J 2494

UPSTREAM ACTIONS: ECOSYSTEM RESTORATION PROGRAM PLAN

ACTIONS TO CONTRIBUTE TO THE RECOVERY OF CHINOOK SALMON, STEELHEAD, SPLITTAIL, AND ASSIST IN THE MANAGEMENT OF STRIPED BASS

PREPARED FOR THE

DIVERSION EFFECTS ON FISHERIES TEAM

PRELIMINARY DRAFT

AUGUST 4, 1998

TABLE OF CONTENTS

ACTION TO BE IMPLEMENTED UPSTREAM OF THE DELTA TO PROMOTE THE "RECOVERY" OF LISTED, PROPOSED FOR LISTING, AND CANDIDATE THREATENED OR ENDANGERED SPECIES

Sacramento River Ecological Management Zone

Category	Target	Action	Species of Benefit
Streamflow	More closely emulate the seasonal streamflow patterns in dry and normal year- types by allowing a late-winter or early-spring flow event of approximately 8,000 to 10,000 cfs in dry years and 15,000 to 20,000 cfs in below normal water-years to occur below Keswick Dam	Provide a flow event by supplementing normal operating flows from Shasta and Keswick Dams in March during years when no flow event has occurred during winter or is expected to occur. Flow events would be provided only when sufficient inflow to Lake Shasta is available to sustain the prescribed releases. This action can be refined by evaluating its indirect costs and the overall effectiveness of achieving objectives.	Fall-run chinook fry and smolts Spring-run chinook fry and smolts Late-fall-run chinook fry and smolts Winter-run chinook adults Steelhead adults
	Maintain base flows of 6,000 to 8,000 cfs during the fall	Provide flow releases from Shasta Lake and Keswick Dam when necessary to provide the target base flows. Releases would be made only when inflows equal or exceed prescribed releases.	Fall-run chinook adults Spring-run chinook adults Winter-run chinook fry
	Justification: *Increasing releases from Shasta Reservoir is the only means of maintaining base flows in the upper river. Late-winter or early-spring flow events of sufficient magnitude attract and sustain adult salmon, steelhead, sturgeon, and American shad; improve transport of juvenile fish downstream; sustain riparian habitat; and sustain gravel recruitment, transport, and cleansing processes. The target flows are consistent with historic and unimpaired flows for the Sacramento River in dry and normal years. These flows may not occur in some years under the present level of project development and operation. Implementing the target level of the flow event must necessarily be on a conservative basis because of the potential cost to water supply. The fall flow pattern needs to be carefully evaluated to ensure protection for incubating chinook salmon and steelhead eggs. The chinook salmon and steelhead that spawn in the fall have eggs in the river that incubate into the winter season. Incubating eggs can be severely damaged when wintertime releases from Keswick Dam are dropped below the fall release levels. Other concerns include maintaining high base flows during the fall would cause temperature control problems in the following year under conditions of low carryover storage in Shasta Reservoir or low inter inflow conditions. The fall flow needs to consider the need for carryover storage to provide temperature control in the following year.*		

Category	Target	Action	Species of Benefit
	If a flow event of equal or greater magnitude has not occurred between Keswick Dam and Red Bluff by March, then supplementing base flows or augmenting small natural releases or reservoir spills with additional reservoir releases is the only means to provide flow events. Such releases would be used only if there is an equivalent or greater inflow to Lake Shasta. March is the logical month to provide such flows, because it is the month when "natural" flow events occurred historically in dry and below normal years, and because opportunities for such flow to occur "naturally" as a function of normal project operation would have been exhausted by then. Water forecasts of the water-year type (critically dry, dry, below normal, above normal, or wet) are available by February and March. The flow event in March would be expected to proceed unimpaired downstream to the Delta, because few or no diversions from the Sacramento River occur during March. (Note that additional flow events are prescribed for the Feather River in March, which will further enhance Sacramento River flows below its confluence with the Feather River.) A March flow event could also help satisfy Delta outflow requirements. *Maintaining natural base flows will help promote natural channel forming, riparian vegetation, and foodweb functions. Base flows also serve to attract steelhead and fall-run and late-fall-run chinook salmon. Unimpaired base flows in fall are approximately 4,000 cfs to 6,000 cfs in dry years, and up to 8,000 cfs in wetter years. Natural base flows are prescribed only for fall, because, under present project operation, flows in excess of 10,000 cfs are maintained in summer for irrigation and to lower water temperatures for winter-run salmon.*		
Natural Sediment Supply	Increase gravel recruitment in the upper Sacramento River between Keswick Dam and the RBDD by 10,000 to 20,000 cubic yards annually to provide adequate spawning habitat for targeted levels of salmon and steelhead and to sustain stream meander processes below Red Bluff. (This is the estimated amount of spawning-sized gravel captured annually by Shasta Dam.)	Develop a cooperative program to stockpile gravel at strategic locations along the Sacramento River below Keswick Dam where river flow will move gravel into the river channel to mimic natural gravel recruitment into the upper river. Determine the adequacy of this action and adjust amount and locations as necessary.	All stocks of chinook salmon that spawn or rear in the Sacramento River
		Develop a cooperative program to reactivate gravel recruitment to the river by exposing existing sources of river gravel on islands, bars, and banks that have become armored to riverflows. This action should be implemented on a conservative basis, because the availability of such inchannel gravel, costs of activating the gravel, indirect impacts, and potential effectiveness have not been determined.	All stocks of chinook salmon that spawn or rear in the Sacramento River

