandhill crane).

   a. **Lack of Foraging Habitats** of high quality for cranes in proximity to roosting habitats limits supportable wintering populations.

   b. **Lack of Roosting Habitats** of high quality for cranes in proximity to foraging habitats limits supportable wintering populations.

7. **Restricted Flood Plains and Associated Riparian Habitat** of sufficient size and high quality in the Delta reduce the diversity and sizes of fish and wildlife populations.

   a. **Lack of Suitable Flood Plains** reduces the availability of temporarily flooded spawning habitat for fish such as the Sacramento splittail.

   b. **Narrow Restricted Channels** increase the risk of levee failure and subsequent catastrophic losses of wildlife habitat protected by these levees.

C. **Populations of some species of plants and animals** dependent on the Delta have declined.

3. **Increase Amount of Quality Tidal Slough Habitat** containing emergent and submerged vegetation to support the fish production capacity of the Delta.

   a. **Increase Amount of Dead-End Slough Habitat** to allow spawning and rearing of sustainable populations of some resident species.

   b. **Reduce Water Hyacinth** populations in tidal slough habitats to improve habitat quality for sustainable populations of Delta fish.

   c. **Increase Amount of High Quality Tidal Slough Habitat** to allow increased primary biological production.

4. **Increase Amount of High Quality Estuary Entrapment/Null Zone Habitat** to support sustainable fish populations in the Bay-Delta system.

   a. **Reduce Saltwater Intrusion** into Suisun Bay to increase the nursery area for sustainable populations of plants and animals.

   b. **Expand** the geographic extent of **Low Salinity Habitat** in Suisun Bay.

   c. **Increase** the occurrence of **Brackish Water Habitat** in San Pablo Bay during the winter and spring to support sustainable populations of Bay species.

5. **Provide Sufficient Transport Flows** at the proper times to move eggs, larvae, and juvenile fish from spawning habitats to nursery habitats in the Delta and Bay.

   a. **Increase the Transport of Young Fish from the Delta to Suisun Bay** nursery areas to support sustainable populations of important estuarine species.

   b. **Increase the Transport of Young Fish Through the Delta** to the ocean to support sustainable populations of estuarine and anadromous fish species.

   c. **Reduce the Transport of Young Fish from North to South across the Delta** and the entrainment of fish in the Delta to increase the survival and abundance of estuarine and anadromous species.

   d. **Reduce the Blockage of and Alterations to Transport Flows** by local structures.

6. **Reestablish Appropriate upstream and downstream movement** of anadromous and estuarine fish.

a. **Enhance Upstream Migration of Adult Salmonids** through the Delta.

b. **Increase Successful Outmigration of Juvenile Fish** through the Delta.

c. **Enhance Upstream Migration of Adult Estuarine Fish** into the Delta and river spawning areas.

7. **Improve the Productivity of the Bay-Delta Aquatic Habitat Food Web** to support sustainable populations of desirable fish (and other) species.

a. **Reduce Entrainment** of biological productivity throughout the aquatic food web.

b. **Reduce Concentrations of Toxicants** in the water column and in sediments.

c. **Reduce the Effects of Introduced Species** on ecosystem productivity and in competing with desirable species for habitat.

d. **Increase the Residence Time of Water in Delta Channels** to increase plankton productivity and reduce undesirable algal-mat growth in the Delta.

e. **Increase the Input of Nutrients** from wetland and riparian habitats to aquatic habitats.

f. **Reduce Salinity Levels** in Delta aquatic habitats.

g. **Increase Flows of Freshwater** into the estuary.

8. **Reduce Concentrations of Toxic Constituents and Their Bioaccumulation** to eliminate their adverse effects on populations of fish and wildlife species.

a. **Reduce the Concentrations of Pesticide Residues** in Bay-Delta system water and sediments.

b. **Reduce the Concentrations of Hydrocarbons, Heavy Metals, and other Pollutants** in Bay-Delta system water and sediments.

B. **Improve and Increase Important Wetland Habitats** so that they can support the sustainable production and survival of wildlife species.

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1. **Increase the Amount of High Quality Brackish Tidal Marsh Habitat** in the Bay-Delta system to better support sustainable populations of native wildlife species.

   a. **Modify salinity levels in Brackish Tidal Marshes** to improve their vegetation composition.

   b. **Increase the Areal Extent** of brackish tidal marsh habitats.

   c. **Improve the Connectivity** between brackish tidal marsh habitats and their supporting habitats such as aquatic habitats and riparian woodlands and adjacent uplands.

2. **Increase the Amount of High Quality Freshwater Marsh Habitat** to better support sustainable populations of native wildlife species in the Delta.

   a. **Restore Appropriate Salinity Levels** in freshwater marsh habitat in the Delta to enhance forage productivity and habitat suitability for some native species.

   b. **Increase the Areal Extent** of freshwater marsh habitats.

   c. **Improve the Connectivity** among freshwater marsh habitats to provide corridors for population movement and genetic exchange for dependent species.

   d. **Reduce the Vulnerability** of existing freshwater marshes to levee failure.

3. **Increase the Amount of High Quality Riparian Woodland Habitat** in the Delta to better support sustainable populations of native wildlife populations.

   a. **Increase Amounts of Riparian Habitat Structure** for nesting near foraging areas for some native bird species.

   b. **Reduce the Fragmentation** of riparian woodland habitat patches to provide corridors for population movement and genetic exchange for dependent species.

   c. **Increase the Areal Extent** of riparian woodland habitats.

   d. **Improve the Connectivity** between riparian woodlands and their supporting habitats such as aquatic habitats and brackish marsh habitats.

4. **Increase the Amount of Breeding Waterfowl Habitat** to better support sustainable populations of dabbling ducks.

   a. **Increase the Amount of High Quality Brood Habitat** near nesting habitat for dabbling ducks.

   b. **Increase the Amount of High Quality Nesting Habitat** near brood habitat for dabbling ducks.

5. **Increase the Amount of Wintering Wildlife Habitat** for foraging and resting to better support sustainable populations of wintering waterfowl.

   a. **Increase** supplies of suitable forage such as **Waste Grain** on agricultural lands.

   b. **Increase** the amount of **Resting Areas** near foraging areas for wintering wildlife.

   c. **Increase** the amount of high quality **Foraging Areas** (e.g. freshwater marsh and brackish water marsh) for wintering wildlife.

   d. **Reduce the Vulnerability** of some existing wintering wildlife habitats to levee failures.

