Appendix B
Action Category Descriptions

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November 14, 1995

Potential Action Categories and Actions for Bay-Delta Solutions

Introduction

Organization of Action Categories

This appendix provides a list of actions organized into action categories and further organized into groupings of categories. Following this list are narrative descriptions of 50 action categories. The organization of actions into action categories and groupings of categories contained in this appendix provides some organization of the diverse actions that may be useful for helping attain the CALFED Bay-Delta Program objectives. Other methods for organizing actions into categories and groups are possible. The organization that has been used here represents a method based on the function of the actions. Some actions may be associated with more than one action category. In most cases, we have chosen to include such actions under only one action category. This list of action categories and actions has been modified based on comments received in connection with the October 12 workshop. Subsequent changes in this organization may be necessary to facilitate the development of alternatives.

Definition of Actions

An action is an activity that is intended to address a problem or resolve a conflict in the Bay-Delta system. An action could be a structure, operating criteria, a program, a regulation, a policy, or a restoration activity. The list of action categories and actions identifies actions that the CALFED Bay-Delta Program will consider to meet Program objectives to solve problems or contribute to solutions in the Bay-Delta system. The list of actions is a dynamic list in that it is not comprehensive and has not undergone a technical evaluation of the merits of the individual actions. These actions represent ideas and recommendations regarding possible ways to address problems of the Bay-Delta system which have been extracted from numerous reports, programs and planning efforts by agencies and organizations.

This appendix does not include narrative descriptions of actions. When such descriptions are prepared they will be at a level of detail that is appropriate for assembly into program alternatives and evaluation in a Tier 1 or programmatic level environmental document. Specific projects will not be described or evaluated until the Tier 2 project-level environmental documents are prepared.

Definition of Action Categories

An action category is a set of similar actions. Action categories are described in this appendix. The description of each action category identifies the types of actions encompassed by the category, the purposes of those types of actions, and constraints in implementing those types of actions. Each also describes linkages to other actions that would produce synergism in implementation.

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List of Action Categories and Actions

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Action Categories to Restore Upstream Habitat

Action Categories to Reduce Effects of Diversions

Action Categories to Manage the Enhancement of Anadromous Fish Populations

Action Categories for Reducing Reliance on Delta Exports

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Action Categories to Enhance Water Supplies

Action Categories for Managing Water Quality

Action Categories for Improving System Reliability

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Restoration of Bay-Delta System Shallow Water (Tidal) Habitat

Description

Bay-Delta system shallow water habitat includes areas subject to tidal flooding to depths of 10 feet or less. Typically, this includes shallow, vegetated marsh flats; sloughs; tidal channels; shoals of main channels; shorelines; and bays. The shallow water depths allow light penetration and consequent plant production that provide habitat and food supply for fish. Shallow-water tidal habitat in the Bay-Delta system has declined drastically over time because of agricultural lands reclamation, channel and bay dredging, shoreline filling for urban and industrial use, and erosion of remaining shallow water habitats (e.g., channel islands) by wind-driven waves, boat wakes, or high-velocity flows. Restoration of shallow water habitat in the Bay-Delta system may include various means of converting existing islands or other leveed lands having elevations near or below sea level into shallow-water tidal habitat. Other options include converting deeper water habitat into shallow water habitat by filling the former with dredged materials; and protecting existing shallow water habitats from additional erosion, dredging, or filling.

This category includes the following actions:

- convert existing leveed lands to tidal action,
- protect existing shallow habitat from erosion,
- provide tidal access to existing adjacent nontidal wetlands,
- reconstruct levees to include shallow water habitat, and
- fill deep water to produce shallow habitat.

Purpose

Restoration of shallow water habitat in the Bay-Delta system may, in concert with other actions, improve survival and production of native fish species. Restoration would increase the amount of spawning, rearing, and feeding habitat for many Bay-Delta system fishes and invertebrates, and would provide foraging habitat for wildlife. It could also increase the residence time for water in the Bay-Delta system, which may improve the productivity of this ecosystem.

Constraints

Restoration of shallow water habitat can be costly and could result in conversion of agricultural lands to aquatic habitat. Filling Delta channels may affect the normal flow and flood-conveyance capacity of channels, and filling deeper waters may constrain navigation and increase sediment loads in Delta waters. Changing hydraulic flow patterns in affected Delta channels could cause a change in the present balance between saltwater and freshwater in the Bay-Delta system. In addition, converting Bay-Delta system deepwater habitat into shallow water habitat would require large quantities of fill material. The use of dredged materials must address the possible existence of toxic constituents in dredged sediments.

Linkage to Other CALFED Action Categories

Restoration of shallow water habitat can be combined with channel modifications that reduce flow velocities to provide higher quality spawning and rearing habitat for resident fish species. Restoration of Bay-Delta system riverine and riparian habitats adjacent to shallow water habitat can produce naturally occurring combinations of habitats that provide food, cover, and flow conditions conducive to a wide variety of species.

Restoration of Bay-Delta System Riverine Habitat

Description

Bay-Delta system riverine habitat includes river channels with natural configurations (meanders, shoreline shallows, shoals, islands, and backwaters); flow conditions (depth, velocity profiles); and vegetation (tule beds). The amount of high-quality riverine habitat remaining in the Bay-Delta system has decreased over time as a result of levee maintenance, channel dredging, erosion from boat wakes, and other Delta land use activities. Restoration of Bay-Delta system riverine habitat may include physical reconstruction of the river bank and shallow areas; revegetation; and placement of physical objects, such as woody materials, to enhance aquatic habitat value.

This category includes the following actions:

- restore and reconstruct river banks and shallow areas,
- restore and preserve channel islands,
- restore natural channel configurations, and
- modify channel/levee construction practices to include riverine elements.

Purpose

Restoration of riverine habitat is intended to improve degraded riverine areas by increasing the quantity and enhancing the quality of habitat for resident fishes, other aquatic plants and animals, and wildlife through physically enhancing riverbanks and shallow areas, and through revegetation. Riverine restoration in the Bay-Delta system would contribute to a greater diversity of habitat types than is currently available and would improve holding and foraging areas for a number of species. It would provide temporary habitat for the juvenile life stages of several anadromous species, including Chinook salmon, Sacramento splittail, and striped bass.

Constraints

Restoration of riverine habitat may have environmental impacts on water quality and terrestrial habitat. Channel alterations may increase sediment load to the estuary. Conversion of terrestrial habitat to river habitat would reduce acreage of upland habitat. Protecting restored riverine areas requires addressing erosion caused by channel flows, waves as a result of wind and/or boat wakes, and trespassing. Constraints to restoration may include the need to continue channel dredging and levee maintenance, which often requires removal of vegetation and disposal of new dredged materials and an increase in levee maintenance costs. Modification of riverine habitat may also impact channel flood control capacities and channel carrying capacities for conveyance of water to export pumps, and may lead to an increase in predatory species.

Linkage to Other CALFED Action Categories

Restoration of Bay-Delta system riverine habitat can be combined with restoration of shallow water (tidal) and riparian habitats to produce naturally occurring combinations of habitats that provide food, cover, and flow conditions conducive to a wide variety of species.

Restoration of Bay-Delta System Riparian Habitat

Description

Bay-Delta system riparian habitat consists of river and channel shorelines vegetated with trees, shrubs, and grasses. This habitat type is found along many older levees and is superior to managed riprap levees as fish and wildlife habitat. The quantity and quality of riparian woodland and scrub habitats in the Bay-Delta system have decreased over time because of levee construction and maintenance, island flooding as a result of levee failure, conversion of riparian habitats to agriculture, and other human activities. Restoration of Bay-Delta system riparian habitat includes improving and protecting degraded riparian woodland and scrub habitats, establishing riparian habitats in new areas, and reestablishing historic riparian habitat. Restoration may also include actions to prevent future degradation of existing and restored riparian areas and protection and restoration of remaining channel islands.

This category includes the following actions:

- improve and protect degraded riparian habitats,
- establish new areas of riparian habitat,
- reestablish historic riparian areas,
- modify levee maintenance practices, and
- protect existing riparian habitat.

Purpose

Restoration of riparian habitats is intended to increase the quantity and enhance the quality of habitat for resident and migratory wildlife; to create and maintain wildlife dispersal corridors; and to provide shaded, aquatic cover for fish. Protection of existing levees against erosion may also result although current practice is to remove vegetation from levees. Riparian habitat may contribute to an increase in the productivity of the ecosystem by serving as a source of insects and vegetative material. Riparian vegetation may also contribute to aquatic habitats where undercut banks and exposed rootballs occur.

Constraints

Protecting existing habitat and establishing new habitat areas could result in a reduction in the amount of land in Delta agricultural production and a decrease in the effectiveness of established levee maintenance programs. Developing riparian habitat along levees may be constrained by needs for levee maintenance and stabilization and may increase the demand for removal of large floating vegetative matter because of hazards to boating. Increased riparian vegetation may also alter the hydraulic characteristics of some channels, affecting their conveyance capacities. Restoring riparian habitats may be costly if easements or purchase of restoration lands in fee title is required. Upgrading levees to create a riparian zone may also be expensive.

Linkage to Other CALFED Action Categories

To increase their value, riparian restoration activities should also be coordinated with restoration of Bay-Delta system aquatic, wetland, and terrestrial habitats. By combining restoration of a mixture of habitats, movement corridors for wildlife species can be created within the Bay-Delta system. Riparian habitat restoration at the edges of Bay-Delta system channels and sloughs can greatly enhance the quality of adjacent riverine and shallow water habitats.

Restoration of Bay-Delta System Wetland Habitat

Description

Bay-Delta system wetland habitat includes lands flooded intermittently either through tidal action or through freshwater runoff. Tidal wetlands consist primarily of tule marsh lands with wetted submergent and emergent rooted vegetation. Tidal flooding, typically to less than 3 feet, may include wetted shorelines and islands. Nontidal wetlands are typically flooded seasonally by floodwaters or by the application of diverted water. These are disconnected from other wetlands and are typically managed for waterfowl. Restoration of Bay-Delta system wetland habitat involves improving degraded wetlands and establishing wetlands in areas that formerly supported or could now support them. Restoration may also include actions to prevent future degradation of existing and restored wetlands.

This category includes the following actions:

- restore, enhance, and create wetlands;
- expand wetland acquisition programs;
- convert agricultural lands to wetlands; and
- protect existing wetland habitat.

Purpose

Restoration of Bay-Delta system wetlands is intended to increase the quantity and enhance the quality of habitat for waterfowl and other resident and migratory wildlife, and to protect and enhance fisheries values (e.g., carbon production, spawning, and rearing habitat, etc.) associated with tidal marshes. In addition, enhancement and creation of wetlands would increase availability of brood and nesting habitat for waterfowl and other water birds that nest in the Bay-Delta system, provide foraging and roosting habitat for the large number of shorebirds that annually winter or migrate through the Bay-Delta system, and create habitat for several threatened or endangered species that are associated with Bay-Delta system wetlands. Establishing wetlands on the interiors of below-sea-level Delta islands can also reduce the rate of island subsidence.

Constraints

Protecting existing wetlands and establishing new wetlands could also result in reduced agricultural production and increased mosquito abatement costs. In addition, restored wetlands can attract waterfowl from other hunted areas. The costs and benefits of Bay-Delta system wetland restoration are not known because little wetland restoration and management has occurred there. The effects of managed wetlands on municipal water quality are also a concern. Restoring wetlands may be costly if it requires extensive grading, easements, or purchase of restoration lands in fee title.

Linkage to Other CALFED Action Categories

Wetland restoration activities should be coordinated with restoring Bay-Delta system riparian, aquatic, and terrestrial habitats to increase the value of wetland restoration by juxtaposing related habitats for overall ecosystem diversity.

Restoration of Bay-Delta System Terrestrial Habitat

Description

Bay-Delta system terrestrial habitat includes upland areas that are not wet and not riparian, such as island interiors, levees, and shorelines with higher elevations. They are typically vegetated with trees, shrubs, and grasses and provide habitat for many wildlife species. Restoration of Bay-Delta system terrestrial habitats includes improving habitat values associated with degraded uplands and agricultural lands and establishing new uplands in areas that formerly supported or could now support upland habitats.

This category includes the following actions:

- protect existing upland habitats;
- establish upland habitat on levees;
- establish upland habitat on fallowed croplands;
- establish oak woodlands on suitable soils;
- encourage wildlife-friendly agricultural practices;
- preserve agricultural land uses providing habitat; and
- clean up sites containing toxic substances such as fertilizer, pesticides, and herbicides.