Category	Target	Action	Species of Benefit
	Justification: *Replenishing gravel supplies to a level sufficient to support target populations of salmon and steelhead will help to improve populations to desirable levels and to maintain such levels once achieved. Replenishing gravels to maintain channel-forming processes and stream meanders in the upper Sacramento River will help to maintain fish and wildlife habitats, aquatic algae and invertebrate production, and streamside vegetation (DWR 1980). A predevelopment level of gravel recruitment should be adequate to restore the natural ecological processes supported by gravel recruitment, but may require experimenting, monitoring, and experience to determine the exact amount of gravel supplies necessary to meet the objective. Implementation of gravel supplementation projects above RBDD will be subject to adaptive management, with elements that include focused research on sediment transport processes, and monitoring of gravel quality and quantity. Sediment supplementation programs need to be integrated with downstream channel forming processes, which will be subject to adaptive management, as well as to a different set of indicators, monitoring, and focused research.* *On the river side of natural levees in alluvial valleys, fluvial processes typically create dynamic river meander patterns, including oxbow lakes from bend cutoffs, secondary channels that carry flow only during high stage, and nonvegetated point bars where new deposits of sand and gravel collect in low-energy zones of inside bends and bendway crossovers (riffles). In cross section, natural alluvial streams are typically terraced and asymmetrical, with steep banks on eroding outside bends, low-angle banks on inside bends, and several nearly horizontal surfaces corresponding to river floodplain elevations of various magnitude and frequency. If a river has incised (i.e., eroded down below the original channelbed surface) as a result of natural or human-induced factors, the abandoned upper floodplain may become a "terrace" (former floodplain) where riparian forest may then convert to valley oak woodlands or grassland-oak savannah.* *The characteristic three-dimensional shape of a river described above (its "fluvial geomorphology" or landforms created by flowing water) is indicative of a river that is in dynamic balance with the interaction of its flood regime, sediment supply, vegetation patterns, climate, and valley slope. Rivers with a natural shape and hydrologic condition generally support the most diverse mixture of habitats and fish and wildlife species and are the most resilient to natural or human disturbance.*		
Stream Meander	Preserve and improve the existing stream meander belt in the Sacramento River between Red Bluff and Chico Landing by purchase in fee or through easements of 8,000 to 12,000 acres of riparian lands in the meander zone	Develop a cooperative program to evaluate the feasibility of removing riprap from banks to the extent possible, consistent with flood management requirements, and reduce effects of other structures, such as bridges, to provide a sustainable meander corridor. Purchase easements to offset losses to property owners for land lost to meander process.	All chinook and steelhead stocks that depend on SRA and near shore rearing habitat

Category	Target	Action	Species of Benefit
	Preserve and improve the existing stream meander belt in the Sacramento River between Chico Landing and Colusa by purchase in fee or through easements of 8,000 to 12,000 acres of riparian lands in the meander zone	Develop a cooperative program to evaluate the feasibility of removing riprap from banks to the extent possible, consistent with flood control management, and reduce effects of other structures, such as bridges, to provide a sustainable meander corridor. Purchase easements to offset losses to property owners for land lost to meander process.	All chinook and steelhead stocks that depend on SRA and near shore rearing habitat
	Justification: *Preserving and improving the stream meander belt below Red Bluff will ensure that this important natural process is maintained in the Sacramento River. This reach is important for spawning and rearing salmon and steelhead. A natural meander process will provide near-optimal habitat for spawning (through gravel recruitment), rearing (channel configuration, cover, and foodweb), and migration. There is limited potential natural channel above Red Bluff. Below Chico Landing, flood control levees limit the potential of restoring the natural meander of that reach. Overall, the program must be consistent with flood control requirements and in the longer-term, should reduce need for future flood control efforts by using natural system resilience and flood control characteristics.* *During the selection process and during implementation, additional benefits will accrue by looking for land within or adjacent to the meander belt which support special status species and to include these areas whenever available in the acquisition. Some the species to be considered include the valley elderberry longhorn beetle, bank swallow, western yellow-billed cuckoo, and giant garter snake.*		
Natural Floodplain and Flood Processes	Increase and maintain floodplains in conjunction with stream meander corridor restoration	Develop and implement a cooperative program, consistent with flood control requirements, to evaluate the feasibility of altering river channel configurations in leveed reaches of the Sacramento River to increase the areal extent of floodplains inundated during high flow periods.	All chinook and steelhead stocks that depend on SRA and near shore rearing habitat and splittail spawning and rearing

Category	Target	Action	Species of Benefit
	Justification: *Floodplain inundation is the seasonal flooding of floodplain habitats, including riparian and riverine aquatic habitats. Flooding of these lands provides important seasonal habitat for fish and wildlife and provides sediment and nutrients to both the flooded lands and aquatic habitats that receive the returning or abating floodwater. The flooding also shapes the plant and animal communities in the riparian, wetland, and upland areas subject to flooding. Floodplain flooding is a secondary ecosystem process related to water and sediment flow through the Sacramento-San Joaquin basin and their landforms. Opportunities to restore or enhance this process are possible by changing landscape features, landforms, and seasonal distribution of flow volume through the system.* *Channelizing and shortening rivers; removing instream vegetation and gravel; and creating symmetrical, trapezoidal channels sandwiched between narrow, steep-sided levees diminish the natural tendency of alluvial rivers to form characteristic compound dimensions and patterns. A channelized river may be relatively stable if the potential for major flood events has been eliminated, sediment input is minimal, vegetation does not naturally grow along the banks, and the channelbed is incapable of incising. The absence of river floodplains and adequate meander width for bar and riffle formation within levee-confined channels prevents or depresses the formation of natural river morphology that is the structural framework for riverine and estuarine fish and wildlife habitats. Stabilizing artificial banks with rock riprap and clearing vegetation further degrades habitat and diminishes natural channel-forming processes.* *An important exception here is the existence of the Sacramento River basin overflow system: the Butte basin and Sutter and Yolo Bypasses. Although considerably smaller than their original extent, these three floodplains move and detain floodwaters in volumes and patterns similar to those of presettlement flow, while reducing the risk of overtopping levees near populated areas. At flood peak, there is approximately five times more flow in the Sacramento River bypass floodplain system than in the main river channel it drains. However, the floodplain bypass system does not exist in the largest historic flood basin of the Sacramento River, the Colusa basin, which is disconnected by levees from the river. Also, the lowest areas of the Sutter basin are outside of the levees and the Sutter Bypass traverses slightly higher ground on a portion of the historical basin floodplain.*		
Central Valley Stream Temperatures	Maintain mean daily water temperatures at levels suitable for maintaining all life-history stages of chinook salmon and steelhead in the Sacramento River between Keswick Dam and RBDD in above normal and wet years, and between Keswick Dam and RBDD in other year types	Cooperatively develop and implement a balanced river regulation program that provides sufficient carryover storage at Shasta Dam to ensure that suitably low water temperatures are reached to protect chinook salmon spawning, incubating eggs, and young fish, particularly in consecutive dry and critically dry years.	All chinook and steelhead stocks that depend on the main stem Sacramento River for spawning, egg incubation, emergence, and early rearing