6. **Increase the Amount of Managed Permanent Pasture Habitat for** to better support wintering crane populations.

   a. **Increase** the amount of **Foraging Habitat** in proximity to roosting habitat.

   b. **Increase** the amount of **Roosting Habitat** in proximity to foraging habitat.

7. **Increase Flood Plains and Associated Riparian Habitat** to improve diversity and sizes of fish and wildlife populations.

   a. **Increase** suitable flood plains to improve the availability of **Temporary Flooded Spawning Habitat** for fish.

   b. Improve narrow restricted channels to **Reduce the Risk of Catastrophic Losses** of wildlife habitat from levee failure.

C. **Increase population health and population size** of Delta species to levels that assure sustained survival.

1. **Contribute to the recovery** of threatened, endangered or species of special concern.

2. **Increase populations** of economically important species.

3. **Increase populations** of prey or food species.

III. CALFED Bay-Delta Program Ecosystem Restoration Strategy

The primary ecosystem quality objective of the CALFED Bay-Delta Program is to "Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species." The Program's strategy to achieve this objective is to reverse the decline in ecosystem health by reducing or eliminating factors which degrade habitat, impair ecological functions, or reduce the population size or health of species. These factors may cause direct mortality of plants and animals in the system, but more often they result in indirect mortality by degrading habitat conditions or functions. For this reason, the Program objectives emphasize the improvement of habitats and ecological functions.

When there is a single factor limiting an ecological function or the population size or health of a species, remedial actions to restore functions or populations are clear. Often, however, there are many factors that reduce ecological functions or cause mortality of species at different stages in the life cycle. In the Bay-Delta system, some of these include inadequate physical habitat that fails to provide areas for reproduction, foraging, or escaping from predators; inadequate water quality including temperature and toxic contaminants; fragmented habitat that impedes migration; inadequate or altered water flow regimes; direct and indirect mortality caused by water diversions from the system; presence of undesirable introduced species that compete with or prey upon other species; and recreational and commercial harvest. In cases where there are multiple factors affecting species, the strategy of the program is to make incremental improvements in all the significant identified factors that affect important species and their habitats.

Several criteria will help to focus efforts aimed at achieving ecosystem quality objectives:

Address Limiting Factors. To the extent that a single limiting factor can be identified for a species or race, actions will be designed to overcome the limiting factor. This will result in the most efficient use of limited resources for restoration.

Use Natural Processes. Selection of actions will favor those that take advantage of natural processes to achieve desired results. This will reduce the amount of effort to carry out and maintain our actions, and increase the likelihood of long-term sustainability of the Bay-Delta system.

Increase Resilience. Actions will be selected so that some of the system's natural resilience to variation and disturbance is restored. Restoration of particular habitat types will be undertaken at appropriate sites distributed throughout the system, and genetic diversity will be protected so that species maintain the ability to respond to gradual changes in conditions.

Achieve Multiple Benefits. Efforts will be made to increase benefits by selecting or designing actions that improve habitat conditions or ecological functions for multiple species. Actions will also be favored if they improve other resource areas including water quality, vulnerability of system functions, and water supply reliability as well as improving ecosystem quality.

Measure Results. Program results will be measured on two different levels. First, actions will be structured so that the effectiveness of each one is measurable. At a broader scale, the program will include monitoring to assess the overall success of the many actions. This will allow adaptive management of the restoration effort: adjustment of our actions to make them more effective, and changes in emphasis as the condition of the ecosystem improves.

Make up for Unavoidable Losses. Finally, where competing uses of Bay-Delta resources make it impossible to avoid specific impacts on species, habitats, or ecological functions, efforts will be made to compensate by reducing other causes of mortality or improving habitats and functions elsewhere in the system.

Actions to restore the health of the Bay-Delta ecosystem will vary in emphasis. Some actions will be directed toward increasing the size and health of populations of single species or races, particularly if they are endangered, threatened, or of special concern. Other actions will be designed to restore habitat and ecological functions in particular geographic areas. Still other actions may focus on reducing mortality from a particular factor throughout the system.

Actions to increase the size and health of populations of single species or races may be necessary because these species are endangered, threatened, or of special concern. This will help prevent extinction or loss of genetic diversity, and will reduce the economic impacts caused by special efforts to protect dwindling populations. When such actions are taken, priority will be given to actions that achieve multiple benefits.

Within species or races, priority will be given to actions that will have the greatest impact on population size and genetic diversity. Generally, this will result in greater emphasis on protection of adults because the survival of a single adult contributes more to population size than the survival of many larvae or juveniles. Protection of genetic diversity will emphasize natural production of species rather than artificial propagation. Protection of genetic diversity will also result in emphasis on reducing the likelihood that an entire year class of fish might be lost due to habitat conditions such as temperature or toxic conditions.

Actions that improve conditions in particular geographic areas will be prioritized according to criteria already enumerated. Emphasis will be on projects that are measurable, projects that will improve conditions for endangered, threatened, or species of special concern, projects that will have the greatest impact on population size and genetic diversity.

Similarly, actions to improve one factor throughout the system will emphasize the most vulnerable species, multi species benefits, and greatest impact on population size and diversity. For instance, detailed criteria will be developed to ensure that fish screens are installed on diversions where the greatest benefit will be derived. Restoration of shaded riverine aquatic

habitat will be focused on migration routes for anadromous fish and areas where anadromous as well as Delta native fish will benefit. Restoration of shallow water habitat in the Delta will emphasize areas where multiple species will benefit and where other factors such as water diversions are least likely to affect population size.

This strategy is being followed to develop alternatives through the following process:

A comprehensive description of the problems affecting the ecosystem was developed at two public workshops. The problems were converted into an overall objective, a set of primary objectives and a set of secondary objectives. Again, this was the subject of public workshops. The objectives were used to identify actions which would meet or help meet the objectives. The actions were then compared to existing plans or programs, like the Central Valley Project Improvement Act or the Upper Sacramento River Riparian and Anadromous Fishes Program to see where incorporation of existing activities could be incorporated. The actions were also evaluated for opportunities for linkage with other actions developed for other aspects of the CALFED comprehensive planning effort. For example, actions to increase shallow aquatic habitat in the Delta were linked to levee restoration actions.

