

Table 1. Key CALFED action groups for ecosystem restoration in the Bay-Delta and its watershed.

Component	Subcomponent	Key Actions Groups	Ecosystem Function	Limiting Factors	Species Benefited	Indicators / Target Level	How Implemented
Habitat Restoration Aquatic, Wetland, and Terrestrial	Sacramento River and Tributary	Meander - Sacramento River Allow meander belt to function naturally in upper Sacramento River from Redding downstream to Chico Landing.	Restore spawning, rearing, and migration habitat of anadromous fish by allowing natural meander process; also provides riparian and upland habitat for waterfowl, birds and mammals.	Reduce occurrence of high water temperatures; improve gravel recruitment and fish, birds, and mammal habitat.	anadromous fish, riparian and upland vegetation, birds and mammals.	gravel spawning area; suitable rearing habitat for juvenile salmonids; shaded riparian habitat; water temperature; habitat use by fish, birds, mammals	Coordinate funding available from SB 1086 and 2261, FWS refuges, CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, Salmon Stamp, Environmental License Plate Fund, and other sources. Involve property owners and other stakeholders in specific projects.
		Temperature Control Placement of temperature control devices in Shasta and Whiskeytown reservoirs that release water to upper Sacramento River. Alleviate the need to release extra water from lower level outlets.	Maintain adequate water temperature for salmon and steelhead. Preserve cold water pool in reservoirs.	Reduce occurrence of high water temperature during summer spawning season of winter run chinook salmon; reduce the loss of cold water storage volume in Whiskeytown and Shasta reservoirs that may become limiting later in season for juvenile winter run, as well as eggs, young, and adults of spring, fall, and late fall run chinook salmon and steelhead.	winter-run chinook salmon, spring and fall run chinook salmon	water temperature from spring through fall in upper Sacramento River, lower Spring Creek, and Clear Creek. Storage levels in Whiskeytown and Shasta reservoirs. Survival of eggs and fry of chinook salmon in upper Sacramento River and Clear Creek. Production of juvenile salmon from upper Sacramento River.	Provide state cost-share of Shasta and Whiskeytown reservoir temperature control devices.
		Spawning Gravel Restoration Directly replace spawning gravel below Keswick, RBDD, ACID, and tributary dams that affect gravel recruitment. Reduce gravel mining effects in tributaries. Restore natural gravel recruitment processes in Sacramento River and tributaries.	Restore natural sediment transport, recruitment, distribution, and abundance of spawning gravel in upper Sacramento River and tributaries. Enhance natural spawning by anadromous fish.	Improve spawning gravel in upper Sacramento River and tributaries.	salmon (four races) and steelhead	square yards of spawning beds available in upper Sacramento River and tributaries.	Coordinate funding from CAT III, CVPIA, and Four Pumps and Two Agency agreements. Expand existing programs as needed. Encourage private sector involvement. Evaluate need for spawning gravel. Evaluate effectiveness of gravel introductions, gravel mining restrictions and mitigation, and restoration of natural gravel recruitment processes. Map gravel distribution and changes. Determine potential for expanding spawning habitat in upper Sacramento River and tributaries.
		Setback Levee Mid-Sacramento River Setback flood control levees in the Sacramento River corridor from Chico Landing downstream to Verona.	Restore natural meander and natural aquatic and riparian habitat corridor. Improve flood control.	Improve shaded riparian aquatic habitat, aquatic and terrestrial insect production important as food to juvenile salmonids. Improve the amount of riparian and upland habitats limiting waterfowl, bird, and mammal habitat in this portion of the Sacramento River.	anadromous fish including four races of salmon, steelhead, sturgeon, and native resident fish including Sacramento splittail; and riparian and upland vegetation, birds and mammals.	miles of setback levees; acres of restored riparian habitat; miles of SRA restored. Gravel spawning area; suitable rearing habitat for juvenile salmonids; water temperature; habitat use by fish, birds, mammals	Cooperative effort with Corps of Engineers, landowners, and agencies drawing upon Corps levee mitigation, Cat III, Four Pumps and Two Agency agreement, and CVPIA funding.