Category	Target	Action	Species of Benefit
	Justification: *The temperature objective for the upper Sacramento River is less than or equal to 56°F from Keswick Dam to RBDD for operation of CVP in the State Water Resources Control Board's (SWRCB's) Order 90-5. However, these criteria cannot be met consistently, and other structural facilities and operation measures are needed. These facilities and operational measures must be developed and implemented to enable the long-term attainment of the SWRCB-required temperature criteria.* *A temperature control or "shutter device" has been installed to permit the selective withdrawal of water from Shasta Reservoir over a wide range of depths and temperatures. With this device, warm water could be withdrawn from the upper lake levels when needed, while conserving the deeper, cold water for release when it would most benefit chinook salmon. Operating the temperature control device allows Reclamation greater effectiveness and flexibility in temperature control operations while maintaining hydroelectric power generation. The temperature control device also provides a secondary benefit to anadromous fish by controlling turbidity. Because the temperature control device is installed and operational, operations and carryover storage requirements must be reassessed and new criteria established to optimize attainment of water temperature objectives.* *In the long term, Sacramento River water temperatures can be moderated by restoring a healthy riparian forest. Implicit in restoring an extensive riparian forest is a need to reconnect the river with its floodplain to promote natural riparian succession.*		
Riparian and Riverine Aquatic Habitats	Provide conditions for riparian vegetation growth along channelized portions of the Sacramento River	Develop a cooperative program to plant vegetation on unvegetated, riprapped banks consistent with flood control requirements. Implementation will occur in phases, results will be monitored and restoration approach will be adjusted as necessary under adaptive management.	
		Setback levees may be constructed on leveed reaches of the river to provide a wider floodplain and greater development of SRA habitat. Because of the potential indirect impacts on land use and uncertainty of cost and technical feasibility of setback levees, such development will be experimental and conservative, and will depend on adaptive management.	
		Cooperatively develop and implement a study to determine appropriate conditions for the germination and establishment of riparian woody plants along the river.	

Category	Target	Action	Species of Benefit
	Increase the ecological value of low-to moderate-quality SRA habitat by changing land use and land management practices	Purchase property or easements and allow habitat to improve naturally. Properties to be considered should be developed through a prioritizing process that considers habitat quality and importance, technical feasibility and cost of purchase and improvement, and consent of landowners.	
		Provide incentives and technical support for private landowners to protect and improve existing SRA habitat.	
	Maintain existing streamside riparian vegetation	Through purchase, conservation easement, and voluntary participation of landowners, protect SRA habitat from development. Where high-priority properties are already in government ownership or available for purchase or easement, preservation efforts should be undertaken as experiments to develop technical details, cost-effectiveness, and overall approach and consensus for the program. Full implementation of this program would depend on results of experiments and would be subject to adaptive management.	
	Justification: *Riprapped banks in the leveed section of the river below Chico Landing downstream to Sacramento are the greatest cause of SRA fragmentation. Restoring vegetation will benefit juvenile salmon rearing by providing cover and food, spawning substrate for other fish, such as Sacramento splittail, and refuge for juvenile fish during periods of high water. Improving low- to moderate-quality SRA habitat will benefit juvenile salmon and steelhead by providing improved shade, cover, and food. Wildlife will also benefit from improved habitat. Protecting and improving existing SRA habitat may involve changes in land use. Limited available funds may require that priorities be set, with high-priority, low-cost sites developed initially. For sites where consensus exists, immediate experimental action can be taken. Because of the importance and limited distribution and abundance of SRA habitat, all existing quality habitat should be protected.* *In developing this element of the restoration plan, it is important not to develop just a very long, narrow band of riparian vegetation. Although it needs further development, a "string-of-pearls" approach should be considered. In this concept the long, narrow band of riparian vegetation would be interspersed with larger patches of riparian vegetation. This concept would mesh well with nodes of setback levees to provide a minimal floodplain, seasonal floodplain inundation, and natural or supplemented riparian revegetation.*		
Water Diversions	Reduce entrainment of juvenile salmon, steelhead, sturgeon, and splittail into water diversions to levels that will not impair stock rebuilding or species restoration	Develop a cooperative program to screen all diversions greater than 250 cfs and one- to two-thirds of all smaller unscreened diversions. This programmatic level of action should be sufficient to provide the data necessary to modify this target through adaptive management.	

Category	Target	Action	Species of Benefit
		Develop a cooperative program to upgrade screening at diversions with ineffective screening. Where existing screening has proven less than effective and entrainment problems continue, immediate action should be taken to upgrade screens.	
		Develop a cooperative program to reduce diversions when and where juvenile salmon are present in large or significant numbers. Even with screens, some diversions may pose a threat to young salmon and steelhead, and it may be necessary to modify operations of the diversion. Such determinations will be made after necessary monitoring and evaluation, and on a case-by-case basis. Decisions will be made with agency and stakeholder involvement and with consideration given to appropriate alternatives.	
		Promote and support relocating water diversions and developing alternate methods of supplying water from the Sacramento River that protect fish but also minimize conflict with maintaining dynamic fluvial processes.	

Category	Target	Action	Species of Benefit
	Justification: *Juvenile chinook salmon, steelhead, green and white sturgeon, Sacramento splittail, and American shad are lost at water diversion sites all along the Sacramento River during the spring-to-fall irrigation season. (Note that diversion losses include direct loss into unscreened diversions and other losses associated with the screened and unscreened intake facilities, such as from predators, including squawfish and striped bass.) Reducing entrainment losses to minimal levels is a reasonable target for the short term, given the existing poor health of many of the fish populations that use the Sacramento River and its tributaries for spawning and rearing of young. Emphasis should be on the upper river above Chico Landing, because this is the reach where winter-run chinook young rearing coincides with the spring-to-fall irrigation season.* *Determining which diversions need to be screened will be based on appropriate monitoring and evaluation, with decisions made with agency and stakeholder involvement, and with consideration given to appropriate alternatives. Actions will be taken on a case-by-case basis, with consideration given to results of pilot experiments to determine technical feasibility and cost-effectiveness of screening diversions of different size, type, and location. Priority will be given to screening diversions that pose the most threat and where screening has been determined to be effective. Emphasis should be given to projects that include the consolidation of several diversion points to a single location.* *In application, priority for screening diversions will be based on several criteria including but not limited to the geographical location, the volume of water diverted, the location of the intake in the water column, and the cost effectiveness of the installation. Alternatives to screening will be considered. When a fish screen is installed it should be tested to determine that it can perform to the criteria of the fish regulatory agencies. After testing has indicated that the screen meets the criteria, monitoring should be conducted to ensure that the screen can meet the criteria under the range of hydrologic conditions expected at the site. When operation monitoring indicates that everything is working satisfactorily, the diverter should routinely inspect the screen to ensure that the facility is undamaged.*		
Dams, Reservoirs, Weirs, and Other Structures	Minimize survival problems for adult and juvenile anadromous fish at RBDD by permanently raising the gates during the non-irrigation season and improving passage facilities during the irrigation season	Upgrade fish passage facilities at the RBDD.	
	Reduce blockage to fish migrations at the ACID dam	Upgrade fish passage facilities at the ACID dam.	