This process then led to the development of components to the draft preliminary alternatives. These we developed by matching the objectives with actions in existing restoration programs or the incorporation of new actions to provide for various combinations which accommodate other program objectives.

As the draft preliminary alternatives are being refined, a method of staging the actions is being developed. This process will include the use of the following set of general priorities:

Species status. Priority will be placed on actions which benefit species and races with the greatest need for recovery. The maintenance of genetic diversity and population resilience to catastrophic loss are essential goals.

Natural habitat functions. Wherever feasible, the restoration of natural habitat, together with the natural geomorphic, nutrient dynamics, variety and connectivity that results from natural processes will be emphasized.

Magnitude of benefits. Priority will be given to actions that can result enlarge increases of natural production and/or which can provide scientific insight to the restoration and management requirements of the Bay-Delta Ecosystem.

A final step in the process will be the adoption of a suite of indicators of ecosystem health. These indicators will be used to measure progress and, in conjunction with monitoring, will provide support for adaptive management decisions.

IV. ECOSYSTEM RESTORATION ACTIONS POTENTIALLY COMPRISING CALFED CORE ACTIONS CLASSIFIED BY ECOLOGICAL ZONES OF THE BAY-DELTA AND ITS WATERSHED

SACRAMENTO RIVER MAINSTEM

UPSTREAM HABITAT RESTORATION

Improve Flows and Temperatures in Upstream Habitats

- Install and operate permanent structural temperature control devices at Shasta and Whiskeytown dams and develop and implement modifications in CVP operations as needed to assist in the Secretary of Interior's efforts to control water temperatures in the upper Sacramento River (p.5, CVAFP).

Improve Floodway Drainage to Reduce Fish Stranding

- Implement a program to improve drainage of floodway lands in the Yolo and Sutter bypasses to reduce the numbers of salmon, steelhead, splittail, and other fish stranded or lost to predation.

Maintain Adequate Spawning Substrates

- Develop and implement a program for restoring and replenishing spawning gravel, where appropriate, in the Sacramento River (p.31, AFRP).

- Replenish gravel and restore gravel recruitment blocked by Whiskeytown Dam on Clear Creek (p.35, AFRP). Restore spawning gravel in Clear Creek for salmon and steelhead (p.5, CVAFP).

- Develop cooperative agreements to promote the stockpiling of spawning gravel from existing mining operations in Cottonwood Creek for subsequent placement in the Sacramento River (p.7, CVAFP).

- Work with state and local agencies to protect spawning gravel and enhance recruitment of spawning gravel to the Sacramento River in the valley sections of Cottonwood Creek (p.37, AFRP).

Modify Fish Passage at Upstream Dams or Through Other Barriers

- Work with Anderson-Cottonwood Irrigation District (ACID) to implement operational modifications to the ACID diversion dam to eliminate passage and stranding problems for chinook salmon and steelhead adult and early life stages in the Sacramento River (p.31, AFRP).

- Modify or rebuild, as necessary, the fish ladders at weirs on the upper ends of the Yolo and Sutter bypasses.

Revegetate Degraded Riparian Habitats

- Implement opportunities for restoring riparian forests in channelized sections of the upper mainstem Sacramento River that are appropriate with flood control and other water management constraints (p.32, AFRP).

- Implement pilot study of setback levees in channelized portion of Sacramento River below Chico Landing.

- Continue acquisition of land and conservation easements from willing sellers to protect the riparian corridor along the Sacramento River (p.7, CVAFP).

- Acquire land or conservation easements from willing sellers along the riparian corridor of the Sacramento River.

- Pursue opportunities to replant riparian vegetation along channelized sections of the Sacramento River. All revegetation will be consistent with existing flood control and land use constraints.

REDUCTIONS IN THE EFFECTS OF DIVERSIONS

Install or Upgrade Screens on Upstream Diversions

- Implement a comprehensive program to install positive barrier fish screens at unscreened or poorly screened diversions on the Sacramento River, in the Sacramento-San Joaquin Delta, and Suisun Marsh Sloughs. Priorities for screen should be based on diversion location, size, period of use and available partnership funding.

- Implement a pilot screening project on the Sacramento River upstream of the Delta.

- Continue to implement the Anadromous Fish Screen Program (p.30, AFRP).

- Implement structural and operational modifications to the Glenn-Colusa Irrigation District's (GCID) water diversion facility to minimize impingement and entrainment of juvenile salmon (p.30, AFRP).

Evaluate and Implement Effective Acoustic Barriers to Anadromous Fish Movement

- Implement a comprehensive program to install positive barrier fish screens at unscreened or poorly screened diversions on the Sacramento River. Priorities for screen should be based on diversion location, size, period of use and available partnership funding.

- Continue to evaluate effects of hydroacoustic barriers on fish movement (DNFRP, AFRP).

MANAGEMENT OF WATER QUALITY

Establish Incentives for Retirement of Lands with Drainage Problems

- Develop a cooperative program to retire agricultural lands where large quantities or high concentrations of contaminants drain into the Delta (DNFRP).

Provide Incentives for Pollution Source Control on Agricultural Lands

- To improve conditions for winter -run chinook salmon, implement a program to promote water use efficiency and drainage source reduction and measures to reduce pesticide and herbicide discharge to the Colusa Basin Drain. Implement programs to provide for agricultural reuse of water from the Colusa Basin Drain.

SACRAMENTO RIVER TRIBUTARIES

UPSTREAM HABITAT RESTORATION

Improve Flows and Temperatures in Upstream Habitats

- Obtain 50 cubic feet per second (cfs) for fish migration in Cow Creek through a cooperative agreement with private water-rights holders (p.15, CVAFP).

- Obtain cooperative agreements to provide flows for suitable passage and spawning for fall-run chinook salmon adults and adequate summer rearing habitat for juvenile steelhead in Cow Creek (p.35, AFRP).