Purpose

Remaining upland habitat in the Bay-Delta system is primarily associated with levee slopes and fallow croplands. Developing grassland habitats on levee slopes and permanently fallow land would provide nesting habitat for ducks, and nesting and foraging habitat for other wildlife species that use grasslands. Establishing oak woodlands on suitable soils would also provide nesting and roosting habitat for raptors and songbirds, and would increase the diversity of wildlife species that use Delta islands. Much of the historic wintering waterfowl habitat in California has been lost as a result of converting wetlands to other land uses. Croplands in the Bay-Delta system now provide foraging habitat for a major segment of the Pacific Flyway's wintering waterfowl population. Managing croplands to sustain or increase the production of high-value waterfowl food crops and implementing practices that make food crops more available to waterfowl would increase the value of the Bay-Delta system as a waterfowl wintering area.

Constraints

Protecting existing uplands and establishing new uplands could result in reduced agricultural production. An increase in funding for existing conservation easement programs could be required in order to effectively encourage management practices on agricultural lands that would increase the quantity and quality of foraging habitat for waterfowl wintering in the Bay-Delta system. Farmers with land adjacent to the Bay-Delta system may be adversely affected if they do not want waterfowl foraging on their lands. Restoring uplands may be costly if it requires easements or purchase of restoration lands in fee title.

Linkage to Other CALFED Action Categories

Terrestrial habitat restoration can be linked to restoring Bay-Delta system riparian and Bay-Delta system wetland habitats to increase the wildlife value of each. It can also be linked to waterfowl habitat management actions to increase the effectiveness of efforts to improve conditions for waterfowl.

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Implementation of Integrated Habitat Management Programs

Description

The Delta is a large area with numerous organizations and agencies working to accomplish various habitat management goals. Integrating the habitat management programs among these various agencies would allow for more integrated management of terrestrial and aquatic resources in the Delta and upstream areas of the Delta watershed. Integrated habitat management programs for the Delta or upstream habitats could draw on previous efforts to implement Habitat Conservation Plans and Natural Community Conservation Plans to protect biodiversity.

This category includes the following actions:

- establish regional ecosystem restoration guidelines,
- implement integrated regional habitat management,
- develop cooperative management agreements, and
- establish mitigation banking program.

Purpose

Implementation of integrated habitat management programs is intended to increase the efficiency and success of habitat management actions designed to enhance the integrity and sustainability of the Bay-Delta system. Actions now taken by various resource management and regulatory agencies are sometimes not compatible and may not support each other. Integrated management programs could ensure that management goals and activities are compatible and supportive of each other and that resources can be pooled to achieve greater results.

Constraints

Implementing integrated habitat management programs may require extensive coordination and consultations among authorities and agencies that now have distinct jurisdictions and objectives. These entities may need to modify their management priorities and goals in such a way as to be compatible with the goals of the integrated program. Such organizational restructuring and reprioritizing may be complex and difficult to achieve given the sometimes conflicting goals and objectives of agencies at different levels of government and representing different jurisdictions.

Linkage to Other CALFED Action Categories

Integrated habitat management programs can be linked to all types of habitat restoration in the Delta and in areas upstream from the Delta watershed, improvements to flood protection, reduction of land subsidence, and establishment of floodways and meander belts, which would be implemented more effectively if done in an integrated manner. Other actions that can provide opportunities for habitat restoration, such as Delta channel modifications, improvement of conveyance facilities, offstream water storage in the Delta, and levee maintenance, can be implemented for greater overall benefit as a result of increased integration between responsible resource management and regulatory agencies.

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Establishment of Floodways and Meander Belts

Description

Floodways are channels for diversion and detention of floodflows. Floodways can be established either by constructing separate bypass channels (e.g., Sutter and Yolo bypasses) or by widening existing river channels to create low-flow and floodflow portions of the channel. Meander belts are floodplains of rivers or streams where natural channel meandering is allowed to occur. The amount of riparian and seasonal wetland habitats associated with floodways and meander belts in the Delta has decreased and its connectivity has been disrupted over time as a result of waterway channelization, levee construction, and Delta land reclamation in historic floodplains. Establishment of floodways and meander belts could include all areas to be incorporated in floodways that would either be purchased, secured through conservation easements, or leased as floodway easements.

This category includes the following actions:

- relocate levees to widen floodways,
- allow river channels to meander,
- acquire Delta islands as overflow areas, and
- restore floodways as habitat corridors.

Purpose

Establishing floodways and meander belts is intended to restore corridors of connected seasonal wetland and riparian habitats. Increasing the quantity and quality of these habitats in the Delta would benefit associated waterfowl and other wildlife species and provide habitat for several threatened and endangered species. Reestablishing habitat corridors would benefit movement and gene flow among wildlife populations. Establishing floodways and meander belts would also increase the flood conveyance capacity of waterways.

Constraints

Establishing floodways and meander belts would be constrained by the need to acquire or lease land available for seasonal flooding and the cost of purchasing this land or obtaining conservation easements. Levees, other flood control features (e.g., weirs), and infrastructure would have to be relocated or reconstructed.

Linkage to Other CALFED Action Categories

Establishment of floodways and meander belts can be implemented to benefit riparian and wetland habitats and to provide increased levels of flood protection. In addition, improvements of through-Delta conveyance could be designed to incorporate floodways and meander belts. If a sufficient amount of additional flood capacity were created this way, a higher carryover storage could be allowed in upstream reservoirs.

Control of Introduced Species

Description

The introduction of non-native species to the Bay/Delta has resulted in significant changes in the ecology of the estuary. New species have altered all trophic (food chain) levels of the Bay-Delta food web to such an extent that native species are directly affected by predation and indirectly affected by competition for habitat and food supply. Controlling existing introduced species and further introductions is difficult but could be important if native species in the estuary are to be protected and enhanced.

This category includes the following actions:

- remove or reduce nuisance species in key habitats,
- improve regulation of ballast-water releases,
- inspect for invasions of nuisance species,
- modify habitat to favor native species, and
- improve border inspection practices.

Purpose

Controlling previously introduced species and the introduction of new non-native species is intended to curtail adverse changes in aquatic and terrestrial habitats of the estuary and potentially protect and enhance populations of native species and communities. The control of introduced species can also contribute to system reliability. If allowed to enter the Bay-Delta ecosystem, introduced species, such as the zebra mussel, could have substantial negative effects on operations.

Constraints

Some non-native species are well established in the estuary. Control of new introductions would require considerable political effort to change existing laws and regulations governing the release of ballast water into the estuary. Controlling previously introduced species and limiting further non-native introductions is a costly and a very difficult task because of the rapid population growth of some introduced species and the variety of mechanisms by which they can be introduced.

Linkage to Other CALFED Action Categories

Controlling introduced species can be combined with other actions intended to benefit aquatic and terrestrial species to provide greater results. For example, harvesting the introduced aquatic weed, water hyacinth, can be linked to restoration of Bay-Delta System shallow water and riverine habitats.

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Delta Waterfowl Habitat Management

Description

Conversion of seasonal wetlands to agricultural and other uses in the Bay-Delta System region have reduced available habitat for migrating waterfowl. Delta waterfowl habitat management consists of activities that would create new habitats for waterfowl and improve the productivity of existing habitats through alterations to land use management practices on wildlife management areas and areas in agricultural production.

This category includes the following actions:

- manage crops for waterfowl food crops,
- improve management of public waterfowl areas,
- manage croplands to improve gamebird habitat,
- implement terrestrial predator control programs, and
- increase sources and availability of wildlife forage.

Purpose

The Bay-Delta System serves as an important component of the Pacific Flyway for wintering waterfowl. Its importance can be measured both in terms of the number of species and the abundance of each species that uses the Bay-Delta System. These species include white fronted geese, snow geese, mallards, northern pintails, and American widgeons. Management actions for waterfowl species are intended to improve habitat conditions and populations of these wildlife. Management would identify factors that limit the distribution and abundance of these species and improve habitat conditions through actions that address these limiting factors. The end result would be an increase in the variety, abundance, and distribution of waterfowl species.

Constraints

Management actions to increase available forage and improve winter habitat conditions for waterfowl could require that private landowners modify agricultural practices, possibly resulting in a reduction in annual productivity on croplands. Such changes in agricultural practices may require land purchases or conservation easements for implementation.

Linkage to Other CALFED Action Categories

Restoration of Bay-Delta System wetland habitat and management of adjacent agricultural land for waterfowl forage would provide additional benefits for waterfowl species. Waterfowl management actions could be coupled with the construction of floodways and meander belts to provide similar benefits.

Restoration of tidal wetlands would provide benefits for waterfowl and for native and other important fish species.

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Restoration of Upstream Anadromous Fish Habitat

Description

Upstream anadromous fish habitat includes physical factors affecting fish in rivers and streams that flow into the Bay-Delta System. These factors may include the rate and timing of flows, water temperature, dissolved oxygen levels in the water, availability of spawning gravels, and the quantity and quality of river edge vegetation. The quantity and quality of upstream anadromous fish habitat has decreased drastically over time as a result of past mining practices, the construction of dams, the diversion of water to out-of-stream uses, and agricultural and grazing practices. Anadromous fish habitat has declined drastically over time in the Central Valley rivers because of human activities in the watershed. The restoration of upstream anadromous fish habitat would include actions to restore these physical factors to levels better suited for anadromous fish.

This category includes the following actions:

- manage flows and temperatures in upstream habitats,
- restore and replenish spawning gravels,
- restore channel configurations,
- restore shoreline habitat conditions,
- modify gravel mining practices, and
- improve floodway drainage to reduce fish stranding.

Purpose

Where the availability of upstream habitat is the limiting factor for populations, restoration of anadromous fish habitat in the rivers and tributaries upstream from the Bay-Delta System may improve anadromous fish production in the Central Valley by increasing the amount of spawning, rearing, and migration habitat in rivers and tributaries.

Constraints

Restoring instream flows to rivers and tributaries will reduce the amount of water available locally for out-of-stream uses. Focusing planning efforts on anadromous fish restoration in some watersheds may restrict other activities and uses, including navigation, water quality, and downstream diversion.

Linkage to Other CALFED Action Categories

Many factors may limit anadromous fish production in Central Valley streams, and these factors may vary by stream. By combining upstream habitat restoration with other actions, such as changes in the management of hatchery operations, changes in legal and illegal harvesting of fish, watershed management to improve water quality, and improvements in Bay-Delta System fish habitats, the likelihood of success of fish restoration activities can be increased.

Improvements for Upstream Fish Passage

Description

Improvements for upstream fish passage may include improving flows for downstream migrating juveniles; removing or minimizing effects of migration barriers, such as diversion dams; improving fish passage where blocked or hindered by natural barriers; increasing flows in hydropower bypass areas; providing attraction flows for upstream migrating adult anadromous fish in the estuary and rivers; and minimizing effects of migration barriers, such as the low dissolved oxygen condition in the San Joaquin River near Stockton that acts as a barrier to fish movement.

This category includes the following actions:

- modify passage at upstream dams and other barriers and
- modify natural barriers to improve passage.

Purpose

Natural events and human activities have blocked or hindered the upstream and downstream migrations of anadromous fish. Fish passage and migration improvements will increase the chances that upstream-migrating adult salmonids will reach spawning rivers and streams and that downstream-migrating juvenile and adult salmonids will reach the lower rivers, estuary, and ocean. Improving flow conditions and reducing problems with water quality and physical barriers will potentially increase the numbers of anadromous fish that reach spawning areas and the numbers of juveniles that reach the estuary and ocean, ultimately increasing the overall production of the populations.

Constraints

Increasing flows during upstream and downstream migration periods may reduce availability of water supplies for urban and agricultural purposes. Modifications to diversion dams or other physical barriers are very costly and, at times, may not be technologically feasible. Improving fish passage by altering flows and modifying migration barriers can be costly.

Linkage to Other CALFED Action Categories

Improving fish passage problems can be implemented with restoration of upstream anadromous fish habitat, upstream riparian habitat, and upstream wetland habitat to improve the overall habitat conditions for anadromous fish and increase spawning success. In the Bay-Delta System, fish passage solutions can be linked to modifications to project operations, Bay-Delta System inflow/outflow/export management, and changes in the location and timing of diversions to increase the number of fish making a successful outmigration to the Bay.

Restoration of Upstream Riparian Habitat

Description

Upstream riparian habitat includes river shorelines vegetated with trees, shrubs, and grasses. This habitat type is found along many nonleveed reaches of rivers and streams and is superior to managed riprap levees as fish and wildlife habitat. The quantity and quality of upstream riparian habitat has decreased over time because of the construction and maintenance of levees, the conversion of riparian areas to other land uses, and the construction of upstream dams. Restoration of riparian habitat along rivers and tributaries upstream from the Delta may include protecting riparian vegetation from grazing animals, planting riparian vegetation, restoring flows that are more supportive of riparian vegetation, and purchasing riparian corridors along watercourses.

This category includes the following actions:

- restrict livestock grazing in riparian corridors,
- revegetate degraded riparian habitats,
- protect riparian lands through purchase/easements, and
- restore flows to dewatered riparian habitats.