Category	Target	Action	Species of Benefit
	Justification: *At present, the RBDD gates are in the raised position from September 15 through May 14, allowing free passage to about 85% of the spawning run (based on average run timing from 1982-1986). This may have reduced the number of redds (spawning nests created by salmon) being built below the dam. The remaining portion of the run migrating upstream after May 15 is likely to be delayed or blocked from passing the dam.* *Adults that are obstructed from passing the dam are forced to spawn downstream where temperature conditions are typically unsuitable during the spawning and incubation period. Temperatures of 56 °F usually cannot be maintained below RBDD without severely depleting Shasta carryover storage during the winter-run chinook incubation period; eggs and larvae usually have 100% mortality.* *Adults that must make repeated attempts to pass the dam, but eventually are successful, undergo physiological stress that may contribute to their reduced fecundity. Because migration of these adults is delayed, the fish are likely to spawn farther downstream where suitable temperatures for spawning and incubation may not be attainable.* *Adult chinook salmon must negotiate fish ladders at the ACID dam during the irrigation season (typically April through November) to reach upstream spawning habitat. However, an antiquated ladder on the east abutment of the dam is ineffective in providing safe passage, and a recently installed denil ladder on the west abutment has proved only marginally successful. The ladders at this facility do not provide suitable flows to attract adults, and the ladders are not easily adjustable to compensate for varying flow conditions. A feasibility study is being conducted by the ACID to identify, develop, and evaluate alternatives to resolve adult passage problems.*		
Levees, Bridges, and Bank Protection	Construct setback levees along leveed reaches of the river as part of the stream meander corridor	Develop a cooperative program, consistent with flood control requirements, to evaluate potential sites for establishing setback levees along leveed reaches of the Sacramento River.	
	Justification: *Levees, bridges, and bank protection structures inhibit overland flow and erosion and depositional processes that develop and maintain floodplains and allow stream channels to meander. Levees prevent flood flows from entering historic floodplains behind levees, stopping evolution of floodplain habitats dependent on overbank flows. Confinement of flood flows to channels by levees and bank protection structures also increases the fluvial energy of flows that scour or incise channel beds and reduces or halts the rate of channel migration and oxbow formation.*		
Predation and Competition	Reduce the adverse effects of predatory fish by identifying and eliminating humanmade instream structures or operational conditions that allow unnatural predation rates	Selectively evaluate areas and make physical changes to structures in the Sacramento River, such as bridge abutments, diversion dams, rip-rap banks, and water intakes, that currently may attract predators and provide them with additional advantages in preying on juvenile salmon and steelhead. Pilot studies and evaluations are needed to determine the types of changes required and the potential degree of implementation.	

Category	Target	Action	Species of Benefit
	Justification: *Upgrading fish passage facilities at the two diversion dams will reduce delays to upstream migrating winter-run chinook salmon and hindrance of downstream migrating juvenile winter-run chinook salmon. This will contribute to a reduction in predation rates on young fish.* *During operation of RBDD, juvenile chinook are adversely affected while approaching the dam, passing the dam, and moving downstream of the dam. As juveniles migrate toward the dam, they experience increased predation in Lake Red Bluff from predatory fish and birds. Juveniles passing under the lowered dam gates become disoriented because of high water velocities and turbulence, and are subject to heavy predation downstream by squawfish and striped bass. Juveniles bypassed around the dam through the Tehama-Colusa fish bypass system may have improved survival rates because of new facilities and positive-barrier fish screens, but complete evaluations are needed.* *To help protect winter-run chinook from predation and other losses associated with passage at RBDD, the dam gates have been raised for varying durations since the end of 1986. Juvenile chinook suffer mortality in passing the dam from squawfish and striped bass predation and disorientation or injury when passing beneath the dam gates or through the fish bypass system. Under the present schedule of gate operations, about 26% of the juvenile outmigrants must pass the dam when the gates are lowered and are susceptible to mortality associated with that passage. In a 1988 study, juvenile hatchery salmon were released above and below the dam to estimate total mortality during dam passage. In all, 16% to 55% fewer fish were recaptured from the releases made above dam than those made below. USFWS determined predation, primarily by squawfish, as the major cause of mortality to juvenile salmon migrating past the dam, whereas the number of deaths from physical injury received while passing under the dam were minor.*		
Contaminants	Reduce losses of fish and wildlife resulting from pesticide, hydrocarbon, heavy metal, and other pollutants in the Sacramento River	Develop a cooperative program to remedy heavy metal pollution from IMM to meet basin plan standards, and implement reliable and proven remedies that ensure continued treatment and control of heavy metal waste before water is discharged to the Sacramento River.	
		Develop a cooperative program to eliminate scouring of toxic, metal-laden sediments in the Spring Creek and Keswick Reservoirs.	
		Control contaminant input to the Sacramento River system by constructing and operating stormwater treatment facilities and implementing industrial best management practices (BMPs) for stormwater and erosion control.	
		Develop a cooperative program to assess and monitor contaminant input from agricultural drainages in the Sacramento River watershed.	

Category	Target	Action	Species of Benefit
	Justification: *Actions proposed here to reduce the adverse effects of contaminants in the Bay-Delta system will be coordinated with recommendations and actions developed by the CALFED Water Quality Common Program.* *The drainage from inactive mines on the IMM Superfund site represents the largest source of pollutant discharge to the Sacramento River. This discharge is at least equal to all the combined industrial and municipal discharges of dissolved metals to the San Francisco Bay and estuary system. This mine water is among the most acidic in the world and contains extremely elevated concentrations of copper, zinc, cadmium, and other metals known to be toxic to fish and wildlife. On occasion, fish deaths (including salmon) may have occurred as toxicity levels have been exceeded and documented in the upper Sacramento River as a result of IMM waste. More frequently, there are documented instances of metal concentrations that exceed toxic levels considered safe for early life stages of salmon.* *The wastes from IMM, located in the Spring Creek watershed, are collected in the Spring Creek Reservoir and metered out into the releases of clean water from Shasta and Whiskeytown Reservoirs to achieve the best water quality possible. However, because of the extremely large waste load (averaging more than 1 ton of copper and zinc per day), it has not always been possible to consistently attain the water quality objectives for copper, cadmium, and zinc in the basin plan, and interim criteria have been established until pollution control is completed. Highly toxic conditions are exacerbated when heavy winter rains induce uncontrolled spills from Spring Creek Reservoir, and flows from Shasta and Whiskeytown Reservoirs are not made available for dilution because of other CVP constraints.* *Within the lower portion of the IMM site, remediation must be developed for the metal sludge deposits in Spring Creek Reservoir and in Keswick Reservoir adjacent and downstream of the Spring Creek power plant tailrace. Preliminary monitoring in the Keswick Reservoir has documented that the sludge is highly toxic and that the deposits are extensive and up to 15 feet thick. Under certain conditions, flows from the Spring Creek power plant can mobilize large quantities of the sludge into the river, creating an acute toxicity risk to aquatic species. The sludge deposits can also contribute to chronic toxicity when combined with other sources.* *Major sources of pollution include industries, municipalities, and agriculture, which discharge such contaminants as herbicides, pesticides, organic compounds, inorganic compounds, and warm water. Pollution is described as originating from point sources, such as discharge pipes or other localized sources, or from nonpoint sources, which are dispersed. Individual sources of nonpoint pollution may be insignificant, but the cumulative effects can be significant and can contribute high levels of pathogens, suspended solids, and toxins. Major contributors of nonpoint-source pollution to the Sacramento River, Sacramento-San Joaquin Delta, and San Francisco Bay include sediment discharge, stormwater and erosion, and agricultural drainage. Mandatory performance standards are needed for these sources, with flexibility granted to landowners to adopt whatever management practices are best suited for local conditions.* *A primary point source of pollution is from municipal treatment plants, which release heavy metal contaminants, thermal pollution, pathogens, suspended solids, and other constituents. Implementing enhanced treatment, pretreatment programs, and tertiary treatment should help to reduce contaminant input.* *Sediments constitute nearly half of the materials introduced into rivers from nonpoint sources, such as plowed fields, construction and logging sites, and mined land, and are mainly generated during storm events. Stormwater runoff in urban and developing areas is another major source of sediments and contaminants. Sedimentation from nonpoint sources should be reduced by implementing BMPs for urban and nonurban pollution, and implementing appropriate treatment and technological options that reduce pollutant loads.*		