- Develop a cooperative agreement to increase flows past PG&E's hydropower diversions on Battle Creek in two phases to provide adequate holding, spawning, and rearing habitat for anadromous salmonids (p.39, AFRP):

Diversion	Months	Flow (cfs)
Keswick ditch	All year	30

Diversion	Months	Flow (cfs)
North Battle Creek feeder	Sept-Nov	40
	Jan-Apr	40
	May-Aug	30
Eagle Canyon	May-Nov	30
	Dec-Apr	50
Wildcat	May-Nov	30
	Dec-Apr	50
South	May-Nov	20
	Dec-Apr	30
Inskip	May-Nov	30
	Dec-Apr	40
Coleman	Sept-Apr	50
	May-Aug	30

- Continue, through cooperative agreements, to provide instream flows in the valley reach of Mill Creek to facilitate the passage of adult and juvenile spring-, fall- and late-fall-run chinook salmon and steelhead (p.43, AFRP).

- Develop cooperative agreements to improve instream flows in the lower 10 miles of Deer Creek to ensure passage of adult and juvenile spring- and fall-run chinook salmon and steelhead over three diversion dams (p.46, AFRP).

- Develop cooperative agreements to obtain additional instream flows in Butte Creek from Parrott-Phelan Diversion (p.50, AFRP).

- Reconfigure Folsom Dam shutters for improved management of Folsom Reservoir's cold water pool and better control over the temperature of water released downstream (p.66, AFRP).

- Develop cooperative agreements to reduce water diversions or augment instream flows during critical periods for salmonids in Cosumnes River (p.71, AFRP).

Maintain Adequate Spawning Substrates

- Pursue opportunities to create a meander belt from Keswick Dam to Chico Landing to recruit gravel and large woody debris to moderate temperatures and to enhance nutrient input (p.30, AFRP).

- Replenish gravel and restore gravel recruitment blocked by Whiskeytown Dam on Clear Creek (p.35, AFRP). Restore spawning gravel in Clear Creek for salmon and steelhead (p.5, CVAFP).

- Develop cooperative agreements to promote the stockpiling of spawning gravel from existing mining operations in Cottonwood Creek for subsequent placement in the Sacramento River (p.7, CVAFP).

- Work with state and local agencies to protect spawning gravel and enhance recruitment of spawning gravel to the Sacramento River in the valley sections of Cottonwood Creek (p.37, AFRP).

- Restore and enhance spawning gravel in Paynes Creek (p.41, AFRP).

- Improve spawning habitats in lower Mill Creek and lower Deer Creek for fall- and late-fall-run chinook salmon (p.43, AFRP).

- Replenish spawning gravel in reaches modified for flood control in Big Chico Creek (p.48, AFRP).

- Replenish spawning gravel and restore existing spawning grounds in the American River (p.66, AFRP).

- Replenish gravel suitable for salmonid spawning and cleanse spawning gravel of fine sediments and prevent sedimentation of spawning gravel in the Mokelumne River (p.68, AFRP, p.7, CVAFP).

Encourage Gravel-Mining Practices that Protect Fish Habitat

- Develop cooperative agreements to modify gravel mining methods to reduce their effects on salmonid spawning habitat in Central Valley streams (p.44, AFRP).

Modify Fish Passage at Upstream Dams or Through Other Barriers

- Provide fish passage facilities at McCormick-Saeltzer Dam (Clear Creek) and remove sediment from behind the dam (p.34, AFRP).

- Improve passage at agricultural diversion dams on Cow Creek (p.36, AFRP).

- Restore the stream channel to prevent ACID Siphon on Cottonwood Creek from becoming a barrier to migration of spring- and fall-run chinook salmon and steelhead (p.37, AFRP).

- Eliminate adult fall-run chinook stranding by stopping attraction flows in Crowley Gulch or by constructing a barrier at the mouth of Crowley Gulch (p.37, AFRP).

- Construct barrier racks at the Gover Diversion Dam and wastegates from the Gover Canal to prevent adult chinook salmon in Battle Creek from entering Gover Diversion (p.40, AFRP).

- Improve fish passage in Eagle Canyon on Battle Creek. Allow adult spring-run access to Battle Creek above the Coleman Hatchery Weir.

- Construct a fish passage structure over the Corning Canal siphon in Elder Creek (p.8, CVAFP).

- Work cooperatively to develop a permanent solution for fish passage at Clough Dam on Mill Creek (p.44, AFRP).

- Develop cooperative agreements to reduce use of seasonal diversion dams that may be barriers to migrating chinook salmon and steelhead in Thomes Creek (p.45, AFRP).

- Repair the Iron Canyon fish ladder on Big Chico Creek (p.48, AFRP).

- Repair the Lindo Channel weir and fishway at the Lindo Channel box culvert at the Five-Mile Diversion on Big Chico Creek (p.48, AFRP).

- Build a new high-water-volume fish ladder at Durham Mutual Dam on Butte Creek (p.50, AFRP).

- Remove the Western Canal Dam on Butte Creek and construct the Western Canal Siphon. If the dam is not removed and siphon not constructed, support California Department of Fish and Game's (DFG's) efforts to build a new-high-water volume fish ladder and to install fish screens on both diversions at the Western Canal Dam (p.51, AFRP).

- Remove McPherrin and McGowan dams on Butte Creek and provide an alternate source of water as part of the Western Canal Dam (WCD) removal and siphon construction. If McPherrin and McGowan dams are not removed and alternate sources of water are not supplied as part of the WCD dam removal and siphon construction, support DFG's efforts to build new high-water-volume fish ladders at both dams and to install fish screens on both diversions (p.51, AFRP).

- Build a new high-water-volume fish ladder at Adams Dam and Gorril Dam on Butte Creek (p.52, AFRP).

- Work cooperatively with the operators to establish operational criteria for Sanborn Slough Bifurcation and Nelson Slough on Butte Creek (p.52, AFRP).

- Develop a cooperative agreement to eliminate stranding of chinook salmon at White Mallard Duck Club outfall on Butte Creek (p.53, AFRP).

- Implement new operational criteria, modifications to existing structures, or new fish ladders at the following locations in the Butte Creek watershed: Butte Slough Outfall; East-West Diversion Weir; Sutter Bypass Weir #2; Sutter Bypass Weir #1; Sutter Bypass Weir #5; Sutter Bypass Weir #3; and the natural barrier below Centerville Dam

- Implement a program to allow spring-run access to Butte Creek above Centerville Dam.

- Rebuild and maintain existing culvert and riser at Drumheller Slough outfall on Butte Creek (p.53, AFRP).

- Install a high-water-volume fish ladder at White Mallard Dam (p.54, AFRP).