Purpose

Restoration of riparian habitat in rivers and tributaries upstream from the Delta could provide habitat for many wildlife species. It could also improve anadromous fish production in the Central Valley by providing feeding habitat for young fish and by reducing water temperatures. In addition, riparian habitat restoration would increase the quality of rearing and migration habitat for anadromous fish in rivers and streams by producing shade and cover along the water's edge. Therefore, riparian habitat restoration could potentially improve survival and production of wild anadromous fish populations in the Central Valley.

Constraints

Restoring riparian habitat along rivers and streams may require limiting land uses, such as grazing, along watercourses. In addition, increasing instream flows to benefit desirable riparian vegetation may restrict other activities and uses, including navigation, water quality control, and downstream diversion. Riparian planting programs are also costly.

Linkage to Other CALFED Action Categories

Restoration of upstream riparian habitat can be combined with restoration of upstream anadromous fish habitat (e.g., spawning beds), improvements for fish passage and migration, and Delta inflow/outflow/export management to increase the populations of anadromous fish species.

Restoration of Upstream Wetland Habitat

Description

Upstream wetland habitats are areas subject to seasonal flooding either through natural inundation from floodflows or through diversions to areas managed for waterfowl. Wetland habitat along the margins of rivers has declined drastically as a result of channelization, levee construction, bank protection, and other activities. Restoring wetland habitat along the margins of rivers may include expanding floodplains by modifying or removing levees, protecting and restoring existing wetlands in floodplains, controlling in-channel aggradation, and modifying existing floodways (e.g., Sutter and Yolo bypasses). In addition, new wetlands can be constructed using discharges from agriculture or urban wastewater treatment facilities.

This category includes the following actions:

- modify floodways to support wetland habitats,
- reuse agricultural drainage to create wetlands,
- reuse urban wastewater effluent to create wetlands, and
- manage groundwater recharge for wetland habitat.

Purpose

Restoration of wetlands upstream from the Delta can improve wetland and wildlife habitats in the floodplains of the Sacramento and San Joaquin Rivers. These wetlands may provide important spawning and rearing habitat for the Sacramento splittail. In addition, seasonal wetlands can provide rearing habitat and migration routes for fry salmon during winter and spring.

Constraints

Restoring wetland habitat along the rivers and floodway corridors can conflict with existing land uses in some areas and could potentially affect flood conveyance capacity and flood protection. Because of the extensive amount of levee construction on upstream river channels, the amount of area readily available for wetland restoration is limited. The construction of setback levees would be required to create wetland habitat in already leveed areas. Where required to implement wetland restoration, levee modification and construction along rivers would be costly because of construction costs and the potential need for relocating existing roads and infrastructure.

Linkage to Other CALFED Action Categories

Restoration of upstream wetland habitat can be combined with anadromous fish habitat restoration, upstream riparian habitat restoration, and fish passage and migration improvements to increase populations of anadromous fish species. It can also be combined with restoration of Delta wetland habitats and Delta waterfowl habitat management to provide greater benefits for waterfowl.

Delta Inflow/Outflow/Export Management

Description

Water management in the Delta primarily involves manipulation of allowable exports as a function of required Delta outflow or as a specified fraction of Delta inflow. For example, the 1995 Water Quality Control Plan (WQCP) established monthly minimum outflows to control salinity and maximum export/inflow ratios to limit entrainment effects. The WQCP also specified San Joaquin River flows to assist downstream migration of salmon and establish exports limited to a specified fraction of this flow. While Delta inflows are partially controlled by upstream reservoir releases, the primary management of Delta operations are the daily or monthly allocation of Delta inflows for in-Delta diversions (consumptive use), Delta exports, and Delta outflows. In June 1994, the CALFED Framework Agreement established a Delta operations coordination group that has been delegated authority to recommend changes in allowable exports based on available ("real-time") fish monitoring information. Future changes could include establishing a formal Delta watermaster to manage Delta inflow/outflow/export.

This category includes the following actions affecting Delta inflows:

- modify upstream consumptive use,
- modify upstream reservoir operations criteria,
- modify Delta inflow timing pattern,
- provide instream pulse flows for fish passage, and
- provide instream flows for fish attraction,

and the following actions affecting Delta diversions and outflows:

- modify volumes and timing of exports,
- modify in-Delta consumptive use,
- modify central Delta channel operations,
- modify export operations criteria,
- establish a Delta watermaster to manage flows, and
- use real-time monitoring and adaptive management.

Purpose

Carefully managing allocation of Delta inflows between Delta outflow and Delta exports could provide many potential environmental benefits. Sufficient Delta outflow is needed to maintain the freshwater/saline water balance in the Bay-Delta estuary, and to protect agricultural and drinking water diversions from salinity intrusion. It may be possible to provide improved drinking water quality by controlling salinity intrusion with increased outflows or by reducing water supply exports during the initial flush of runoff and agricultural drainage following major rainfall events. Many possible fisheries benefits can be achieved by managing the fraction of Delta inflow that can be exported (e.g., improving downstream transport of migrating salmon or survival of early life stages of fish that spawn within Delta channels or in upstream areas).

Constraints

Predictability of the Delta inflow water supply is the primary constraint on management of outflow and exports. Managing exports in conjunction with providing aquatic habitat benefits is difficult because of uncertainties in the risk of a reduced water supply and in the fisheries benefits that would be achieved.

Linkage to Other CALFED Action Categories

Management of Delta inflow/outflow/export will be more effective if it is linked to flow and/or fish barriers to provide a wider range of water transport and fish transport/migration controls. Managing the timing of Delta flows can be facilitated by new or expanded onstream or offstream storage, groundwater banking and conjunctive use, the construction of conveyance facilities, and the implementation of water transfers. Water resources data and information management can provide the tools needed to minimize the effects of diversions on fish and to manage saltwater in the Bay-Delta estuary. Management of Delta inflow, outflow, and export would be more effective in reducing fish entrainment if it is implemented with barriers to fish movement and changes in the location and timing of diversions. It is linked to wetland habitat restoration through the salinity control it provides.

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Modification of Diversion Timing Patterns

Description

Modification of diversion patterns would consist of shifting the seasonal pattern (i.e., timing) of diversions to allow higher instream flows or reduced entrainment effects during periods when instream flow requirements for fish habitat are most important or when fish life stages are most vulnerable to diversions. A shift in diversion timing is more feasible if water can be stored offstream after diversion. For example, the San Luis Reservoir storage capacity is used to allow the pumping timing pattern to be shifted relative to the demand pattern. As another example, the Best Available Technology (BAT) portions of the National Pollutant Discharge Elimination System (NPDES) permits for Pacific Gas & Electric (PG&E) Pittsburgh and Contra Costa power plants includes reduced diversions and possible shifting of diversions to the power plant. The Los Vaqueros reservoir project involves modified diversion patterns (i.e., increase diversions during periods with low salinity) to improve Contra Costa Water District's drinking water quality. Because the reservoir allows a modified diversion pattern relative to demands, fish mitigation measures that reduce diversions during spring to provide entrainment protection for vulnerable life stages of fish are included.

This category includes the following actions:

- modify diversion timing of in-Delta diversions,
- modify diversion timing of export diversions,
- coordinate State Water Project (SWP)/Central Valley Project (CVP) diversion timing,
- modify diversion timing through Montezuma salinity control gate, and
- use real-time monitoring and adaptive management.

Purpose

The purpose of modification of diversion patterns is to provide fish with enhanced habitats and protection from entrainment without reducing the total allowable diversion volume available for achieving water supply benefits.

Constraints

Diversion facilities have generally been sized to allow the maximum seasonal demand to be obtained from a river or the Delta. Diversion or pumping capacity limits diversion patterns. Adding pumping or diversion capacity may be expensive. The recent installation of additional pumps at the SWP pumping plant could allow increased pumping capacity relative to historic patterns with reduced impacts to fish; however, concerns with south Delta channel flows and stages need to be resolved.

Linkage to Other CALFED Action Categories

Providing additional storage can facilitate the separation of diversion schedules from demand schedules. Additional diversion pumping capacity (or additional permitted rates) may also be needed to facilitate modification of diversion timing patterns. When combined with additional storage and diversion pumping capacity, modification of diversion timing can also provide improvements in diversion water quality by allowing diversions to occur when source quality is highest.

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Increased Rates of Diversion Capacity

Description

Increasing the rates of diversion capacity would involve construction of new or enlarged diversion facilities and new or enlarged canals or pipelines for delivering water from the point of diversion to the place of use. Obtaining permits to allow use of additional pumps at the State Water Project's Banks Pumping Plant would enable full-capacity use of the California Aqueduct during hydrologic periods when exportable water is available in the Delta. The California Department of Water Resources has proposed additional diversion facilities at Clifton Court Forebay as part of the Interim South Delta Program to allow increased diversions with fewer environmental impacts. The U.S. Bureau of Reclamation is experimenting with diversion pumps at the Red Bluff Diversion Dam to divert water when the dam gates remain open for fish migration.

This category includes the following actions:

- obtain approvals for expanded export capacities,
- enlarge export pumping capacities, and
- increase diversion capability at Red Bluff Diversion Dam.

Purpose

Increased diversion capacity can be used to more effectively manage water supply during seasonal periods of high water flows. Improved diversion and conveyance facilities can be used to divert additional water supply during brief periods of high flows so that diversions during low flows can be reduced accordingly.

Constraints

The construction of new diversion facilities can have substantial environmental impacts and can be quite costly. Since implementation of increased diversion rates has the potential to change the salinity balance in the Bay-Delta estuary, rules governing this action would need to be adopted.

Linkage to Other CALFED Action Categories

Increasing rates of diversion capacity can be combined with the installation of new or improving existing fish screens to further reduce entrainment. It can also be implemented with other actions designed to reduce entrainment to increase the effectiveness of each. These include changing the location of diversions, fish passage and migration improvements, improvement of fish salvage operations, and Delta inflow/outflow/export management. Increasing diversion capacity may also facilitate water transfers while minimizing impacts on fish by allowing water diversions to take place during selected, short periods of time.

Acquisition of Long-Term Water Supplies for Fish and Wildlife

Description

Long-term water supplies for fish and wildlife can be acquired through contractual mechanisms to obtain water from sources, such as reservoir storage releases, groundwater banking, and long-term water transfers, or through purchase and lease of agricultural water. Water could be obtained from any potential source of inflow to the Bay-Delta System, particularly in the Sacramento River basin. Funds could be used to actually purchase water, or to purchase influence over the timing of water supply deliveries or water transfers, to the advantage of fish and wildlife.

This category includes the following actions:

- acquire water to augment instream flows,
- obtain shifts in timing of instream flows,
- obtain shifts in diversion timing patterns,
- acquire water for refuge habitat use, and
- modify water law to establish instream rights.

Purpose

Long-term water supplies for fish and wildlife would provide greater flexibility for managing Central Valley fish and wildlife resources and provide greater habitat stability for fish survival, growth, and reproduction. Additional water supplies could be used to improve minimum instream flow conditions, provide Bay-Delta System inflow or outflow, increase pulse flows to enhance downstream and upstream migrations, decrease riverine water temperatures, minimize flow fluctuations below dams, enhance wildlife refuge water supplies, and promote riparian vegetation restoration. Properly timed water deliveries from upstream watershed sources could benefit anadromous and native fish populations in tributaries, mainstem rivers, and the Bay-Delta system, as well as water-dependent wildlife resources in the Central Valley. Water transferred from Delta water right holders could provide additional Delta outflow and minimize fish losses from entrainment and impingement at existing diversions.

Constraints

Numerous economic, legal, and institutional constraints exist, such as application of existing water rights laws and area-of-origin statutes. Depending on water supply and user need, the price of water can vary tremendously from $35 to $125 per acre-foot . Acquiring long-term water supplies is costly, and competition for long-term water supplies is intense between environmental, urban, and agricultural user groups. The U.S. Bureau of Reclamation (through the Central Valley Project Improvement Act), California Department of Water Resources, and Delta exporters are independently seeking to purchase large quantities of water primarily for fisheries-related enhancement.

Linkage to Other CALFED Action Categories

Land retirement and fallowing is linked to acquisition of long-term water supplies for fish and wildlife because it is one method of creating a water supply for purchase. The acquisition of long-term water supplies is related to water transfers and establishing an export capacity market because each is a mechanism by which water for fish and wildlife could be purchased. The acquisition of long-term water supplies would accentuate the benefits of upstream habitat restoration. The institution of habitat management programs and establishment of an institution for integrated long-term water management could provide a single entity to serve as a purchaser of water for fish and wildlife.