Category	Target	Action	Species of Benefit
Harvest of Fish and Wildlife	Reduce illegal harvest of fish species to a minimum to maintain or increase populations by increasing enforcement efforts by 50 to 100%	Increase enforcement efforts.	
		Develop a cooperative program to educate the public on the threats to populations from illegal harvest. Various actions include ad campaigns, signs along streams, and various types of outreach programs to schools, watershed conservancies, and groups.	
		Provide additional funding for the poaching hotline and rewards for arrest and convictions of poachers.	
	Manage the legal harvest of chinook salmon, steelhead, and sturgeon by shifting harvest from natural stocks to hatchery-reared stocks, where possible, or reducing harvest of wild stocks until the naturally produced populations recover	Develop a cooperative program to mark all hatchery salmon and steelhead, allowing selective harvest of hatchery fish, while limiting harvest of wild fish. This action should be implemented on a short-term and experimental basis to ensure that it meets its objective and is cost-effective.	
		Encourage regulatory agencies to change fishing regulations (i.e., by restricting seasons, limits, and gear and reducing harvest of wild fish) to further reduce legal harvest and any ancillary effects of fishing gear or techniques. Restrictions should be severe in the short term. Long-term restrictions would depend on response of populations and effectiveness of restrictions and the degree of effectiveness of the action.	
	Justification: *Some populations of salmon and steelhead in the Sacramento River are at such depressed levels that drastic reductions in any factors that contribute to mortality are necessary. Harvest management policies have been established by state and federal agencies to minimize mortality on natural chinook stocks, including severe harvest restrictions and size limits. Illegal harvest is known to occur along the Sacramento River. This target will be subject to adaptive management.*		
Artificial Fish Propagation	Minimize the likelihood that hatchery-reared salmon and steelhead in the upper Sacramento River will stray into non-natal streams to protect naturally produced salmon and steelhead	Develop a cooperative program to evaluate the costs and benefits of limiting stocking of hatchery-reared salmon and steelhead in the upper Sacramento River. Stocking may be reduced in years when natural production is high in selected populations.	

Category	Target	Action	Species of Benefit
	Limit hatchery stocking to populations that cannot be sustained through natural production	Augment winter-run, spring-run, and late-fall-run chinook salmon and steelhead with hatchery-produced smolts during the short-term rebuilding phase of restoration efforts and only when alternative measures are deemed insufficient to provide recovery of the populations. Stocking of hatchery-reared fish will be undertaken as experiments and adjusted or terminated as necessary, depending on results.	
	Employ methods to limit straying and loss of genetic integrity of wild and hatchery supported stocks	Rear salmon and steelhead in hatcheries on natal streams to limit straying. If hatchery augmentation of Sacramento River populations of salmon and steelhead is necessary, then hatcheries should be built on the Sacramento River for that purpose.	
		Limit stocking of salmon and steelhead fry and smolts to natal watersheds to minimize straying that may compromise the genetic integrity of naturally producing populations.	
	Minimize further threats of hatchery fish contaminating wild stocks of salmon and steelhead	Where hatchery production is underway and continues, methods should be adopted and improved for the selection of an appropriate cross section of the adult population for spawning at the hatchery.	
		Select spawning adults of appropriate genetic makeup to minimize genetic contamination of existing hatchery and naturally producing stocks of salmon and steelhead. Given the present difficulty of determining genetic makeup of spawning adults selected for hatcheries, this action will necessarily be experimental. Hatchery-reared adults may be preferentially selected or not selected if they are adequately marked or tagged, or have other identifiable feature. Other methods may be developed to genetically categorize naturally produced or hatchery fish.	

Category	Target	Action	Species of Benefit
	Justification: *In watersheds such as the Sacramento River, where dams and habitat degradation have limited natural spawning, some hatchery supplementation may be necessary to sustain fishery harvest at former levels and to maintain a wild or natural spawning population during adverse conditions, such as droughts. However, hatchery augmentation should be limited in extent and to levels that do not inhibit recovery and maintenance of wild populations. Hatchery-reared salmon and steelhead may directly compete with and prey on wild salmon and steelhead. Straying of adult hatchery fish into non-natal watersheds may also threaten the genetics of wild stocks. Hatchery fish may also threaten the genetic makeup of stocks in natal rivers. Some general scientific information and theory from studies of other river systems indicate that hatchery supplementation may limit recovery and long-term maintenance of naturally producing populations of salmon and steelhead. Further research and experimentation are necessary to determine the degree to which this issue is addressed. Long-term hatchery augmentation of healthy wild stocks may genetically undermine that stock and threaten the genetic integrity of other stocks. Spawning and rearing habitat are limited, and adverse conditions may occur in drought or flood years that would undermine the population without additional hatchery production.* *Release of hatchery-reared fish into the upper Sacramento River and its tributaries could lead to a loss of the genetic integrity of wild salmon and steelhead populations. Adults straying into non-natal streams may interbreed with a wild population specifically adapted to that watershed, possibly leading to the loss of genetic integrity in the wild population. Although some irreversible contamination has occurred in salmon and steelhead populations, measures are necessary to minimize further deterioration of contaminated populations and to protect populations that are not contaminated.* *Recent returns to CNFH of fall-run chinook salmon seem to indicate that the hatchery is heavily supporting the entire fall-run population, particularly in Battle Creek, all of which probably originated from CNFH. A recent estimate for the rest of the Sacramento River above RBDD, excluding Battle Creek, was only 40,000 fish, which may also have been heavily supported by CNFH production.* *Some stocking of hatchery-reared fish may be necessary in the short term to rebuild naturally spawning populations; however, there is a lack of consensus among agencies and stakeholders as to the degree of stocking that is detrimental or necessary to sustain sport and commercial fisheries. This action will necessarily be short term and experimental, with subsequent efforts dependent on results and effectiveness.*		
Splittail	Increase the average annual abundance and distribution of adult fish to levels that existed from 1967 to 1983	Actions in the Sacramento River Ecological Zone have been designed specifically to restore splittail or their habitat. This species will directly benefit from actions in this zone to increase the area and distribution of riparian and riverine aquatic habitats and natural flood and floodplain processes. These programmatic actions address: ■ riparian and riverine aquatic habitat, and ■ natural flood and floodplain processes. Additional restoration actions that will benefit splittail are proposed for the American River Basin, Yolo Basin, Feather River/Sutter Basin, Eastside Delta Tributaries, and San Joaquin River Ecological Zones.	