- Construct or improve fish bypasses at Hallwood-Cordua and Brophy-South Yuba water diversions in the Yuba River (p.61, AFRP).

- Negotiate removal or modification of the culvert crossing at Patterson Sand and Gravel and other physical barriers impeding anadromous fish migration in Bear River (p.63, AFRP)

- Develop cooperative agreements to facilitate passage of adult and juvenile salmonids at existing diversion dams and barriers in Calaveras River (p.72, AFRP).

Modify Natural Barriers to Improve Fish Passage

- Improve fish passage in Eagle Canyon on Battle Creek by modifying a bedrock ledge and boulders that are potential barriers to adult salmonids (p.40, AFRP).

Encourage Improved Livestock Management in Riparian Habitats

- Develop cooperative agreements to fence select riparian corridors within the Cow Creek watershed to exclude livestock (p.36, AFRP).

- Develop cooperative agreements to employ the most ecologically sound grazing practices by implementing the Forest Plan on federal lands with the Thomes Creek drainage (p.45, AFRP).

- Cooperate with landowners to install livestock exclusion fencing along Deer Creek.

Revegetate Degraded Riparian Habitats

- Implement partnership programs to maintain and restore the riparian habitat along the lower reaches of Mill Creek (p.43, AFRP).

- Preserve the habitat productivity of upper Mill Creek through cooperative watershed management (p.43, AFRP).

- Negotiate long-term agreements to maintain and restore riparian habitats along the lower reaches of Deer Creek (p.46, AFRP). Control or remove bamboo at several sites.

- Plan and coordinate required flood management activities with least damage to the fishery resources and riparian habitats of lower Deer Creek (p.47, AFRP).

- Cooperate with local landowners in Big Chico watershed to encourage revegetation of denuded stream reaches and establish a protected riparian strip (p.49, AFRP).

- Protect spring-run chinook salmon summer holding pools in Big Chico Creek by obtaining titles or conservation easements from willing sellers on lands adjacent to the pools (p.49, AFRP).

- Along Butte Creek, cooperate with landowners to revegetate denuded stream reaches and to establish a protected riparian strip.

- Purchase streambank conservation easements from willing sellers to improve salmonid habitat and instream cover in the Yuba River (p.61, AFRP).

- Implement partnership programs to enhance and maintain the riparian corridor to improve streambank and channel rearing habitat for juvenile salmonids in the Mokelumne River (p.69, AFRP).

- Establish a partnership program to expand the riparian corridor protection zone on the Cosumnes River (p.71, AFRP).

- Implement a cooperative program to rehabilitate damaged areas and remedy incompatible land practices to reduce sedimentation and instream water temperatures in Cosumnes River (p.71, AFRP).

REDUCTIONS IN THE EFFECTS OF DIVERSIONS

Install or Upgrade Screens on Upstream Diversions

- Continue to implement the Anadromous Fish Screen Program (p.30, AFRP).

- Implement structural and operational modifications to the Glenn-Colusa Irrigation District's (GCID) water diversion facility to minimize impingement and entrainment of juvenile salmon (p.30, AFRP).

- Screen Orwick Diversion (Battle Creek) to prevent entrainment of juvenile salmonids and straying of adult chinook salmon (p.40, AFRP).

- Screen tailrace of Coleman Powerhouse (Battle Creek) to eliminate attraction of adult chinook salmon and steelhead into an area with little spawning habitat and great potential for entrainment into the CNFH water supply (p.40, AFRP).

- Construct fish screens on all PG&E diversions after both phases of upstream flow actions are completed and fish ladders on Coleman Powerhouse and Eagle Canyon Diversion Dams are opened (p.40, AFRP).

- Install fish screens on both diversions at Durham Mutual Dam on Butte Creek (p.50, AFRP).

- Install fish screens on both diversions at Adams Dam and at Gorrill Dam on Butte Creek (p.52, AFRP).

- Install fish screens at White Mallard Dam and on Little Dry Creek pumps in the Butte Creek catchment (p.53, AFRP).

- Improve efficiency of screening devices at Hallwood-Cordua and Brophy-South Yuba water diversions, and construct screens at the Browns Valley water diversion and other unscreened diversions on the Yuba River (p.60, AFRP).

- Improve the fish screen at Fairbairn Water Treatment Plant on the American River (p.66, AFRP).

- Upgrade existing fish screens in the Mokelumne River at Woodbridge Irrigation District's diversion (p.7, CVAFP).

- Improve upstream fish passage in the Mokelumne River at Woodbridge Irrigation District Dam (p.7, CVAFP).

- Install fish screens in the Mokelumne River at North San Joaquin Water Conservation District diversions, north and south (p.7, CVAFP).

- Screen all diversions to protect all life history stages of anadromous fish in Cow and Bear creeks and in the Bear, Mokelumne, Cosumnes, and Calaveras rivers (AFRP).

WATERSHED MANAGEMENT

- Cooperate with landowners and managers to organize and/or support local watershed conservancies. Local conservancies should be encouraged on Clear Creek, Deer Creek, Cow Creek, Big Chico, Antelope Creek, and Butte Creek.

- Cooperate with local watershed conservancies to develop and implement watershed management and restoration plans.

SAN JOAQUIN RIVER TRIBUTARIES

UPSTREAM HABITAT RESTORATION

Maintain Adequate Spawning Substrates

- Restore habitat for salmon migration, spawning, and rearing in the Merced River by rehabilitating riffle areas, repairing or constructing levees and channels, and isolating mining pit areas from the active channel (p.6, CVAFP).

- Restore habitat for spawning, rearing, and migration on the Tuolumne River at 17 sites by renovating spawning gravel and riffle areas, increasing side-channel diversity, recontouring channels, and isolating predator habitat (p.6, CVAFP).

- Restore habitat for spawning, rearing, and migration on the Stanislaus River by renovating spawning and rearing habitat and modifying channel morphometry (p.6, CVAFP).

Encourage Gravel-Mining Practices that Protect Fish Habitat

- Develop cooperative agreements to modify gravel mining methods to reduce their effects on salmonid spawning habitat in Central Valley streams (p.44, AFRP).

REDUCTIONS IN THE EFFECTS OF DIVERSIONS

Install or Upgrade Screens on Upstream Diversions

- Screen all diversions to protect all life history stages of anadromous fish in the Merced, Tuolumne, and Stanislaus rivers (AFRP).