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		Restoration of floodway corridor habitat Modify existing Yolo and Sutter bypass floodways to provide corridors of aquatic and wetland habitats.	Restore natural riverine, slough, riparian, wetland, and upland habitat corridors. Habitat for fish, waterfowl, birds, and mammals. Nutrient supply to Bay-Delta. Migratory corridors for anadromous fish.	Increase amount of riverine, slough, riparian, wetland, and upland habitat. Reduce existing stranding problems for anadromous fish in floodways.	Chinook salmon (four races), steelhead, splittail, and other native resident fish; waterfowl, birds and mammals.	5000-7000 acres of slough, wetland, riparian, and upland habitat. Reduction in existing stranding of anadromous fish after bypass flooding.	Cooperative effort with Corps of Engineers, landowners, and agencies drawing upon Corps levee mitigation, Cat III, Four Pumps and Two Agency agreement, and CVPIA funding. Existing ownership includes PG&E and private landowners engaged in agriculture.
		Reduce input of acid mine toxins from Spring Creek Divert Spring Creek around mine; cap mine area; enlarge dam and reservoir.	Reduce chronic toxicity of Spring Creek and upper Sacramento River on juvenile salmon and steelhead.	Improve quality of water in Spring Creek and upper Sacramento River.	Chinook salmon (four races) and steelhead.	Levels of toxic heavy metals (copper and zinc) in Spring Creek and upper Sacramento River.	Cooperative effort using EPA Super Fund, CVPIA, Cat III, and SB 900 funding.
	San Joaquin River and Tributary	Meander - San Joaquin River Restore natural meander in lower San Joaquin upstream of Mossdale.	Restore natural spawning, rearing, and migration habitat of anadromous fish; riparian and upland habitat for waterfowl, birds and mammals.	Reduce occurrence of high water temperatures; improve gravel recruitment and fish, birds, and mammal habitat.	anadromous fish, riparian and upland vegetation, birds and mammals.	gravel spawning area; suitable rearing habitat for juvenile salmonids; shaded riparian habitat; water temperature; habitat use by fish, birds, mammals	Coordinate funding available from CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, Salmon Stamp, Environmental License Plate Fund, and other sources. Involve property owners and other stakeholders in specific projects.
	Bay-Delta	Conversion of leveed lands to tidal wetlands and shallow aquatic habitat in Suisun Marsh and the Delta Convert existing (and former) leveed agricultural lands in the Delta to tidal wetlands and aquatic habitat. Possibilities include Liberty, Little Holland, and Prospect islands in the north Delta, as well as other islands elsewhere in the Delta.	Restore natural tidal-marsh, tidal-slough, and tidal-bay habitat and their associated ecological functions. Tidal marsh and bay habitats would provide habitat for resident and anadromous fish, waterfowl naturally adapted to tidal marsh-bay habitat, and carbon production, sediment collection, adjoining fish and invertebrate habitat to Suisun Bay and Montezuma Slough.	Increase amount of native tidal brackish and freshwater marsh and associated tidal channels, sloughs, and distributaries.	delta smelt, longfin smelt, and splittail (spawning and rearing habitat), winter-run chinook salmon (fingerling and smolt rearing habitat), and other anadromous and estuarine fish rearing habitat, striped bass rearing habitat.	750-1,250 acres of new tidal marsh in Suisun Marsh and open water habitat; ___ acres of tidal marsh in the Delta, 800-1,200 of shallow water, ___ linear miles of new riparian habitat, ___ miles of new tidal sloughs and associated riparian habitat; habitat use by fish, birds, mammals.	Coordinate funding available from CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, and other sources. Involve property owners and other stakeholders in specific projects. Existing ownership includes PG&E, DFG, duck clubs, and private landowners engaged in agriculture.
		Restoration of Delta riparian and shallow water habitat along levees. Improve existing and establish new riparian and shallow water habitat along levees.	Restore natural riparian habitat and their associated ecological functions: provide food supply for fish; provide SRA for fish; enhance habitat for birds and mammals.	Increase the amount of riparian and shaded-riverine-aquatic habitat.	Anadromous and resident fish; birds and mammals.	Improve conditions on 275 to 525 acres; new 400 to 600 acres; 50-100 miles of levee along Delta islands; 50-75 miles along lower Sacramento River; habitat use by fish, birds, mammals.	Coordinate funding available from CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, and other sources.
		Protect and enhance riverine habitats on channel islands Loss of existing channel islands from erosion will be reduced through bank stabilization techniques.	Restore natural island aquatic and wetland habitats and their associated ecological functions: shelter, shallow water refuge, cover, food supply for fish, invertebrates, bird, and mammals.	Increase the amount of shallow water rearing habitat for anadromous and resident fish.	Anadromous and resident fish; birds and mammals.	Protect and restore 800-1500 acres.	Coordinate funding available from CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, and other sources.