Category	Target	Action	Species of Benefit
	Justification: *Splittail are presently restricted to a fraction of their historic range. Restoring splittail to their former range outside the Delta is in an important element for this species. Generally, restoration of the species refers primarily to restoration of the reduced Delta populations. Nonetheless, some actions that may assist in restoration of this native species to a portion of its previous upstream range include: (1) creation of meander belts along the Sacramento River by levee setbacks, (2) creation of floodable wetlands in the lower San Joaquin, Tuolumne, and Stanislaus Rivers, (3) marsh restoration in the Delta and Suisun Marsh, (4) managing bypasses for fish, and (5) removal of upstream barriers to migration.* *Because of its distribution, restoration actions implemented in the following ecological zones will contribute to the recovery of splittail: Sacramento River, East San Joaquin, San Joaquin River, Sacramento-San Joaquin Delta, Suisun Marsh/North San Francisco Bay, Colusa Basin, Feather River/Sutter Basin, American River Basin, and Yolo Basin. Many of the related actions include restoring ecological processes linked to natural floodplains and flood processes.* *Restoration goals established by the U.S. Fish and Wildlife Service for splittail include maintaining an index of population abundance using the fall midwater trawl index equal to the 1967 through 1983 average index. Splittail will be considered restored when the fall midwater trawl index exceeds 19 for 7 out of 15 years. Splittail will be considered restored when Suisun Marsh catch per trawl exceeds 3.8 for 7 out of 15 years and when splittail young abundance exceeds 3.1 catches per trawl for at least 3 out of 15 years. Splittail will be considered restoring when Bay Study otter trawl numbers exceed 18 for 7 out of 15 years and when splittail young numbers exceed 14 for 3 out of 15 years.*		
White Sturgeon	Increase the average annual abundance of adult white sturgeon to levels that will maintain a large sport fishery	Actions in the Sacramento River Ecological Zone have been designed specifically to restore white sturgeon or their habitat. This species will directly benefit from previously described actions in this zone to increase and improve streamflows, natural sediment supply, stream channel meander, and the area and distribution of riverine aquatic habitat. These programmatic actions address: ■ Central Valley streamflows, ■ natural sediment supply, ■ stream channel meander, ■ riparian and riverine aquatic habitat, ■ contaminants, and ■ water diversions. Additional programmatic actions have been proposed in the Feather River/Sutter Basin, San Joaquin River, Sacramento-San Joaquin Delta, and Suisun Marsh/North San Francisco Bay Ecological Zones that will contribute to restoring white sturgeon.	

Category	Target	Action	Species of Benefit
	Justification: *The success of the Department of Fish and Game's white sturgeon management program is clearly indicated by comparison of present day annual numbers of fish harvested, which consistently is nearly 70% of the average commercial catch from 1875 to 1899, about 374,000 pounds. The early unregulated fishery nearly wiped out the populations in a short period of time, while the present managed sport fishery promises to yield continuous returns. The present population goals for white sturgeon are to double the white sturgeon abundance of the average 1967 to 1991 population estimates of fish older than 15 years and to maintain a population that includes at least 100,000 fish that are greater than 102 cm in length.* *Although the DFG and USFWS have set population and harvest goals, actions to accomplish the Ecosystem Restoration Program Plan (ERPP) target will be achieved by restoration actions undertaken and completed in the Sacramento River, Feather River, Sacramento-San Joaquin Delta, and Suisun Marsh/North San Francisco Bay Ecological Zones.*		
Green Sturgeon	Restore access to habitat below Keswick Dam and increase the average annual abundance of adult green sturgeon to levels that will ensure the continued existence of this species	Actions in the Sacramento River Ecological Zone have been designed specifically to restore green sturgeon, access to habitat below Keswick Dam, and habitat quality. This species will directly benefit from previously described actions in this zone to increase and improve streamflows, natural sediment supply, stream channel meander, and the area and distribution of riverine aquatic habitat. These programmatic actions address: ■ Central Valley streamflows, ■ natural sediment supply, ■ stream channel meander, ■ riparian and riverine aquatic habitat, ■ contaminants, ■ water diversions, and ■ dams, reservoirs, weirs, and other human-made structures.. Additional programmatic actions have been proposed in the Feather River/Sutter Basin, San Joaquin River, Sacramento-San Joaquin Delta, and Suisun Marsh/North San Francisco Bay Ecological Zones that will contribute to restoring green sturgeon.	

Category	Target	Action	Species of Benefit
	Justification: *Green sturgeon is a species of concern. It is a legal sport fish in California, Oregon, and Washington. The Bay-Delta system constitutes the southernmost reproducing populations of green sturgeon. There is no direct evidence that green sturgeon have declined in the Sacramento River, but the population is quite small, and a collapse could occur under some conditions. Green sturgeon require additional focused research on life history, distribution and abundance.* *The restoration goal for green sturgeon is to maintain a 50-year median population of 1,000 fish over 1 m in total length (USFWS 1996). The population abundance must not fall below 1,000 fish over 1 m in total length for more than 3 consecutive years. The 1,000 fish over 1 meter (m) in length must include 500 females over 1.3 m in length. Reduce the annual harvest rate to less than 5% of the population.* *Similar to restoration actions for white sturgeon, actions that will contribute to the protection and restoration of green sturgeon will occur in the Sacramento River, Feather River, Sacramento-San Joaquin Delta, and Suisun Marsh/North San Francisco Bay Ecological Zones.*		
Winter-run Chinook Salmon	Restore the winter-run chinook salmon spawning population to levels that ensure its continued existence and allow for sport and commercial harvest	Actions in the Sacramento River Ecological Zone have been designed specifically to restore winter-run chinook and its habitat. This species will directly benefit from previously described actions in this zone to improve or restore ecological processes and functions that create and maintain habitat and to reduce stressors that adversely affect processes, habitats, and winter-run chinook salmon directly. These programmatic actions address: ■ Central Valley streamflows, ■ natural sediment supply, ■ Central Valley water temperatures, ■ stream channel meander, ■ natural flood and floodplain processes, ■ riparian and riverine aquatic habitat, ■ water diversions, dams, reservoirs, and weirs, ■ levees, bridges, and bank protection, ■ predation and competition, ■ contaminants, ■ harvest of fish and wildlife, and ■ artificial propagation of fish. Additional programmatic actions that will contribute to the recovery of winter-run chinook salmon are proposed for the Sacramento-San Joaquin Delta, Suisun Marsh/North San Francisco Bay, and Yolo Basin Ecological Zones	