- Reduce or eliminate entrainment of juvenile chinook salmon at Banta-Carbona, West Stanislaus, Patterson, and El Soyo diversions by implementing the Anadromous Fish Screen Program in conjunction with other programs (p.80, AFRP).

WATERSHED MANAGEMENT

- Cooperate with local watershed conservancies to develop and implement watershed management and restoration plans.

THE DELTA

BAY-DELTA HABITAT RESTORATION

Protect and Enhance Existing Shallow-Water Habitat

- Develop additional habitat and vegetation zones within the Delta. The following spawning and rearing areas should be considered for restoration as tidal, shallow-water vegetated habitat: Prospect Island, Hastings Tract, Liberty Island, Medford Island, New Hope Tract, Brack Tract, and Terminous Tract.

- Implement a pilot project to establish a shallow-water, waterside berm in conjunction with a channel island (Tule berm) along a levee in the western or northern Delta.

- Develop additional shallow-water habitat and vegetation zones in freshwater areas.

Convert Existing Leveed Lands to Tidal Action

- Implement a pilot project to convert an area of leveed lands to tidal action.

Protect and Enhance Existing Wetlands

- Conserve, restore and expand tidal wetlands and shallow-water habitat within the chinook salmon rearing and migratory habitat areas that should be evaluated for tidal marsh and shallow- water habitat restoration. Include the Sacramento River portion of the Northern Delta.

REDUCTIONS IN THE EFFECTS OF DIVERSIONS

Install Screens on Other In-Delta Diversions

- Implement a comprehensive program to install positive barrier fish screens at unscreened or poorly screened diversions in the Delta. Priorities for screen should be based on diversion location, size, period of use and available partnership funding.

- Implement a program to screen agricultural diversions in the Delta and to consolidate agricultural diversions (p.108, DNFRP).

- Implement a pilot project to screen a diversion in the Delta in the lower Sacramento River corridor.

Evaluate and Implement Effective Acoustic Barriers to Anadromous Fish Movement

- Continue to evaluate effects of hydroacoustic barriers on fish movement (DNFRP, AFRP).

- Continue to evaluate the benefits and detriments of hydroacoustic barriers at locations where positive barrier fish screens are infeasible.

- Seek out opportunities to consolidate agricultural diversions in the Delta.

MANAGEMENT OF WATER QUALITY

Establish Incentives for Retirement of Lands with Drainage Problems

- Develop a cooperative program to retire agricultural lands where large quantities or high concentrations of contaminants drain into the Delta (DNFRP).

IMPROVEMENTS TO SYSTEM RELIABILITY

Protect Delta Levees

- Implement a pilot project to reduce subsidence in agricultural lands on the inward side of a levee on a Delta island.

SUISUN BAY AND SAN PABLO BAY

BAY-DELTA HABITAT RESTORATION

- Implement a pilot project to convert an area of leveed land to tidal action.

MANAGEMENT OF WATER QUALITY

Establish Incentives for Retirement of Lands with Drainage Problems

- Develop a cooperative program to retire agricultural lands where large quantities or high concentrations of contaminants drain into the Delta (DNFRP).

FISH SPECIES RECOVERY ACTIONS POTENTIALLY COMPRISING CALFED CORE ACTIONS CLASSIFIED BY SPECIES OR GROUP OF SPECIAL CONCERN

WINTER-RUN CHINOOK SALMON

BAY-DELTA HABITAT RESTORATION:

Protect and Enhance Existing Shallow-Water Habitat

- Conserve, restore and expand tidal wetlands and shallow-water habitat within the winter-run chinook rearing and migratory habitat areas that should be evaluated for tidal marsh and shallow- water habitat restoration. Include the Sacramento River portion of the Northern Delta, Suisun Marsh Sloughs, the northern shoreline of Suisun and Grizzly Bays, and the northern shoreline of San Pablo Bay.

Convert Existing Leveed Lands to Tidal Action

- Convert existing leveed lands in Suisun Marsh and northern Delta to tidal marsh and shallow-water habitat.

UPSTREAM HABITAT RESTORATION:

Modify Fish Passage at Upstream Dams or Through Other Barriers

- Eliminate adverse flow fluctuations by working with Anderson-Cottonwood Irrigation District to modify their dam operations or to modify or replace the facility. Evaluate the need for alternative fish ladders and flashboards. Upgrade fish ladders on weirs at the head of the Sutter and Yolo bypasses.

Revegetate Degraded Riparian Habitats

- Acquire land or conservation easements from willing sellers along the riparian corridor of the Sacramento River.

- Pursue opportunities to replant riparian vegetation along channelized sections of the Sacramento River. All revegetation will be consistent with existing flood control and land use constraints.

Improve Floodway Drainage to Reduce Fish Stranding

- Implement a program to improve drainage of floodway lands in the Yolo and Sutter bypasses to reduce the numbers of winter-run salmon stranded or lost to predators.

REDUCTIONS OF THE EFFECTS OF DIVERSIONS:

Install Screens on Unscreened In-Delta Diversions

- Implement a comprehensive program to install positive barrier fish screens at unscreened or poorly screened diversions on the Sacramento River, in the Sacramento-San Joaquin

Delta, and Suisun Marsh Sloughs. Priorities for screen should be based on diversion location, size, period of use and available partnership funding.

Evaluate and Implement Effective Acoustic Barriers to Anadromous Fish Movement

- Continue to evaluate the benefits and detriments of hydroacoustic barriers at locations where positive barrier fish screens are infeasible.

MANAGEMENT OF WATER QUALITY:

Provide Incentives for Pollution Source Control on Agricultural Lands

- Implement a program to promote water use efficiency and drainage source reduction and measures to reduce pesticide and herbicide discharge to the Colusa Basin Drain. Implement programs to provide for agricultural reuse of water from the Colusa Basin Drain.

DELTA SMELT AND OTHER SACRAMENTO-SAN JOAQUIN DELTA NATIVE FISH

BAY-DELTA HABITAT RESTORATION:

Protect and Enhance Existing Shallow-Water Habitat

- Develop additional habitat and vegetation zones within the Delta. The following spawning and rearing areas should be considered for restoration as tidal, shallow-water

vegetated habitat: Prospect Island, Hastings Tract, Liberty Island, Medford Island, New Hope Tract, Brack Tract, and Terminous Tract.