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Installation of and Improvement to Fish Screens

Description

Entrainment of fish at water diversions used for agricultural, urban, and industrial uses in the Bay, Delta, rivers, and tributaries has contributed substantially to reduced fish populations in the Bay-Delta system. Fish screens can be provided or improved by consolidating existing small water diversions and screening the larger, combined diversion; optimizing screening efficiency at existing screens; and designing, installing, and operating effective screens at unscreened diversions to reduce entrainment and impingement of fish.

This category includes the following actions:

- improve screens at Delta export pumps,
- improve other existing fish screen systems,
- install screens on other in-Delta diversions,
- install screens on upstream diversions,
- consolidate and screen existing small diversions, and
- enforce screening requirements.

Purpose

Installing fish screens at unscreened diversions and improving fish screen systems at screened diversions will greatly reduce losses of fish at vulnerable life stages at water diversions in the Bay, Delta, rivers, and tributary streams and potentially lead to improvements in survival and population abundance.

Constraints

In many cases, technology is not yet available that protects some fish populations at vulnerable life stages in the estuarine environment. Additional research and demonstration studies are necessary to confirm the feasibility and effectiveness of suggested, new screen designs. Screening existing unscreened diversions and improving screening systems at screened diversions can be very costly to install, operate, and maintain.

Linkages to Other CALFED Action Categories

The installation of or improvements to fish screens can be made in concert with changes to the location of diversions and increases in the rates of diversion capacity. Implementing these fish screen improvements would increase the benefits of the changes in diversions. New or improved fish screens can also contribute to the effectiveness of other actions designed to reduce fish entrainment, such as the installation of barriers to steer fish away from the diversion locations, and improvement of fish salvage operations (to improve the salvage rates at the CVP and SWP diversion pumps).

Improvement of Fish Migration

Description

Improvements to assist fish migration can consist of physical barriers (such as gates and screens), behavioral barriers (such as acoustic devices that alter fish swimming behavior to direct them away from predominant flow patterns), or changes in stream flows (to assist in fish migration). Behavioral barriers do not block water movement and navigation as do physical barriers. Fish barriers are being considered for the upper and lower ends of Old River and at other Delta locations where substantial flows are directed away from historical migratory pathways by export pumping. For example, behavioral barriers are being considered to prevent fish from moving toward the central Delta with flows diverted from the Sacramento River through the Delta Cross Channel, Georgiana Slough, and Three-Mile Slough. Additionally, the Delta Cross Channel gates can be operated to form a physical barrier to fish transport toward the central Delta when critical life stages of fish are moving down the Sacramento River near the cross channel.

This category includes the following actions:

- install barriers to block fish movement into Old River,
- install barriers to keep fish in Sacramento River,
- install barriers to divert fish from Sacramento River to western distributaries,
- operate fish barrier on San Joaquin River at Merced River confluence in fall,
- provide instream pulse flows for fish passage, and
- provide instream flows for fish attraction.

Purpose

Installation of fish barriers in the Delta could reduce the movement of fish toward the south Delta pumping plants and help direct the fish downstream to the Bay, thus reducing losses of anadromous fish to Delta diversions. By directing outmigrating fish through the Delta, fish barriers would increase the flexibility of export pumping while reducing losses of anadromous fish populations. Physical barriers, but not behavioral barriers, may also improve water circulation and quality. Physical barriers can also be installed at upstream locations to prevent anadromous fish from straying into uninhabitable watercourses (e.g., the San Joaquin River above the Merced River). Flow improvements provide instream flows to provide natural cues to fish migration or to assist downstream migration.

Constraints

Installations of fish barriers in the Delta can have logistical and technical problems. A barrier in one location may create problems at other locations. For example, a physical barrier at the head of Old River to keep San Joaquin River salmon from moving into Old River in spring may block recreational navigation or the transport of flows important for water quality. Also, construction and operation of physical barriers may be costly. Because of uncertainties in the performance of behavioral barriers, such barriers should be installed using adaptive management strategies in conjunction with real-time monitoring. Operation and maintenance of behavioral barriers would be labor intensive and costly. Providing flows to assist fish migration may prevent the use of this water for out-of-stream uses.

Linkages to Other Action Categories

Improvements to assist fish migration can contribute to the effectiveness of other actions designed to reduce fish entrainment, such as the installation of or improvements to fish screens, changes in the location and timing of diversions, and improvement of fish salvage operations (to improve the salvage rates at the CVP and SWP diversion pumps).

Improvement of Fish Salvage Operations

Description

Fish salvage operations return fish entrained at the export pumps to the Delta through transport by tanker trucks. Currently, salvage operations occur only at the export pumping plants of the Central Valley Project (CVP) and the State Water Project (SWP) in the south Delta. Fish are trucked to the west Delta where they will not be reentrained. Fish entrained at other diversions are returned to the river at the point of entrainment, so no transport is required. Salvage operations have been incrementally improved in recent years, but further improvements may reduce further losses of fish.

This category includes the following actions:

- improve design of salvage facilities,
- improve operation of salvage facilities, and
- improve fish hauling and release procedures.

Purpose

Improvements in fish salvage operations could increase the health and survival rates of certain species of anadromous and resident fish that are collected at CVP and SWP pumping plants and would result in the take of fewer endangered species. Increases in health and survival of salvaged fish would contribute to enhanced populations of these species.

Constraints

In general, modifications to improve fish salvage operations are likely to have relatively little incremental benefit to the fish populations susceptible to salvage. Changes in the location of diversions are more likely to improve fish survival and to meet other Bay-Delta objectives. Improved salvage of some non-native fishes, such as striped bass, may reduce survival of species of special concern, such as delta smelt and winter-run chinook salmon. New physical facilities and equipment are costly; improved handling and hauling procedures are likely to be both costly and labor intensive.

Linkages to Other CALFED Action Categories

Improvements in fish salvage operations could be implemented in combination with improved fish screens to greatly reduce the take of fish and reduce the cost of salvage operations. In addition, these actions could be combined with changing the location of the Delta export diversions so that fewer fish are entrained.

Removal and Control of Aquatic Predators

Description

Many native and non-native fish, such as squawfish, steelhead, striped bass, catfish, large- and smallmouth bass, crappie, and inland silversides, are predators of juvenile native fish species, such as delta smelt and chinook salmon. Predator removal and control consists of reducing the effects of predators on important fish species on which they prey by reducing predator populations in critical habitat locations.

This category includes the following actions:

- harvest predators at Delta export pumps and
- harvest predators in upstream habitats.

Purpose

Predators constitute a substantial problem for native fish survival in many locations, such as Clifton Court Forebay at the State Water Project export pumping plant. Removing or controlling these predators at locations where they cause particular problems for survival of species of concern could possibly improve production of native fish populations. For example, warmwater game fish comprise large predator populations in tributaries of the San Joaquin River because of low flows, channel modifications, and aquatic plant growth. These predator populations cause increased mortality in juvenile salmon populations.

Constraints

Many predator species are highly valued by recreational groups as sport fish, and removal or control of these species may be controversial as well as difficult to implement. Modifying habitat conditions (e.g., using higher flows or channel modifications) to favor native species has doubtful effectiveness in controlling predation and would most likely be complex and costly to implement. Removal and control efforts for large bodies of water are difficult and costly, and often insufficiently effective.

Linkages to Other CALFED Action Categories

Actions to remove and control aquatic predators can be made more effective by being linked with on-stream storage (to reserve flows for critical periods of vulnerable native species), management of agricultural drainage (to avoid warmwater discharges to sensitive river reaches during critical periods), and changes in harvest regulations (to increase recreational take limits for non-native fish that prey on native species).

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Fish Hatchery Operations

Description

Hatchery operations in the Central Valley augment the natural propagation of certain fish species. While increasing the size of fish populations, hatchery practices can contribute to the pressures on wild salmon and steelhead stocks by increasing competition, predation, and harvest rates on those species. Better spawning and rearing practices can be developed to improve the survival and return rate of hatchery stocks and hatchery capacity can be expanded to increase production from selected species. Changes in selection procedures for hatchery spawning can be implemented to reduce dilution of the gene pool in wild stocks.

This category includes the following actions:

- expand hatchery capacities,
- improve hatchery operations, and
- establish new captive breeding programs.

Purpose

Current fish hatchery operations, while boosting the populations of some fish species, may also contribute to dilution of the gene pool and increased disease rates in native stocks. In addition, they may contribute to pressures on wild stocks by increasing competition, predation, and harvest rates on those species. Changes in fish hatchery operations are intended to boost the effectiveness of existing hatchery operations while reducing the impacts of these operations on wild stocks.

Constraints

Increasing hatchery production may stimulate an increase in commercial fishing that could take a greater portion of natural production, decreasing spawning escapement. It may also result in increases in poaching in the Central Valley and coastal waters. Interbreeding hatchery and wild stocks may reduce natural genetic variations that protect populations against long-term changes in environmental conditions.

Linkages to Other CALFED Action Categories

Changes in fish hatchery operations will require coordination with harvest management actions. Fish hatchery operation actions can be implemented with upstream anadromous fish habitat restoration and acquisition of long-term water supplies for fish and wildlife to improve the survival of native stocks of anadromous fish in upstream areas.

Fish Harvest Management

Description

Harvesting fish within and outside the estuary contributes to the decline in populations of fish that reside in or migrate through the estuary. Management of fish harvest consists of actions to control the effects of commercial and recreational catch on wild populations of important fish such as chinook salmon through improved regulations and improved enforcement of existing regulations.

This category includes the following actions:

- improve regulation of commercial take,
- improve regulation of recreational take, and
- improve enforcement of harvest regulations.

Purpose

Ocean harvest of salmon in commercial and sport fisheries has contributed to the decline of various runs of salmon including the winter-run chinook salmon presently designated as endangered. The goal of harvest management is to ensure that harvest levels for each fish population are sustainable. Limits on harvest can potentially reduce stresses on wild stocks of salmon and steelhead in the Bay-Delta watershed. Controlling harvest along the coast can potentially reduce the harvest rate on wild stocks and thus contribute to their protection and recovery. Mixed stock fisheries, such as those occurring along the coast, may require protection to the extent needed by the most limited stock.

Constraints

Limiting fishery harvest rates may cause economic stress on some industries such as commercial fishers and those businesses that depend directly or indirectly on fisheries and the recreation and tourism associated with fisheries. Changes in harvest management may require wholesale shifts in fishery efforts, marketing, and new investment to take advantage of available harvestable stocks. Limitations on sport fisheries along the coast would have significant economic effects on coastal communities. Businesses depending on river fisheries may also face economic effects.

Linkage to Other CALFED Action Categories

Harvest management will require coordination with fish hatchery management. For example, if hatchery fish can be marked and regulations changed to restrict catches to marked fish, wild salmon populations would benefit. Harvest management actions can be implemented with upstream anadromous fish habitat restoration and acquisition of long-term water supplies for fish and wildlife to improve the survival of native stocks of anadromous fish in upstream areas.

Desalination

Description

Desalination is the process by which water that has a high salt content is treated to reduce salt concentrations and produce potable water. Several different processes are available to desalinate water, including distillation and reverse osmosis. Desalination can be used to produce drinkable water from seawater, brackish water, or saline groundwater. Because of the high energy costs associated with current technologies, desalination is most cost effective for desalting low-salt groundwater and for municipal recycling. Successful groundwater and municipal desalination projects are currently operating in California.

This category includes the following actions:

- expand desalination of Southern California supplies,
- expand desalination of San Joaquin Valley supplies,
- improve desalination technologies and cost, and
- educate users about desalination feasibility.

Purpose

Desalination is generally identified as a potential solution for water supply limitations in coastal areas and Southern California. Large-scale desalination of seawater could provide a major source of water to Southern California and an alternative to diversions through or around the Delta. This substitute supply could reduce water demands on the Delta, reducing demands for Delta exports and benefitting Delta water and ecosystem quality. Desalination could also be used to improve the quality of drinking water taken from the Delta during periods of salinity intrusion.

Constraints

Desalination is energy-intensive, resulting in a high cost per acre-foot of potable water produced. Implementation of a large-scale desalination program could require construction of new power sources. Withdrawal of seawater and its associated effects on marine life are a potential concern, and desalination produces a waste product of highly concentrated brine that must be disposed.

Linkage to Other CALFED Action Categories

Desalination can be used to complement groundwater banking and conjunctive use. The quality of water being banked in the groundwater aquifer can be improved through desalination either before injecting it or after removing it. This combined process allows banking of groundwater where water quality problems would otherwise make it infeasible.

Water Conservation

Description

Water conservation focuses on reducing the demand for water in agricultural, industrial, and urban settings. Conservation programs can be divided into shortage management measures and long-term conservation programs. Shortage management measures are actions taken to achieve temporary reductions in water use to match a shortfall in current and near-term supplies. Such drought reductions measures may include temporary restrictions on landscape watering and indoor water use. This category focuses instead on permanent, long-term water conservation measures that create efficiencies by changing water conveyance and use infrastructure. In urban settings, a long-term conservation program may include measures to encourage households to purchase appliances that use less water. In industrial settings it may include measures to retrofit industrial cooling towers to reduce usage. In agricultural settings, the program may include lining irrigation canals and using high-efficiency irrigation systems. Although these programs may involve significant up-front capital costs, these costs can be offset by long-term savings from reduced usage.