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		Protect and enhance existing tidal wetlands Existing tidal wetlands in Suisun Marsh will be protected by purchasing from willing landowners. Existing wetlands will be enhanced through funding of operations and maintenance costs.	Protect natural tidal wetlands and associated aquatic habitats and vegetation and their associated ecological functions: habitat for waterfowl, fish, birds, and mammal; nutrient supply to the estuary; sediment collection.	Increase the amount of tidal wetlands and associated aquatic habitats.	Anadromous and resident fish; birds and mammals.	Protect and enhance 100-300 acres.	Coordinate funding available from CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, and other sources.
Fish Protection from Diversions	Screening Diversions	Install Fish Screens on Unscreened Diversion Install new or upgrade existing screens on water diversions upstream of the Delta, in the Delta, and Suisun Bay/Marsh.	Reduce mortality on juvenile fish.	Reduce mortality on juvenile fish at unscreened diversions.	Anadromous and resident riverine fishes.	New screens on high priority diversions.	Coordinate funding available from CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, and other sources including irrigation districts and landowners.
	Real-time Monitoring and Diversion Management	Expand existing Real-Time Monitoring Program Monitor more species and habitat conditions, more locations and higher frequency.	Reduce mortality on juvenile fish.	Reduce mortality on juvenile fish at south Delta pumping plants.	Anadromous and resident fishes.	Real-time fish distribution and abundance. Reductions in numbers of fish entrained into south Delta pumping plants.	Additional funding provided to IEP through CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, and other sources.
	Modify fish passage at upstream dams and other barriers	Barrier Removal Improve natural and man-made barriers to fish passage.	Restore and enhance migration pathways of anadromous fish.	Migration blockage and hindrance.	Anadromous fish.	Lack of blockage or hindrance of anadromous fish movement.	Coordinate funding available from CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, and other sources.
		Install or upgrade fish passage facilities at diversion dams Upgrade fish passage facilities at diversion dams in upper Sacramento River (RBDD, ACID, and floodway weirs) and tributaries.	Restore and enhance natural unhindered migration pathways of anadromous fish.	Migration blockage and hindrance.	Anadromous fish.	Lack of blockage or hindrance of anadromous fish movement.	Coordinate funding available from CVPIA, SB 900, Four Pumps and Two Agency Agreements, Cat III, and other sources.
Flow Management	Sacramento River and Tributaries Upstream and Delta Inflow	Flow Management - Supplement flows as needed to enhance habitat and natural processes.	Spawning, rearing, temperature, outmigration, and water quality upstream. Protect and enhance flows to maximize survival of anadromous and resident fish, and their invertebrate food supply. Restore and enhance primary and secondary production in rivers and estuary.	Organism transport, migration, food production, physiological tolerance of individual organisms, and the amount of tidal freshwater and brackish water habitat in the estuary.	Anadromous and resident fish in Sacramento River and Bay-Delta.	Sacramento River flow below Keswick and at I-Street in city of Sacramento. Also flows in tributaries.	Flow requirement of WQCP (standards); CVPIA Section 3406 (b)(2) and (b)(3) water; supplemental water purchase from SB 900, Category III, and other sources.

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	San Joaquin River and Tributaries Upstream and Delta Inflow	Flow Management - Supplement flows as needed to enhance habitat and natural processes.	Spawning, rearing, temperature, dissolved oxygen, outmigration, and water quality upstream. Protect and enhance flows to maximize survival of anadromous and resident fish, and their invertebrate food supply. Restore and enhance primary and secondary production in rivers and estuary.	Organism transport, migration, food production, physiological tolerance of individual organisms, and the amount of tidal freshwater and brackish water habitat in the estuary. Susceptibility of San Joaquin salmon to losses at south Delta pumping plants.	Anadromous and resident fish in San Joaquin River and its tributaries, and in Bay-Delta.	San Joaquin River flow at Vernalis, and in tributaries.	Flow requirement of WQCP (standards); CVPIA Section 3406 (b)(2) and (b)(3) water; supplemental water purchase from SB 900, Category III, and other sources.
	Delta Outflow and Export Level; In-Delta Transport Flows	Outflow - Supplement flows as needed to enhance habitat and natural processes in Delta and Bay. Export - Limit exports as needed to enhance outflow.	X2, transport, Bay hydrodynamics migratory cues. Restore and enhance primary and secondary production in rivers and estuary.	Transport of organisms through Delta into Bay. Organism migration, food production, physiological tolerance of individual organisms, and the amount of tidal freshwater and brackish water habitat in the estuary. Susceptibility of fish to entrainment into PG&E power plants and south Delta pumping plants.	Anadromous and estuarine resident fish.	Chippis Island outflow.	Limitations on exports, export demands, outflow requirements of WQCP (standards); CVPIA Section 3406 (b)(2) and (b)(3) water; supplemental water purchase from SB 900, Category III, and other sources.
Fisheries Management	Hatcheries	Hatchery Management - Improve operations of state and federal hatcheries; improve genetics; reduce effects on wild fish; reduce benefits to predators.	Enhance natural fish production.	Reduce negative effects of wild fish populations.	Chinook salmon (four races) and steelhead.	Production of wild fish.	CVPIA, SB 900, Category III, Four Pumps and Two-agency Agreement, and other sources.
	Harvest	Fish Harvest Management - reduce harvest of wild salmon and steelhead in sport and commercial fisheries through improved management data and marking of hatchery fish to allow wild fish release in fisheries.	Enhance natural fish production.	Reduce negative effects of wild fish populations.	Chinook salmon (four races) and steelhead.	Production of wild fish.	CVPIA, SB 900, Category III, Four Pumps and Two-agency Agreement, and other sources.