- Develop additional shallow-water, tidal habitat and vegetation zones within Suisun Marsh and Suisun Bay. In Suisun Marsh these areas should include fresh- and brackish water habitats.

- Develop additional shallow-water habitat and vegetation zones in freshwater areas. In the Suisun Marsh region these areas include Joyce Island, Hill Slough, Cutoff Slough, First Mallard Slough, Northern Suisun Slough, and Nurse Slough. Along the Sacramento River these areas include Prospect Island, Cache Slough, Sutter Slough, Steamboat Slough, and Deicker Island. Along the San Joaquin River, this would include the area upstream of the City of Stockton and below the mouth of the Stanislaus River.

- Implement pilot projects in Suisun Bay and the Delta to establish shallow-water habitat on the outer sides of levees and to convert existing leveed lands to tidal action.

REDUCTION OF EFFECTS ON DIVERSIONS:

Install Screens on Unscreened In-Delta Diversions

- Seek out opportunities to consolidate agricultural diversions in the Delta. Implement a pilot project to screen a diversion in the Delta in the lower Sacramento River corridor.

Evaluate and Implement Effective Acoustic Barriers to Anadromous Fish Movement

- Continue to evaluate the benefits and detriments of hydroacoustic barriers at locations where positive barrier fish screens are infeasible.

SPRING-RUN CHINOOK SALMON

BAY-DELTA HABITAT RESTORATION:

Protect and Enhance Existing Shallow-Water Habitat

- Conserve, restore, and expand tidal wetlands and shallow-water habitat within the spring-run chinook rearing and migratory habitats. Areas that should be evaluated for tidal marsh and shallow-water habitat restoration include the Sacramento River portion of the Northern Delta, Suisun Marsh sloughs, the northern shoreline of Suisun and Grizzly Bays, and the northern shoreline of San Pablo Bay.

UPSTREAM HABITAT RESTORATION:

Modify Fish Passage at Upstream Dams or Through Other Barriers

- Improve fish passage in Eagle Canyon on Battle Creek. Allow adult spring-run access to Battle Creek above the Coleman Hatchery Weir.

- Replace or repair existing fish ladders on Big Chico Creek.

- Correct fish passage problems on Butte Creek through dam removal or improvements to existing fish ladders at the following locations:

  - Durham - Mutual Dam,

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- Adams Dam,
- Gorrill Dam,
- Western Canal Dam,
- McGowan Dam,
- McPherrin Dam, and
- White Mallard Dam.

- Implement new operational criteria, modifications to existing structures, or new fish ladders at the following locations in the Butte Creek watershed:

  - Butte Slough Outfall,
  - East-West Diversion Weir,
  - Sutter Bypass Weir #2,
  - Sutter Bypass Weir #1,
  - Sutter Bypass Weir #5,
  - Sutter Bypass Weir #3, and
  - the natural barrier below Centerville Dam..

- Implement a program to allow spring-run access to Butte Creek above Centerville Dam.

- Implement a program to provide for adult salmon and steelhead passage above Saeltzer Dam on Clear Creek.

Modify Natural Barriers to Improve Fish Passage

- Provide for improved fish passage at Clough Dam on Mill Creek.

Revegetate Degraded Riparian Habitats

- Acquire land or conservation easements from willing sellers along the riparian corridor of the Sacramento River.

- Pursue opportunities to replant riparian vegetation along channelized sections of the Sacramento River. All revegetation will be consistent with existing flood control and land use constraints.

- On Big Chico Creek, cooperate with local landowners to encourage revegetation of denuded stream reaches and to establish a protected riparian strip.

- Along Butte Creek, cooperate with landowners to revegetate denuded stream reaches and to establish a protected riparian strip.

- Control or remove bamboo at several sites in lower Deer Creek.

- Cooperate with landowners to maintain and restore riparian habitat along the lower reaches of Mill Creek

Encourage Appropriate Livestock Management in Riparian Habitats

- Cooperate with landowners to install livestock exclusion fencing along Deer Creek.

REDUCTIONS OF THE EFFECTS OF DIVERSIONS:

Install Screens on Unscreened In-Delta Diversions

- Implement a comprehensive program to install positive barrier fish screens at unscreened

or poorly screened diversions on the Sacramento River, in the Sacramento-San Joaquin Delta, and Suisun Marsh Sloughs. Priorities for screening should be based on diversion location, size, period of use, and available partnership funding.

- Cooperate with local diverters to install fish screens on agricultural diversions along Battle Creek.

- Cooperate with PG&E to screen all unscreened hydropower diversions on Battle Creek.

- Work with local diverters to install fish screens as necessary along Butte Creek at the following locations:

  - Durham - Mutual Dam,
  - Adams Dam,
  - Gorrill Dam,
  - Little Dry Creek pumps, and
  - White Mallard Dam.

MANAGEMENT OF WATER QUALITY:

Encourage Management of Land Uses to Protect Water Quality

- Cooperate with landowners and managers to organize and/or support local watershed conservancies. Local conservancies should be encouraged on Clear Creek, Deer Creek, Cow Creek, Big Chico, Antelope Creek, and Butte Creek.

- Cooperate with local watershed conservancies to develop and implement watershed management and restoration plans.

FALL-RUN CHINOOK SALMON DEPENDENT ON THE SAN JOAQUIN RIVER SYSTEM

BAY-DELTA HABITAT RESTORATION:

- Conserve, restore, and expand riparian habitat within the San Joaquin Fall-Run chinook rearing and migratory habitat areas. Areas that should be evaluated for habitat restoration and protection include the San Joaquin River portion of the Eastern and Central Delta.

UPSTREAM HABITAT RESTORATION:

Encourage Gravel-Mining Practices that Protect Fish Habitat

- Develop cooperative agreements to modify gravel mining methods to reduce their effects on salmon spawning and rearing habitat on streams tributary to the San Joaquin River.

- Take action to isolate existing gravel mining puts along the Merced, Stanislaus, and Tuolumne Rivers.

Modify Fish Passage at Upstream Dams or Through Other Barriers

- Operate a temporary fish barrier at the head of Old River during fall.

Revegetate Degraded Riparian Habitats

- Acquire land or conservation easements from willing sellers along the riparian corridor of the San Joaquin River downstream of the confluence with the Merced River.