This category includes the following actions:

- increase use of district-wide conservation practices,
- increase use of on-farm conservation practices,
- increase use of municipal conservation practices,
- increase use of industrial conservation policies,
- implement financial incentive policies,
- implement conservation-oriented rate structures, and
- educate users about conservation technologies.

Purpose

Implementing water conservation measures could substantially reduce water needs and may reduce the need for water from the Delta and the necessity of developing new water facilities and sources. Increasing water use efficiency may also buffer water users from the economic effects of a temporary water shortage.

Constraints

Implementing large-scale water conservation programs may require extensive public education to facilitate adoption and may have a high initial cost. As the most cost-effective conservation measures are implemented, subsequent conservation measures yield lower cost-benefit ratios.

Linkage to Other CALFED Action Categories

Water pricing actions can increase the effectiveness of water conservation actions by increasing the potential savings associated with using less water. Increased savings can result in faster paybacks for the initial costs of implementing some water conservation measures. Adopting a water conservation program would also be facilitated by establishing an institution for integrated long-term water management that could coordinate the development of statewide programs.

Water Reclamation

Description

Water reclamation is the process by which water that has been previously used for one purpose is treated and reused. The degree of treatment depends on the subsequent use of the water and is determined by federal and state standards. For example, many agencies are reclaiming treated wastewater and using it to irrigate crops, urban landscapes, and median strips. Others are using reclaimed water for industrial applications, such as power plant cooling and process water for paper mills. Most reclaimed wastewater is used to recharge groundwater basins for later extraction and use or to repel the intrusion of saltwater into aquifers. Use of reclaimed water is highly regulated by California law and extensive studies of health effects in areas of high reuse have shown no measurable adverse effects.

This category includes the following actions:

- recharge groundwater with reclaimed water,
- use reclaimed water for agricultural irrigation,
- reclaim saline agricultural drainage water,
- recycle and treat water for potable reuse,
- educate the public about water reclamation,
- use reclaimed water for nonpotable urban uses,
- use reclaimed water for landscape irrigation,
- use reclaimed water for power plant cooling,
- use reclaimed water for industrial processes,
- use reclaimed water to repel salinity intrusion, and
- improve reclamation technologies and cost.

Purpose

Water reclamation and reuse is generally considered as a way to reduce water demands for water imports by reusing local supplies. Implementation of major water reclamation programs, such as those currently underway in Southern California, could reduce demands on the Delta by providing an alternative source to diversions through or around the Delta. This reduction of Delta export demand would benefit Delta water and ecosystem quality.

Constraints

Depending on the type of reuse scenario, reclamation can be moderately expensive and can require parallel transmission and distribution systems to ensure separation of potable and reclaimed water. Groundwater recharge, however, is generally cost-effective because large amounts of reclaimed water can be reused with relatively minimal capital costs. The use of reclaimed water often requires an extensive public education program to deal with public perceptions on health issues.

Linkage to Other CALFED Action Categories

Reclaimed water could be used to enhance or create new habitat areas for fish and wildlife. For example, wastewater treatment plant effluent can be used as a water source for constructed wetlands. Water reclamation can be implemented in conjunction with groundwater banking and conjunctive use by banking reclaimed water. This form of conjunctive use provides additional benefits by providing a ready source of water for banking and a destination for reclaimed water where impacts would be low. Reclaimed water can also be a source of water for transfers, allowing the costs of the reclamation process to be at least partially offset.

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Land Retirement and Fallowing

Description

Land retirement and temporary land fallowing consist of removing actively farmed and irrigated land from production so that the water used to irrigate that land can be used for some other beneficial use. Permanent land retirement can be accomplished through the purchase of land, with the purchase of water rights, or through the purchase of conservation easements. Land retirement is often suggested for farmlands that have problems with drainage that collects in saline sumps or contaminates offsite locations. Temporary land fallowing is a means by which to deal with shortages of irrigation water during drought periods.

This category includes the following actions:

- encourage land fallowing during drought periods,
- develop incentive programs for land retirement,
- purchase lands or easements, and
- retire lands with drainage problems.

Purpose

Temporary land fallowing or permanent land retirement could make substantial amounts of water available for other uses, thereby reducing Delta exports and benefitting Delta water quality and ecosystem quality. Land retirement could also reduce agricultural drainage problems. Some retired agricultural lands can be managed for their value as wildlife habitat.

Constraints

Large-scale land retirement or temporary fallowing could have local or regional economic consequences. Fallowed land would not require labor and materials for farming, causing secondary effects on "third party" businesses and local populations that depend on agricultural activities for income. The issue may be raised as to ownership of water made available through fallowing. Permanent land retirement from production may require purchase of agricultural lands.

Linkage to Other CALFED Action Categories

Temporary land fallowing can be implemented in association with water transfers and groundwater banking (as a source of the water). Permanent land retirement programs can be implemented to assist in the management of agricultural drainage (by ceasing irrigation), integrated habitat management programs and habitat restoration programs (by converting the land to habitat), water transfers (as a source of water to be transferred), and watershed management (as a tool for managing land uses within a watershed).

Water Pricing

Description

Water pricing can be used as a tool to reduce the demand by agricultural and urban users for water. Different water rate structures serve to encourage or discourage water consumption. An important role of water prices (or rates) is as a signal to users about the cost of increasing sources of supply or of delivering water during drought periods when supplies are more expensive. Such prices can, therefore, encourage more efficient use of water. The actual volume of water saved by increasing water prices depends on the elasticity of water demand, which varies by area, type of user, and seasonal hydrological cycles. Rate designs can be structured to achieve different policy objectives. For example, a variable design that charges more for water during droughts could reduce demand during drought periods but may reduce the conservation incentive during normal and wet years, possibly encouraging greater overall water use. In addition, fees such as drought surcharges or new development fees can be used to achieve different equity objectives.

This category includes the following actions:

- establish incentives for pricing to reduce demand,
- educate users about pricing feasibility, and
- remove legal obstacles to pricing.

Purpose

Water pricing can be an effective means of influencing the demand for water and can result in more efficient use of scarce water resources. Water pricing structures can result in more efficient use of scarce water resources by more accurately capturing the value of water in market prices based on the consumer's willingness to pay for the commodity. Water pricing changes may reduce the need for additional water exports and reduce the conflict between water supply and ecosystem needs.

Constraints

Changing water pricing policies to reduce the demand for water is constrained by the need to achieve other potentially conflicting policy objectives. The current structure of water prices includes relatively flat water rates and price subsidies that benefit certain users. Eliminating these subsidies could result in undesirable economic effects to disadvantaged sectors of the economy. In addition, increasing water prices could result in revenue shortfalls if the demand for water decreases substantially. Water price increases could lead to reductions in producer surplus (i.e., net revenue to producers) or reductions in consumer surplus (i.e., net value of water to consumers). Some legal obstacles would need to be removed to implement some price structure changes.

Linkages to Other CALFED Action Categories

Water pricing is a tool that can increase the effectiveness of water conservation, water reclamation, and water transfer actions by increasing inducements to undertake these actions. It may also serve as a tool to be used in contingency planning for future droughts.

Watershed Management

Description

Watershed management consists of various land management activities and measures to improve water quality and increase water supplies produced within a watershed. Maintaining appropriate vegetation cover, protecting riparian zones from disturbance, and avoiding soil disturbance that initiates erosion are practices that protect downstream water quality. In headwater areas subject to snowpack accumulation, vegetation manipulation can be used to delay melting of the snowpack to possibly increase total water yield. Maintaining appropriate vegetation cover in areas subject to precipitation can also delay runoff and contribute to total water yield. Delayed runoff is more easily stored in reservoirs or recharged to groundwater than is runoff during peak flood-control periods. Large watersheds in the Sierra Nevada Mountains under the sole management of the U. S. Forest Service may offer the best opportunities for coordinated programs to increase water yields and protect water quality by manipulating vegetation. Watershed management is relatively inexpensive compared with other means by which to enhance supplies or maintain water quality.

This category includes the following actions:

- manage vegetation cover to increase yield,
- manage riparian zones to protect water quality,
- manage land uses to reduce sedimentation, and
- modify weather to increase precipitation.

Purpose

In watersheds around south-of-Delta storage reservoirs, watershed management practices are aimed primarily at maintaining water quality for urban and industrial uses; whereas, watershed management in areas tributary to the Delta can contribute to enhancing water yields in addition to protecting water quality. By reducing sedimentation, watershed management also protects the long-term reliability of reservoirs and conveyance facilities.

Constraints

Watershed management is often constrained by the lack of uniform land ownership across the watershed areas, which can make coordinated management very difficult.

Linkages to Other CALFED Action Categories

Watershed management can contribute to improved aquifer recharge which can be used for groundwater banking. Because watershed management can contribute to enhanced yields, it can also be a source of water for transfers. The higher yields and improved water quality can contribute to restoration of upstream anadromous fish habitat and to the improvement of fish migration and passage.

New or Expanded Onstream Storage

Description

Onstream storage, the most common method of creating water storage capacity along a river, is created by constructing a dam at a suitable site along a river to form an impounded reservoir (e.g., Folsom Reservoir). Additional onstream storage may be provided by constructing new reservoirs, by increasing the capacity of existing reservoirs, or by modifying the operations (e.g., flood control reservations) of existing reservoirs. Several existing onstream storage reservoirs could be enlarged by building higher dams, and other new reservoir sites (e.g., Auburn Dam) have been identified and are being considered in planning studies.

This category includes the following actions:

- construct new storage facilities south of the Delta,
- construct new storage facilities north of the Delta,
- enlarge existing onstream storage reservoirs, and
- modify operations of existing onstream reservoirs.

Purpose

New or expanded onstream storage is intended to increase the reliability and supply of water by providing increased capacity to store runoff when it is available in excess of downstream needs. Additional onstream storage may have fisheries and water quality benefits if seasonal storage allows regulation to provide better and more stable instream flows and cooler water temperatures . The additional storage capacity may also improve the reliability of water supplies by allowing for more water to be held as carry-over storage for times during low water availability. Hydropower and recreation benefits may be possible at new reservoir sites and, with expanded reservoir capacities, increased hydropower benefits can be produced at existing power generating facilities.

Constraints

Two major constraints on reservoir construction are the limited number of appropriate sites, and the environmental impacts associated with construction and operation of reservoirs. New dams may create fish passage barriers that would eliminate upstream spawning and rearing habitat. Enlarging existing reservoirs would have fewer environmental impacts, but because additional areas would be inundated, existing vegetation habitat would be eliminated and recreation development may need to be relocated. The reregulation of flow resulting from constructing new onstream storage could produce environmental effects downstream from the dam. The cost of constructing additional onstream storage can be very high.

Linkage to Other CALFED Action Categories

The provision of additional onstream storage can be a tool that assists in Delta inflow/ outflow/export management by providing the water supply system with additional flexibility in the timing of water flows. Additional onstream storage can also provide more flexibility in providing upstream flows for anadromous fish, can help improve fish migration and passage, and can facilitate water transfers by providing a storage location for the transferred water.

New or Expanded Offstream Storage

Description

New or expanded offstream storage, the creation of water storage capacity in locations away from the sources of water, may include constructing new reservoirs or increasing the capacity of existing reservoirs. Several offstream storage reservoirs are presently in the planning or construction phase, including the Los Vaqueros Reservoir, a project of the Contra Costa Water District; the Domenigoni Valley Reservoir, a project of the Metropolitan Water District of Southern California; Los Banos Grande, a project of the California Department of Water Resources; and the proposed Delta Wetlands project within the Delta.

This category includes the following actions:

- construct new storage facilities south of the Delta,
- construct new storage facilities north of the Delta,
- construct new storage facilities in the Delta,
- enlarge existing offstream storage reservoirs, and
- modify operations of existing offstream reservoirs.

Purpose

New or expanded offstream storage is intended to increase the supply of water. The additional storage capacity can also improve the reliability of water supplies by providing flexibility in the timing of diversions. These diversions can be stored when floodwater is available and used in times of low water availability. The additional storage may also have water quality benefits if the extra capacity allows water to be diverted from the source supply when quality is good (generally, during heavier flows).

Constraints

The cost of constructing additional offstream storage can be very high. Also, the cost of pumping can be very high if the storage site is distant from the water source or the destination. Two other major constraints are the limited number of appropriate sites for constructing reservoirs and the environmental impacts associated with the construction and operation of reservoirs, conveyance facilities, and pumping stations. The diversion of large quantities of water from streams can cause environmental effects at the diversion as well as downstream. Further, reoperation of upstream reservoirs to transfer water downstream can also cause environmental effects.