Category	Target	Action	Species of Benefit
	Justification: *The recovery of the winter-run chinook salmon requires actions to increase their abundance and improve their habitat to the point that the probability of extinction will be very low. Although artificially produced fish may be used to rebuild the population to a level that can satisfy these criteria, direct satisfaction of the criteria will depend on natural reproduction.* *The population criteria proposed to determine when winter-run chinook salmon are recovered require that mean annual spawning abundance over any 13 consecutive years shall be 10,000 females. The geometric mean of the cohort replacement rate (CRR) over the same 13 years shall be greater than 1.0. The variability in cohort replacement rate is assumed to be the same as or less than the current variability. The recovery goal also includes a provision to ensure that the population estimates are sound. The estimation criterion is that there must be a system in place for estimating spawning run abundance with a standard error of less than 25% of the estimate. If this level of precision cannot be achieved, then the sampling period over which the geometric mean of the Cohort Replacement Rate is estimated must be increased by one additional year for each 10% of additional error above 25%.* *With respect to the recovery of the Sacramento River winter-run chinook salmon, there are two genetic issues of concern: (1) the effects of past and present reductions in population size on population fitness and population growth rate and (2) the genetic consequences of meeting the delisting criteria.* *Programmatic actions that will contribute to the recovery of the winter-run chinook salmon will be implemented in the following ecological zones: Sacramento River, Sacramento-San Joaquin Delta, and Suisun Marsh/North San Francisco Bay.*		

Category	Target	Action	Species of Benefit
Fall-run Chinook Salmon	Maintain the average cohort replacement rate of Sacramento fall-run chinook salmon above 1.0 while the stock is rebuilding. Then maintain a replacement rate equal to or greater than 1.0 when the stock reaches restoration goal levels set by the regulatory agencies	Actions in the Sacramento River Ecological Zone have been designed specifically to restore fall-run chinook and its habitat. This species will directly benefit from previously described actions in this zone to improve or restore ecological processes and functions that create and maintain habitat and to reduce stressors that adversely affect processes, habitats, and fall-run chinook salmon directly. These programmatic actions address: ■ Central Valley streamflows, ■ natural sediment supply, ■ Central Valley water temperatures, ■ stream channel meander, ■ natural flood and floodplain processes, ■ riparian and riverine aquatic habitat, ■ water diversions, dams, reservoirs, and weirs, ■ levees, bridges, and bank protection, ■ predation and competition, ■ contaminants, ■ harvest of fish and wildlife, and ■ artificial propagation of fish. Additional programmatic actions that will contribute to the restoration of fall-run chinook salmon are proposed for the Sacramento-San Joaquin Delta, Suisun Marsh/North San Francisco Bay, and Yolo Basin Ecological Zones.	

Category	Target	Action	Species of Benefit
	Justification: *Because of their life-history requirements, typical of all Pacific salmon, Central Valley chinook salmon require high-quality habitats for migration, holding, spawning, egg incubation, emergence, rearing, and emigration to the ocean. These diverse habitats are still present throughout the Central Valley and are successfully maintained to varying degrees by existing ecological processes. Even though the quality and accessibility of the habitats have been diminished by human-caused actions, these habitats can be restored through a comprehensive program that strives to restore or reactivate ecological processes, functions, and habitat elements on a systematic basis, while reducing or eliminating known sources of mortality and other stressors that impair the survival of chinook salmon.* *There are three major programs to restore chinook salmon populations in the Central Valley. The Secretary of the Interior is required by the Central Valley Project Improvement Act (PL 102-575) to double the natural production of Central Valley anadromous fish stocks by 2002 (USFWS 1995). The National Marine Fisheries Service is required under the federal ESA to develop and implement a recovery plan for the endangered winter-run chinook salmon and to restore the stock to levels that will allow its removal from the list of endangered species (NMFS 1996). The California Department of Fish and Game is required under state legislation (the Salmon, Steelhead Trout and Anadromous Fisheries Program Act of 1988) to double the numbers of salmon that were present in the Central Valley in 1988 (Reynolds et al. 1993).* *Each of the major chinook salmon restoration /recovery programs has developed specific goals for Central Valley chinook salmon stocks. ERPP embraces each of the restoration/recovery goals and will contribute to each agency's program by restoring critical ecological processes, functions, and habitats, and by reducing or eliminating stressors. ERPP's approach is to contribute to managing and restoring each stock with the goal of maintaining cohort replacement rates of much greater than 1.0 while the individual stocks are rebuilding to desired levels. When the stocks approach the desired population goals, ERPP will contribute to maintaining a cohort replacement rate of 1.0.*		

Category	Target	Action	Species of Benefit
Spring-run Chinook Salmon	Maintain the average cohort replacement rate of Sacramento spring-run chinook salmon above 1.0 while the stock is rebuilding. Then maintain a replacement rate equal to or greater than 1.0 when the stock reaches restoration goal levels set by the regulatory agencies	Actions in the Sacramento River Ecological Zone have been designed specifically to restore spring-run chinook and its habitat. This species will directly benefit from previously described actions in this zone to improve or restore ecological processes and functions that create and maintain habitat and to reduce stressors that adversely affect processes, habitats, and spring-run chinook salmon directly. These programmatic actions address: ■ Central Valley streamflows, ■ natural sediment supply, ■ Central Valley water temperatures, ■ stream channel meander, ■ natural flood and floodplain processes, ■ riparian and riverine aquatic habitat, ■ water diversions, dams, reservoirs, weirs, ■ levees, bridges, and bank protection, ■ predation and competition, ■ contaminants, ■ harvest of fish and wildlife, and ■ artificial propagation of fish. Additional programmatic actions that will contribute to the restoration of spring-run chinook salmon are proposed for the Sacramento-San Joaquin Delta, Suisun Marsh/North San Francisco Bay, and Yolo Basin Ecological Zones.	
	Justification: *Spring-run chinook salmon are a candidate species under the California Endangered Species Act and is considered a sensitive species by the U.S. Forest Service. Because of their life history patterns, spring-run chinook enter the Sacramento River early in the year and ascend to tibutaries where they oversummer to spawn during the following fall. Young fish may rear for a year or longer in the tributaries before entering the Sacramento River during their seaward migration.* *The status of a spring-run chinook salmon in the mainstem Sacramento River is uncertain, however, evidence suggests that there may be a significant introgression with fall-run chinook. The role of the Sacramento River in sustaining spring-run chinook salmon is primarily to provide adult fish passage to the tributary streams and to provide rearing and emigration habitat for juveniles during their seaward migration.* *Spring-run chinook salmon populations will be considered healthy when the average number of spawners in tributary streams to the Sacramento River exceeds 5,000 fish each year over a 15-year period (five generations times 3 years per generation), with 3 of the 15 years being dry or critically dry. The average number of natural, wild spawners over the 15-year period must not be fewer than 8,000 fish (USFWS 1996).*	