- Acquire land or conservation easements from willing sellers along the riparian corridors of the Merced, Tuolumne, and Stanislaus Rivers.

REDUCTIONS OF THE EFFECTS OF DIVERSIONS:

Install Screens on Unscreened In-Delta Diversions

- Implement a comprehensive program to install positive barrier fish screens at unscreened or poorly screened diversions on the Delta along the San Joaquin River. Priorities for screening should be based on diversion location, size, period of use, and available partnership funding.

MANAGEMENT OF WATER QUALITY:

Establish Incentives for Retirement of Lands with Drainage Problems

- Implement a cooperative program to retire agricultural lands that discharge large quantities of high concentrations of contaminants to the San Joaquin River.

V. Funding Priorities: 1996

The attached specific actions are CALFED Bay-Delta Program recommendations to the Stakeholder community for funding in 1996, under Category III.

These actions were developed consistent with the over-all CALFED Bay-Delta Ecosystem Restoration Strategy. These recommended actions are intended to address limiting factors, that rely on natural processes. The actions are intended to increase the residence of populations or natural habitat. Many of the actions will achieve multiple benefits in that they beneficially impact more than one specie or group of animals or they effectively deal with more than one limiting factor.

We believe the actions will produce measurable results. At the basic level the actions themselves will produce results which can be measured against a performance objective. Collectively, we believe that these actions will produce benefits that can be measured at the watershed level and ultimately at a population level.

Some of the actions proposed are at levels which make up for unavoidable losses which occur elsewhere in the watershed or the ecosystem.

The priorities used to recommend these actions are both straightforward and limited. The number one priority expressed by these proposed actions is the near term reduction or removal of non-flow factors which limit the production and survival of Spring Run Chinook Salmon. The second priority is the restoration of habitat in the Delta proper which is essential to the majority of fish species that rely on the Delta for all or a part of their life-cycle. The Delta specific recommendations also serve as a foundation for a field laboratory to evaluate the benefits and pitfalls of habitat restoration in the complex Bay-Delta System.

Some of the recommendations are for funds necessary to evaluate options, to develop designs and to finalize plans. This aspect of the proposal is absolutely essential and cannot be

dismissed as just another study. The problems identified by biologists and ecosystem managers cannot be converted to effective actions without analysis of options, development of alternative designs, preparation of proposals, and the award of contracts. In the absence of funds to support these essential steps, progress will not occur.

Cost figures for the recommended actions are approximate. In some cases they are based on recent experience, some are quite refined, and some are "in the ballpark." Where costs are estimated for a specific project, ie: "ladder and fish screen at X diversion," they include all anticipated costs from design to permits and environmental documentation, and construction through completion. With the exception of the recommendation for the Western Canal Company Siphon, none of these costs include cost sharing. Substantial local, regional and governmental cost share opportunities exist and partnerships should be sought out as a criteria to developing these recommendations.

Cost savings and efficiencies could be realized if these actions are implemented as groups or programs. It would make sense to prepare program permit applications and environmental documents and to manage inter-linked projects as larger and efficient units.

Each of these actions maybe creditable under some future process which will provide for credit against allocated costs for ecosystem restoration.

1.	Fund a grant program to assist established conservancies to develop or complete stream restoration or watershed management plans.	$ 500,000

BATTLE CREEK

1.	Install fish screen and ladder at Eagle Canyon Diversion Dam.	$ 700,000
2.	Restore and replenish spawning gravel in the North Fork.	$ 100,000
3.	Negotiate and fund a perpetual instream flow agreement with Pacific Gas & Electric Company.	$ 2,000,000
4.	Prepare an options, feasibility analysis for additional fish screens and ladders and a flow allocation methodology.	$ 250,000
5.	Evaluate options to provide a disease free water supply for Coleman Nation Hatchery.	$ 10,000
	Total	$ 2,360,000

ANTELOPE CREEK

1.	Conduct an options, feasibility and engineering analysis of fish passage problems and habitat restoration opportunities.	$ 250,000

BIG CHICO CREEK

1.	Reconstruct existing water control structure at Lindo Channel.	$ 100,000
2.	Replace fish ladders at Iron Canyon and One Mile Pool.	$ 200,000
3.	Install discharge bypass at One Mile Recreation Area.	$ 150,000
	Total	$ 450,000

BUTTE CREEK

1.	Complete construction of fish screens and ladder at Durham-Mutual Dam.	$ 30,000
2.	Construct fish screen and fish ladder at Adams Dam.	$ 935,000
3.	Construct fish screen and fish ladder at Gorrill Dam.	$ 935,000
4.	Cost share removal of Western Canal Company Dam and institution of siphon across Butte Creek.	$ 2,739,000
5.	Construct fish screen and ladder at the White Mallard diversion	$ 300,000
6.	Purchase screened portable pumps as alternative to Little Dry Creek Diversion.	$ 100,000
7.	Conduct stream channel and habitat restoration below Durham-Mutual Dam.	$ 200,000
8.	Provide for fish passage around White Mallard discharge outfall.	$ 10,000
9.	Reconstruct culvert and riser at Drumheller Slough outfall.	$ 10,000
10.	Conduct site survey and prepare options and engineering analysis for the remaining 12 diversions' structures along lower Butte Creek.	$ 100,000
	Total	$ 5,359,000

CLEAR CREEK

1.	Fund title search and escrow preparation for Bureau of Land Management land exchange above Saeltzer Dam.	$ 10,000
2.	Conduct options analysis and design engineering for fish passage at Saeltzer Dam.	$ 750,000
	Total	$ 760,000

YUBA RIVER

1.	Construct fish screen at Browns Valley Irrigation District Diversion.	$ 275,000
2.	Construct fish screen, fish ladder and dam modifications at Daguene Point Dam.	$ 4,700,000
	Total	$ 4,975,000

SACRAMENTO - SAN JOAQUIN DELTA

1.	Cost share habitat restoration on Prospect Island.	$ 2,250,000
2.	Conduct an interdisciplinary evaluation of breached dike wetland recovery sites in the Delta and upper estuary.	$ 350,000
3.	Conduct an analysis of stock identification and life-history success of Chinook Salmon through the use of scale and otolith microstructure analysis.	$ 275,000
	Total	$ 2,880,359
	Grand Total	$ 17,534,000