Linkage to Other CALFED Action Categories

New or expanded offstream storage can be a tool that assists in Delta inflow/outflow/ export management by providing the water supply system with additional flexibility in the timing of water flows. Additional onstream storage can also provide more flexibility in providing upstream flows for anadromous fish and improve fish migration and passage. New or expanded offstream storage requires an increase in diversion and conveyance capacity to effectively use the available supply and developed storage capacity. Increases in diversion and conveyance capacities may also be required to allow offstream storage to facilitate water transfers.

B-000910

Groundwater Banking and Conjunctive Use

Description

Groundwater is used extensively as a water supply source throughout the state. Using groundwater basins as underground water storage facilities for local surface water supplies is often referred to as conjunctive use. Available groundwater storage capacity is used to store excess surface water during wet periods and the additional stored groundwater can be pumped for use during dry periods. Spreading basins or injection wells can be used to increase groundwater recharge. In addition, reclaimed water from water reclamation projects can be used for recharge of groundwater basins. When a groundwater basin is used to store water imported from outside the basin, the storage and recovery process is called groundwater banking.

This category includes the following actions:

- establish incentives for conjunctive use,
- modify the State Water Code to encourage conjunctive use,
- establish conjunctive use programs,
- store groundwater south of the Delta,
- store groundwater north of the Delta, and
- implement techniques to increase groundwater recharge.

Purpose

Groundwater storage capacity can be managed to increase the reliability of water supplies by providing flexibility in timing surface water diversions. A groundwater storage basin provides a buffer for variable surface water supplies, allowing water to be stored during wet periods and extracted during dry periods. Groundwater banking and conjunctive use north of the Delta could decrease use of surface supplies and thereby increase Delta inflows during periods of below-average water supply. Groundwater banking and conjunctive use south of the Delta could reduce export needs on the Delta during dry periods by providing alternate storage supplies recharged during previous wet periods.

Constraints

Lack of suitable groundwater basins and lack of access to available surface water supplies during wet periods are two major constraints on groundwater banking programs. The hydrologic characteristics of groundwater basins govern the feasibility of additional recharge and use of storage capacity. Existing local groundwater uses and well depths must be considered so that changes in water level fluctuations do not cause significant adverse effects. For Southern California groundwater banking and conjunctive use, a source of low-salinity water is needed to avoid contaminating groundwater basins. Land subsidence must also be considered. The cost of constructing additional diversion, recharge, and pumping facilities for groundwater banking programs can be very high. Similarly, increasing conjunctive use often requires a large capital investment to expand the service area of surface water delivery systems. Lack of legal protection and institutional arrangements for groundwater banking and conjunctive use present additional real or perceived constraints.

Linkage to Other CALFED Action Categories

Groundwater banking may require increases in diversion and conveyance capacity and changes in diversion timing in order to use available surface water during wet periods. In addition, groundwater banking and conjunctive use link water transfer and watershed management programs in efforts to stabilize groundwater levels.

Improvement of Through-Delta Conveyance

Description

Improvement of through-Delta conveyance consists of a variety of actions designed to increase the capacity to transport water from through the Delta to the project export pumps in the south Delta and to Delta outflow. These include actions to increase channel capacities and the capacity to move water between channels using pumps and siphons.

This category includes the following actions:

- increase capacities of existing eastside channels,
- increase Sacramento River-to-Central Delta flows,
- modify Delta levees to increase flow cross sections,
- construct pumps/siphons between Delta channels,
- expand existing intakes at the Delta export facilities, and
- construct expanded export intake/forebay pumping system.

Purpose

Improvement of through-Delta conveyance can contribute to Delta water supply and water quality conditions by facilitating the transport of water through the Delta. These improvements can be used to transport water more efficiently to the export pumps or to transport high-quality water to where it is needed for environmental purposes. These modifications can also improve flood control by increasing the capacity of the Delta to transport floodwaters.

Constraints

Constraints on implementation of improvements to Delta conveyance capacity include losses of agricultural land that could result from widening channels and constructing other facilities, blockage of or disruption to fish migration patterns, losses and disturbance of important aquatic and wetland habitats, and the costs and impacts associated with dredged-material disposal. Land acquisition costs may also be a constraint.

Linkage to Other CALFED Action Categories

Improvement of through-Delta conveyance can be implemented through construction of setback levees, which provide both increased flow capacity and the opportunity to restore riparian and shallow water habitat. Improvements to conveyance capacity can also be a tool that assists in Delta inflow/outflow/export management.

Construction and Improvement of Conveyance Facilities

Description

The construction and improvement of conveyance facilities includes actions to improve the transport of water through the Delta using an isolated transfer facility. Facilities to transport water could be routed within or around the Delta, with the water intake located north of the Delta to provide improved water quality. Other options for this category include a facility to transport all water for export and a smaller facility to transport only high-quality water for drinking. This category also includes an option to create a forebay for the export pumps by flooding selected Delta islands and connecting them with a series of pumps and siphons.

This category includes the following actions:

- construct east-side isolated transfer system,
- construct west-side isolated transfer system,
- construct small isolated transfer facility,
- convert Delta islands to storage/conveyance system,
- construct conveyance to offstream storage, and
- construct conveyance to groundwater storage.

Purpose

New or improved conveyance facilities would transfer water through the Delta more efficiently than the current system, and would provide higher quality water to Delta diverters. These more direct and/or enclosed conveyance facilities would conserve water otherwise lost to seepage, leakage, contamination by salinity intrusion, and evaporation. Losses of fish and other aquatic organisms to entrainment could also be reduced by combining all diversions into one location, and by placing that diversion on the Sacramento River where passing fish could more easily avoid the pumps.

Constraints

The construction of an isolated transfer facility could result in the degradation of aquatic and wetland habitats along its route. Depending on the size and operation of the facility, an isolated transfer facility could increase the amount of water diverted from the system for export and could decrease Delta outflows, changing the salinity balance. The use of Delta islands as a transport and storage facility would remove land from agricultural production. Because of a reduced dependence of water diverters on Delta islands, incentives to maintain Delta island levees could be reduced.

Linkage to Other CALFED Action Categories

An isolated transfer facility could result in greatly reduced fish entrainment if implemented with improved fish screens. Such a facility, particularly if combined with groundwater banking or offstream storage, could facilitate water transfers by providing increased conveyance and storage capacity. It could improve Delta inflow/outflow/export management by reducing the number of diversions to be controlled.

Changes in Locations of Diversions

Description

Anadromous and resident fish (juveniles, eggs, and larvae) and other aquatic organisms are lost through entrainment at diversions in the Bay, Delta, rivers, and tributaries. The locations of diversions partially determine the extent of potential losses of fish. Relocation of certain diversions to sites with different flow conditions could reduce the loss of fish at these diversions. For example, relocating the State Water Project (SWP) diversion at Clifton Court Forebay to Italian Slough during specific periods of time when species of concern are found to be adjacent to the forebay intake gates could reduce the loss of vulnerable fish to predators in Clifton Court Forebay. Moving agricultural diversions on Sacramento River tributaries, such as Big Chico Creek, to locations where diversions would comprise a much smaller proportion of total flow could reduce the potentially high loss of young salmon. In addition, relocating the Central Valley Project and SWP diversions to locations more favorable for screening could reduce losses of important fish species.

This category includes the following actions:

- relocate Delta export pumps from key habitats,
- relocate other in-Delta diversions for more reliable supplies,
- consolidate in-Delta agricultural diversions,
- relocate upstream diversions from key habitats, and
- improve diversion designs when relocating.

Purpose

Changing locations of specific diversions in the Bay, Delta, rivers, and tributaries to sites where flow conditions make fish less vulnerable to entrainment could reduce losses of salmon, steelhead, striped bass, and other aquatic organisms during critical life stages.

Constraints

Changing the locations of diversions would require that new diversion facilities and new conveyance facilities be built. This construction could have environmental impacts and would be costly.

Linkages to Other CALFED Action Categories

If the improvement and construction of conveyance facilities is undertaken, changing the location of diversions can be made part of the project. Changing the location of diversions can also be implemented with other actions designed to reduce entrainment to increase the effectiveness of each. These include installation of new or improving existing fish screens, improvements to fish migration and passage, improvement of fish salvage operations, and Delta inflow/outflow/export management.

Water Transfers

Description

Water transfers consist of negotiated agreements between parties that allow water that is typically available or used in one area to be transferred for use in another area. Transfers can occur within a hydrologic basin or between basins and can involve the purchase or exchange of water. Three types of transfers are defined in the California Water Code: temporary urgency transfers (less than 1 year), temporary transfers (also less than 1 year), and long-term transfers (more than 1 year). The water supply for water transfers typically comes from one of four sources: fallowed cropland, surplus water from reservoirs, the exchange of surface water for groundwater, and reductions in irrigation created by switching to crops requiring less water or crops that can be irrigated by precipitation. Transfers from north-of-Delta to south-of-Delta may require use of available excess diversion and conveyance capacity for wheeling of transferred water.

This category includes the following actions:

- modify California Water Code to ease transfers,
- improve procedures for transfer permitting, and
- coordinate diversion and conveyance of transfers.

Purpose

Water transfers are intended to increase the reliability of water supply by reallocating water from areas with excess or unneeded water to areas where demand exceeds supply, either in short-term drought situations or for long-term supplies. In part, transfers are considered an important tool for solving some of California's water supply and allocation problems because they generally have fewer environmental impacts and costs than construction of new facilities. Transfers can be specifically designed to minimize fish and wildlife impacts and take advantage of windows of opportunity to enhance habitat conditions for important fisheries resources. Water transfers can also directly serve environmental purposes if the water is transferred for use at wildlife reserves, for instream flows, or for Delta inflow or outflow.

Constraints

Large-scale and long-term water transfers could have adverse economic consequences if water is made available for transfer by fallowing farmland. The fallowed land would not require labor and materials for farming, causing secondary effects on "third-party" businesses and local agencies that depend on agriculture. Water available for transfer as a result of conservation actions or unneeded supplies in the source area would have fewer economic consequences. In addition, water transfers may be constrained by legal interpretations and applications of the water rights system and area-of-origin statutes. Transfers may also require transport of water through the Delta and increased diversions to deliver water to the end user. Such increases could require increased Delta export pumping that could affect fish and wildlife.

Linkage to Other CALFED Action Categories

Land fallowing and retirement can provide a source of water for transfers. Increases in diversion and conveyance capacity may be required to allow through-Delta water transfers to occur. The timing of water transfers can be altered to benefit Delta inflow/outflow/export. Groundwater banking and conjunctive use and offstream storage can facilitate water transfers by providing a storage location for the transferred water. The establishment of institutions for long-term water management can also facilitate water transfers by providing the market place through which transfers could be managed. Temporary and permanent water transfers can be a tool in planning for long-term drought contingencies.

DRAFT

Long-Term Planning for Drought Contingencies

Description

Contingency planning for future droughts consists of developing plans to accommodate future water shortages. Such planning may include activities to temporarily or permanently reduce demand for water and activities to develop emergency supplies of water. Contingency plans would be developed to accommodate various durations and intensities of drought.

This category includes the following actions:

- increase water storage capacities at user locations,
- establish incentives for long-term planning,
- conduct Integrated Resources Planning,
- establish incentives for long-term conservation, and
- develop alternate supplies for drought situations.

Purpose

Contingency planning for future droughts could improve the predictability of water supplies during both short- and long-term drought periods, and could increase the efficiency of use of available supplies. Such planning could also help to reduce the need for exports from the Delta and river systems during periods of extended drought, thereby reducing detrimental effects on aquatic ecosystems.

Constraints

Creation of new or increased water storage facilities could have direct impacts on the environment, and increased water transfers may result in increased third-party impacts in the water transfer areas. Implementing this action could be costly to local agencies because it would require the creation of mechanisms and infrastructure that would be used only infrequently.

Linkages to Other CALFED Action Categories

Long-term drought contingency planning can be linked with actions to manage demand (e.g., water conservation, water reclamation, water pricing, desalination, and land retirement) and with integration of land use and water supply planning to provide better supply and demand management coordination. This category can be made more effective when linked with establishment of an institution for long-term water supply management, a category providing the institutional basis for long-term planning to occur.

Water Resources Data and Information Management

Description

Water resources data and information management includes accurate and appropriate measurements and data analysis procedures that will support modified operations and effective use of California's limited water resources. Water resources management encompasses beneficial uses for agricultural and urban water supplies and environmental requirements for the aquatic, riparian, and wetland habitats. Data is needed on meteorologic and hydrologic conditions (e.g., precipitation and streamflow), reservoir operations, diversions and exports, water use rates and patterns, and groundwater levels and pumping rates. Data is also needed on water quality (e.g., temperature and salinity), habitat conditions, other environmental phenomena, and populations of organisms that depend on hydrologic conditions. The California Irrigation Management Information System (CIMIS) and California Data Exchange Center (CDEC) provide good examples of what can be accomplished. The Interagency Ecological Program (IEP) is actively pursuing real-time data management goals for the Bay-Delta resources.

This category includes the following actions:

- establish a comprehensive water data system,
- implement real-time data management system,
- integrate data for adaptive management decisions, and
- establish accessible data management system.

Purpose

Water resources data and information must be accurate and comprehensive to adaptively manage operation of the state's water supply system. Available data need to be compiled to identify historical management actions and disclose the environmental effects of these actions, and to guide future allocations and the development of management objectives that may differ from historical patterns. Adaptive management of the water supply system means altering operation of the system based on current real-time conditions rather than on average data or theoretical models. As changes in operations are made and the results measured, future operations may be altered based on the knowledge gained. Comprehensive water resources and ecological data must be collected, processed, and provided to all participants in adaptive management decisions, evaluations, and policy formulation.

Constraints

Data collection for biological variables will probably always require labor-intensive efforts and experienced staff will be needed for data analysis and interpretation. Data must be transformed into usable (understandable and reliable) information for adaptive management decision support. More time and money will be needed to not only collect, but to analyze and interpret available data. Considerable costs are associated with routine data collection procedures, even with the sophisticated electronic measurement and communications systems available today. Budget allocations for traditional water resources data collection (e.g., U.S. Geological Survey stream gages) are declining.

Linkages to Other CALFED Action Categories

Water resources data and information management actions can be implemented with other actions to enhance supplies and increase predictability to produce greater overall benefits to the Bay-Delta system.

DRAFT

Establishment of Institution for Integrated Long-Term Water Management

Description

Water resources planning and management in California is accomplished through a network of state and federal water agencies and regional and local water districts. This category involves either planning coordination of existing water agencies and districts or creation of an institution responsible for comprehensive, integrated management of water supplies and related environmental resources. These changes can take place either through encouragement (incentives) or through legislation (regulations).

This category includes the following actions:

- establish long-term guarantees for management,
- establish an institution to implement guarantees,
- coordinate multi agency roles in management,
- coordinate groundwater/surface water management, and
- establish incentives for cooperation/coordination.

Purpose

The establishment of an institution for integrated long-term water management would be intended to produce more efficient and effective water management that implements and guarantees the long-term solution to problems of the Bay-Delta system. Specifically this institution would provide a forum for the resolution of conflicts between ecosystem quality and water supply in the Bay-Delta system.

Constraints

Existing agencies and systems have considerable political history and precedence for water resource allocation and management (e.g., water rights). New institutional arrangements would probably need to be based on these historical precedents.

Linkages to Other CALFED Action Categories

The establishment of an institution for long-term water planning actions could serve to coordinate, guarantee, and implement solution actions in all other categories.

Establishment of Export Capacity Market

Description

Establishing an export capacity market is one strategy for allocating export capacity at the Central Valley Project (CVP) and State Water Project (SWP) Delta pumping facilities. During certain times of year, excess capacity exists at these pumps. This capacity could be available to purchase for water transfers, additional export, or for environmental purposes. Entities transferring water through the Delta could purchase capacity to facilitate these exports, southern California users could purchase capacity to obtain greater supplies, and resources agencies or nonprofit groups could purchase capacity to prevent further pumping and allow more water to flow out of the Delta. An institutional framework could be established to buy and sell this excess export capacity. The money generated by the market could be used to fund Bay-Delta system habitat improvements.

This category includes the following actions:

- establish procedures for allocation of export capacity,
- establish an institution to allocate export capacity,
- coordinate water transfers and export capacity, and
- market export capacity for environmental benefits.

Purpose

An export capacity market could provide a regulatory mechanism for establishing the value of additional exports relative to possible environmental effects caused by the incremental pumping above CVP and SWP demands. An export capacity market (or rules governing the use of export capacity) would be created to allow the maximum use of Delta export capacity that would result in a minimum of anticipated environmental effects. Conversely, exports could be reduced during periods that would result in the greatest environmental effects. An export capacity market could ensure that balance between water supply and environmental benefits was achieved with a maximum level of benefits for both purposes (i.e., win-win approach).

Constraints

The determination of the amount of export capacity available to market transactions may be very difficult. Changes in project operation rules, water rights law, and existing water quality standards may be necessary to provide the market with the flexibility needed to balance environmental and water supply needs. The market may, if not properly constructed, result in increased exports from the Delta and environmental impacts associated with increased entrainment and decreased outflow.

Linkage to Other CALFED Action Categories

Because the creation of an export capacity market would require determination of the amount and timing of export capacity to sell, implementation of actions in this category may need to be accompanied by establishment of an institution for long-term water management. The operation of an export capacity market would also be facilitated by increased rates of diversion capacity, increased storage south of the Delta, Delta inflow/outflow/export management, and improvement of through-Delta conveyance.

Integration of Land Use and Water Supply Planning

Description

Currently, water supply and land use planning are conducted by separate agencies at the local level (most land use planning occurs at the local level in California). No coordination of water supply and land use planning is required by law and, consequently, these two efforts are usually undertaken independently. The integration of land use and water supply planning does, however, occur in other western states. State laws could be changed to require a closer coordination of these two types of planning as part of the local land use planning process. For example, prior to adopting a general plan, local jurisdictions could be required to determine whether sufficient water supplies are available to reliably serve the uses identified in the land use plan. In addition, local jurisdictions could be required to request an assessment of water availability from the local water agency as part of the environmental impact report process. Conversely, water providers could be prohibited from annexing any additional land unless sufficient water supplies were available to reliably serve the new areas.

This category includes the following actions:

- coordinate land uses with water supplies,
- encourage local determination of supplies available, and
- encourage local assessment of water supply reliability.

Purpose

Integrating land use and water supply planning could help reduce water supply shortages at the local level and reduce costs associated with such shortages. In addition, such integration could help reduce demands in areas where water resources are limited, reduce the need for new Delta diversions, or reduce the demand for new water sources and new water supply projects. An integrated process could also allow for water to be set aside for environmental purposes as part of the planning process.

Constraints

One problem associated with integrating land use and water supply availability is that the basis on which to judge water supply availability is not always clear. The existence of a legal water supply contract may be viewed as availability even though the infrastructure and perhaps the water supply may not be available. Another problem is that integrating land use and water supply planning would result in *de facto* growth control by using water availability as a determining factor for land use planning. A potential for uneven application of these decisions is possible. For example, the growth of one jurisdiction may be limited by water supply availability but a neighboring jurisdiction may not be, even though they have the same water source, simply because the latter has better infrastructure or a firmer water supply contract. In addition, issues may arise regarding the application of this action to agencies that rely on groundwater, as groundwater basins typically supply many jurisdictions.

Linkages to Other CALFED Action Categories

Because environmental needs can be built into the planning process, the integration of land use and water supply planning can be linked to acquisition of long-term water supplies for fish and wildlife. In addition, the integration of land use and water supply planning would be an important tool in long-term planning for drought contingencies and could be facilitated by an institution for integrated long-term water management.

Installation and Operation of Flow Barriers

Description

Flow barriers are gates or weirs, either fixed or operable, that allow streamflow to be directed between two alternative channels. Inflows to the flood bypass channels along the Sacramento River are controlled by weirs; flow into the Delta Cross Channel is controlled by gates. Flows into Suisun Marsh from the Sacramento River are controlled by tidal gates on Montezuma Slough. Several other weirs or gates have been used or proposed within the Delta.

This category includes the following actions:

- install flow barriers to manage south Delta water quality and
- install weirs to control salinity intrusion.

Purpose

Flow barriers may be used for flood, salinity, or fish transport controls and also provide for increased water management control. Flow barriers can eliminate flows, limit flows, or provide one-way tidal flow control. Operation of flow barriers is governed by water management objectives and the relative effects of the flows within alternative channels. For example, the Delta Cross Channel allows increased diversion of Sacramento River water through the Mokelumne River channels toward the Central Valley Project and the State Water Project export pumps, but it may also divert migrating salmon into the central Delta.

Constraints

Construction of new flow barriers can have highly variable impacts on water quality, water levels, and aquatic habitat conditions depending on how they are operated or designed relative to local hydrodynamic conditions. Proposed large-scale barriers between the Delta and Bay would be extremely expensive and potentially disruptive to the Bay-Delta system. Flow barriers may also restrict recreational use of and access to the Delta. Other small-scale barriers would be much less disruptive but would be constrained by local impacts on water quality, fish movement, and recreational uses.

Linkage to Other CALFED Action Categories

Flow barriers can be installed and operated in conjunction with Delta inflow/outflow/export management to control salinity levels in the Bay-Delta system. Flow barriers and physical barriers to fish movement can be constructed and operated in concert to direct the passage of fish in the Delta away from entrainment in export pumps. On the other hand, flow barriers can be implemented with improvements to through-Delta conveyance to more efficiently move water through the Delta to the export pumps.

B-000927

Management of Agricultural Drainage

Description

Agricultural drainage, both within the Delta and in tributary watersheds, can be managed to improve Delta water quality. Agricultural drainage can be managed by reducing or controlling the volume of discharges, reducing or eliminating concentrations of problem constituents in the drainage, timing the drainage to reduce its impact on the receiving waters, and treating agricultural drainage to remove problem constituents.

This category includes the following actions:

- implement source control regulations for pollutants,
- implement pollutant-load limits in the San Joaquin River,
- reduce or control volume of agricultural discharges,
- modify cropping and irrigation practices,
- export agricultural drainage to other watersheds,
- retire lands with drainage disposal problems,
- improve pest control practices,
- avoid use of high-salinity irrigation water,
- manage irrigation tailwater to reduce pesticides,
- manage drainage timing to reduce instream impacts,
- treat drainage to remove pollutants, and
- dilute pollutants in Delta inflows from the San Joaquin River using stored water.

Purpose

Poor water quality in the Delta and its tributaries, which results in part from agricultural drainage, has adverse effects on aquatic and wetland organisms and reduces the suitability of Delta exports for urban, industrial, and agricultural uses. Therefore, management of agricultural drainage can improve Bay-Delta system water quality for all beneficial uses.

Constraints

Agricultural drainage management that relies on new facilities (for conveyance, detention, or treatment) would be very costly and would most likely cause diverse environmental impacts at facility locations. The treatment of agricultural drainage also creates a problem related to the disposal of treatment byproducts such as salt. The use of flushing flows may have limited effectiveness because of the bioaccumulation and persistence in the environment of constituents such as selenium. Managing drainage by changing agricultural operations may be less expensive but may require institutional and/or regulatory changes to provide sufficient incentives for the changes to be widely implemented.

Linkage to Other CALFED Action Categories

Agricultural water conservation can decrease the amount of agricultural drainage and thereby decrease the cost of detention or treatment. Management of agricultural drainage can be implemented to increase the effectiveness of Bay-Delta system habitat restoration by reducing pesticide and other toxic constituent concentrations. Fallowing of land subject to drainage problems and reclamation of agricultural drainage water are two types of actions that can contribute to reducing the effects of agricultural drainage.

DRAFT

Management of Urban/Industrial Drainage and Wastewater Discharge

Description

Urban and industrial drainage includes point and nonpoint discharges from urban and industrial facilities, such as wastewater treatment plants, stormwater systems, manufacturing plants, and industrial cooling systems. Management of urban and industrial drainage consists of reducing concentrations of problem constituents in the discharges (through, for example, education and awareness programs for urban residents); reducing the volume of discharges to the Bay-Delta watershed (by, for example, retaining and managing stormwater runoff); or treating the discharges to remove the problem constituents (by, for example, treating wastewater effluent in constructed wetlands).

This category includes the following actions:

- retain and manage stormwater runoff,
- implement urban awareness/education programs,
- treat discharges to remove problem constituents,
- construct wetlands to treat wastewater effluent,
- increase key nutrient inputs to estuary,
- enforce wastewater discharge requirements, and
- prevent toxic discharges from industrial plants.

Purpose

Managing urban and industrial drainage and wastewater discharges improves the water quality of Delta inflows and the Bay-Delta system. Such drainage may contain substances that are directly toxic to aquatic organisms or that accumulate in aquatic and wetland food webs. Urban and industrial drainage may also contain substances, such as heavy metals, that reduce the quality of water for recreation, such as swimming and fishing, in the Delta. Thus, urban/industrial drainage management can contribute to the health and quality of the Bay-Delta system for aquatic and wetland organisms, water supply, and recreation.

Constraints

Management of urban and industrial discharges requires construction of facilities for detention and treatment of drainage waters to remove or reduce problem constituents. Construction and operation of detention and treatment facilities can be expensive and can create environmental impacts related to disposal of sediments from such facilities and residues remaining after treatment. Although education and awareness programs and urban growth management to better control nonpoint-source drainage may be less costly, they may also be less effective in managing certain problem constituents.

Linkages to Other CALFED Action Categories

Actions to manage urban and industrial drainage can be linked to water conservation among urban and industrial users to help reduce the volume of drainage to the Bay-Delta system watershed and can be combined with restoration of upstream and wetland habitats to provide final treatment of wastewater treatment-plant effluent for improved Bay-Delta system water quality. In addition, urban wastewater can be treated to allow nutrients essential to Bay-Delta system ecosystem functions to remain in the treatment effluent.

Dredged Material Management

Description

Dredging occurs in the Delta to clear channels for shipping and as part of levee maintenance. Dredging can also be done to improve water flow capacity in channels. Managing dredged material involves various measures to reduce adverse impacts of dredging operations and dredged material disposal on the chemical and physical conditions of aquatic habitats in the Bay-Delta system. For example, dredging can be timed to occur at slack tides when tidal movement in dredging sites is minimal, thereby retaining suspended particles near the dredged sites.

This category includes the following actions:

- limit dredging to slack tides,
- limit dredging to avoid fish migration periods,
- use techniques to localize sediment movement,
- dispose dredged materials at nonaquatic or other suitable sites,
- remove contaminated sediments in critical habitat sites, and
- ensure that the material used for levee maintenance is not contaminated.

Purpose

The purpose of dredged material management is to minimize mobilization of sediments that degrade physical or chemical conditions in aquatic habitats, especially in areas and at times supporting critical life stages of aquatic species of concern. Dredging mobilizes sediments that possibly contain toxic substances, blocks fish movement and feeding, and reduces the quality and quantity of shallow water habitat.

Constraints

Disposing of dredged material in nonaquatic sites requires extensive environmental assessment and mitigation efforts to find areas suitable for this activity. Timing dredging operations to better manage dredged material may be constrained by the availability of equipment and labor and the cost of using such resources during only limited portions of a working day or dredging season. Management techniques, such as silt curtains and suction dredges, may be costly where dredging areas and volumes are large. Testing requirements for dredged material and for potential leaching of toxic substances may also be costly.

Linkage to Other CALFED Action Categories

Dredged material management can be linked to restoration of shallow water and wetland habitat by using the dredged material in the restoration process. Dredged material management would need to be implemented in concert with actions that require dredging, such as levee maintenance and stabilization and improvements to through-Delta conveyance, to reduce the impacts of these activities.

B-000933

B-000933

Management of Abandoned Mine Drainage

Description

The management of mine drainage includes various actions to control heavy metals carried in drainage from precious metal mines. Abandoned mines are inactive mines that have no identifiable owners or owners with limited resources. Historical precious-metal mining in the Sacramento and San Joaquin River watersheds left numerous abandoned mines that produce AMD. Sulfur-bearing ores exposed to direct rainfall or groundwater produce acid waters that dissolve heavy metals from the parent rock. State Water Resources Control Board staff have identified approximately 160 large abandoned mines in the state. A great many of these are discharging acid mine drainage (AMD).

This category includes actions to block water draining from these mines from entering public watercourses and actions to remediate or clean up these metals. Dams may be constructed to retain contaminated waters during times of low flow in adjacent watercourses for release when the contaminants can be diluted by higher flows. Remediation consists of efforts to remove contaminants from drainage water or to inactivate them by chemically or physically binding them.

This category includes the following actions:

- manage discharges from abandoned mines, and
- remediate mining sites discharging pollutants.

Purpose

Managing mine drainage would reduce heavy metal pollution of the Sacramento and San Joaquin River systems and reduce the frequency of fish kills caused by AMD. Spawning and rearing habitats would not be subject to pulses of heavy metal pollution, thus increasing the salmon recruitment.

Constraints

Financial and legal constraints are the primary challenges in mine drainage remediation. Many of the mines have been classified as hazardous waste sites under both federal and state toxic cleanup laws. In many cases, responsible parties have not been identified or do not have the financial resources to clean up or prevent further drainage from the mining site. Recent court decisions indicate that a state agency that engages in limited cleanup at an abandoned mine may be exposed to unexpected liability under federal law.

Linkage to Other CALFED Action Categories

Managing abandoned mine drainage is linked to complementary actions to improve water quality conditions in the Bay-Delta system. Implementing more stringent controls on point- and nonpoint-source discharges, and addressing agricultural drainage issues are examples of linkages to CALFED action categories. Another possible linkage is with urban/industrial drainage and wastewater discharge by allowing municipal and industrial dischargers to assist in the removal of pollutants from mines in lieu of further cleanup of their discharges. This allows funds to be spent where the greatest benefits will be gained.

Levee Maintenance and Stabilization

Description

Levees in the Delta become less stable and more vulnerable to failure over time as a result of the erosive effects of high water flows and boat wakes and because of subsidence of the interiors of levee islands. Levee maintenance and stabilization increases the reliability and stability of existing levees that provide flood protection for Delta islands. Therefore, levee maintenance and stabilization actions consist of adding berms, widening levees, placing stone protection, or keeping the levee clear of vegetation.

This category consists of the following actions:

- maintain and stabilize existing levees,
- modify agricultural practices to reduce subsidence,
- use infilling to correct past subsidence,
- implement uniform maintenance standards, and
- provide funding for maintenance and stabilization.

Purpose

Levee maintenance and stabilization contribute to maintaining the reliability of the Bay-Delta system and protecting its beneficial uses. Reliability of existing flood control facilities around Delta islands protects existing land uses for agriculture; wildlife habitat; and infrastructure, such as transportation facilities, gas transmission lines, and water conveyance systems. Levee reliability in the western Delta is also crucial to protecting Delta water quality from salinity intrusion that can result from island inundation.

Constraints

Lack of funding and habitat impacts are major constraints to traditional levee maintenance and stabilization actions. Aquatic habitats provide important habitat features for both aquatic and wetland ecosystems. Thus, levee maintenance and rehabilitation projects need to be designed to address potential impacts to habitats. Both direct maintenance and rehabilitation of levees and establishment of comprehensive institutional arrangements to ensure these actions are implemented would be costly.

Linkage to Other CALFED Action Categories

Levee maintenance and stabilization actions can be linked for combined positive benefits to actions in categories such as reduction of land subsidence (to reduce depths of island interiors under protection), construction of conveyance facilities and channel modifications in the Delta (to achieve water supply or water quality purposes), management of dredged materials (e.g., as a source of levee construction material), restoration of riparián and wetland habitats, establishment of long-term funding mechanisms for levee maintenance, and regional land use planning. Levee maintenance and stabilization could be combined with establishment of floodways and habitat restoration through construction of setback levees to create corridors for wildlife movement between Delta habitats.

Improvement of Flood Protection Levels and Seismic Stabilities

Description

Systems and facilities to increase protection against flood and seismic risks consist of actions to increase the level of flood and seismic protection above that currently provided. For example, a current levee system may provide protection with a probability of flooding in any one year of 1 in 100; that system could be improved to provide protection with a probability of flooding in any one year of 1 in 200. Increasing protection against levee failure as a result of a seismic event could be accomplished by reconstructing levees built to old standards or by moving levees to more stable locations.

This category includes the following actions:

- reconstruct levees to higher design standards,
- reconstruct levees to higher seismic standards,
- relocate levees to more stable sites,
- widen floodways to increase flood conveyance, and
- establish and manage flood overflow areas.

Purpose

Improving flood and seismic protection levels would better maintain the reliability of the Bay-Delta system and protect its beneficial uses. Flood control systems protect existing land for use in agriculture and as wildlife habitat and protect infrastructure, such as transportation facilities and gas transmission lines. Levee reliability in the western Delta is also crucial for protecting Delta water from salinity intrusion resulting from island inundation.

Constraints

Flood-control system improvements to increase levels of protection can cause a wide array of environmental and economic impacts on Delta land uses and aquatic and terrestrial resources if they are not properly integrated. Such improvements would be extremely costly because they would often entail substantial construction and mitigation requirements. Actions to enlarge, move, or relocate levees and flood control features would require land acquisition and disruption of land uses. Lack of long-term funding and institutional support for comprehensive flood protection improvements are severe constraints to this category of actions. Potential conflicts with protection of sensitive species and habitats may also be constraining.

Linkage to Other CALFED Action Categories

Improving flood control systems and levels of flood protection can be linked to actions to restore habitats and improve water supply reliability. For example, flood control improvements can be combined with establishing floodways and meander belts, restoring mosaics of Bay-Delta system habitats, channel improvements, improving conveyance facilities, and protection and rerouting of infrastructure to provide greater overall benefits to uses of the Bay-Delta system. Implementing flood control improvements may require that long-term funding mechanisms be established, possibly in combination with establishing an institution for integrated long-term water management in the Delta.

Protection and Rerouting of Infrastructure from Flooding and Seismic Risks

Description

Many types of infrastructure facilities are located in low-lying portions of the Delta where flooding and subsequent erosion or seismic events could threaten those facilities. Examples are the Mokelumne Aqueduct of East Bay Municipal Utilities District, the Santa Fe Railroad right-of-way from Stockton to Antioch, and State Routes 4, 12, and 160. Western Area Power Administration transmission lines, and Pacific Gas and Electric Company's gas storage facilities on McDonald Tract and transmission pipelines to the Bay Area. Reliability of these infrastructure facilities could be increased by either further protecting them in current locations or in some cases relocating them to more secure sites. For example, improvements to flood control facilities around McDonald Tract could increase protection of gas storage facilities there. In addition, rerouting of some infrastructure corridors might be considered if flood and seismic protection and other purposes (e.g., establishment of habitat corridors) could also be served by that rerouting.

This category includes the following actions:

- maintain/reconstruct levees around infrastructure,
- reconstruct infrastructure to increase reliability, and
- relocate/reroute infrastructure.

Purpose

Infrastructure facilities and associated corridors are critical for supplying energy, water, and transportation to the economy of the Bay-Delta region. These facilities must be protected from interruptions of service to avoid severe economic disruptions. Protection or rerouting of infrastructure facilities would be designed to reduce the vulnerability of these facilities to flooding and seismic damage of disruption.

Constraints

Protection of infrastructure facilities in their current locations would likely be less constrained than rerouting infrastructure corridors. Protection of current facility locations would normally entail maintaining existing levee systems and incrementally improving flood and seismic protection facilities. Environmental impacts and costs of such levee maintenance and incremental improvement would be relatively less than designing, acquiring permits, constructing, and implementing mitigation for new infrastructure routes.

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Linkage to Other CALFED Action Categories

Actions to protect or reroute infrastructure facilities can be linked with other actions, such as levee maintenance and stabilization (where existing levees are reasonably reliable), flood protection improvement (where existing levees are poorly built or sited), and establishment of long-term funding mechanisms (to fund joint efforts to sustain levee protection and infrastructure), to improve system reliability. Infrastructure protection or rerouting could also be combined with Bay-Delta system aquatic and wetland habitat restoration to increase the benefits of the actions. Infrastructure rerouting might also be linked with establishment of floodways and meander belts or improvement of through-Delta conveyance to provide greater overall benefits for ecosystem quality and water supply.

Establishment of Long-Term Funding Mechanisms

Description

This action category consists of developing long-term funding mechanisms to finance improvements in Bay-Delta system reliability, such as levee maintenance and stabilization, and flood and seismic protection improvements. Specific measures may include debt finance options, revenue generation options, and institutional options.

This category includes the following actions:

- establish a Bay-Delta financing authority,
- provide low-cost debt financing for local agencies,
- establish a bond financing mechanism, and
- establish a statewide water utility surcharge.

Purpose

The purpose of these actions is to provide a predictable source of funding for implementing actions to ensure long-term Bay-Delta system reliability. Improving the reliability of the Bay-Delta system for flood control and water supply is an important component to a Bay-Delta solution. These improvements can be expensive for local agencies and landowners to undertake. Providing long-term funding mechanisms for these reliability improvements would be an important step in implementing such improvements.

Constraints

Issuing state general obligation bonds requires a two-thirds vote of the legislature and a majority vote of the electorate. Issuing state general obligation bonds would dilute the state's debt capacity and limit its ability to debt finance other activities. Revenue generation options would require legislative approval. Institutional options would create additional bureaucracy. In addition, some system reliability measures, such as reconstructing levees to increase flood and seismic protection levels could cause substantial effects on the environment.

Linkages to Other CALFED Action Categories

Establishing long-term funding mechanisms for Bay-Delta system reliability could be implemented with levee maintenance and stability or flood and seismic protection improvement actions to ensure the financial feasibility of these actions. In addition, it could be implemented with establishment of floodways and meander belts to fund flood control and seismic protection, and to provide benefits to aquatic habitats.