Category	Target	Action	Species of Benefit
Late-fall-run Chinook Salmon	Maintain the average cohort replacement rate of late-fall-run chinook salmon above 1.0 while the stock is rebuilding. Then maintain a replacement rate equal to or greater than 1.0 when the stock reaches restoration goal levels set by the regulatory agencies	Actions in the Sacramento River Ecological Zone have been designed specifically to restore late-fall-run chinook and its habitat. This species will directly benefit from previously described actions in this zone to improve or restore ecological processes and functions that create and maintain habitat and to reduce stressors that adversely affect processes, habitats, and late-fall-run chinook salmon directly. These programmatic actions address: ■ Central Valley streamflows, ■ natural sediment supply, ■ Central Valley water temperatures, ■ stream channel meander, ■ natural flood and floodplain processes, ■ riparian and riverine aquatic habitat, ■ water diversions, dams, reservoirs, and weirs, ■ levees, bridges, and bank protection, ■ predation and competition, ■ contaminants, ■ harvest of fish and wildlife, and ■ artificial propagation of fish. Additional programmatic actions that will contribute to the recovery of late-fall-run chinook salmon are proposed for the Sacramento-San Joaquin Delta, Suisun Marsh/North San Francisco Bay, and Yolo Basin Ecological Zones.	
	Justification: *Late-fall-run chinook salmon are included in the fall-run chinook salmon ESU and are proposed for listeing as a threatened species under the ESA. The great majority of late-fall-run chinook appear to spawn in the mainstem Sacramento River during January, February, and March. Late-fall-run chinook abundance has declined due to passage problems at Red Bluff Diversion Dam, loss of habitat, poor survival of emigrating smolts, sport and commercial harvest, and other factors, such as disease and pollutants.* *Sacramento River late-fall-run chinook salmon populations will be regarded as healthy when the average number of spawners in the Sacramento River basin exceeds 15,000 fish each year over a 15-year period (five generations times 3 years per generation), with 3 of the 15 years being dry or critically dry (USFWS 1996).*		

Category	Target	Action	Species of Benefit
Steelhead Trout	Maintain the average cohort replacement rate of steelhead trout above 1.0 during the period that the species is rebuilding and then maintain a replacement rate equal to or greater than 1.0 when the species reaches restoration goals set by the regulatory agencies	Actions in the Sacramento River Ecological Zone have been designed specifically to restore steelhead or their habitat. This species will directly benefit from previously described actions in this zone to improve or restore ecological processes and functions that create and maintain habitat and to reduce stressors that adversely affect processes, habitats, and steelhead directly. These programmatic actions address: ■ Central Valley streamflows, ■ natural sediment supply, ■ Central Valley water temperatures, ■ stream channel meander, ■ natural flood and floodplain processes, ■ riparian and riverine aquatic habitat, ■ water diversions, dams, reservoirs, and weirs, ■ levees, bridges, and bank protection, ■ predation and competition, ■ contaminants, ■ harvest of fish and wildlife, and ■ artificial propagation of fish. Additional programmatic actions that will contribute to the recovery of steelhead are proposed for the Sacramento-San Joaquin Delta, Suisun Marsh/North San Francisco Bay, and Yolo Basin Ecological Zones.	

Category	Target	Action	Species of Benefit
	Justification: *NMFS has identified steelhead populations in the Central Valley as composing a single evolutionary significant unit (ESU) based on a variety of physical and biological data. These data include the physical environment (geology, soil type, air temperature, precipitation, riverflow patterns, water temperature, and vegetation); biogeography (marine, estuarine, and freshwater fish distributions); and life history traits (age at smolting, age at spawning, river entry timing, spawning timing, and genetic uniqueness).* *The Central Valley steelhead ESU encompasses the Sacramento and San Joaquin Rivers and their tributaries. Recent data from genetic studies show that samples of steelhead from Deer and Mill Creeks and Coleman National Fish Hatchery on Battle Creek are well differentiated from all other samples of steelhead from California.* *Within the broad context of ecosystem restoration, steelhead restoration will include a wide variety of efforts, many of which are being implemented for other ecological purposes, or that are nonspecific to steelhead trout. For example, restoration of riparian woodlands along the Sacramento River between Keswick Dam and Verona will focus on natural stream meander, flow, and natural revegetation/successional processes. These will be extremely important in providing shaded riverine aquatic habitat, woody debris, and other necessary habitats required by lower trophic organisms and juvenile and adult steelhead populations.* *Operation of the water storage and conveyance systems throughout the Central Valley for their potential ecological benefits can be one of the more important elements in restoring a wide spectrum of ecological resources, including steelhead trout.*		
Striped Bass	Maintain an adult population of 3.0 million adult fish	Achieving the target population of 3.0 million adult striped bass will require restoration actions in the San Joaquin River, Sacramento-San Joaquin Delta, and Sacramento River Ecological Zones. Within the Sacramento River Ecological Zone, proposed programmatic actions for Central Valley stream temperatures, Central Valley stream flow, and water diversions will contribute to restoration of striped bass.	
	Justification: *Most of the broader restoration actions for striped bass are centered in the Delta. However, the Sacramento River near Colusa is the primary spawning area for adult striped bass. A water temperature of 61°F is required to trigger striped bass spawning in the spring. Therefore, in some years it may be possible to manipulate water temperatures to reach the threshold for spawning.* *Striped bass eggs require sufficient flow velocity to keep the eggs suspended for two to three days before they hatch. Typically, flow velocity in the Sacramento River is more than adequate to maintain egg suspension.* *Very young fish (larvae and fry) are susceptible to entrainment at diversions and are not protected by positive barrier fish screens designed to protect young salmon.*		

North Sacramento Valley Ecological Management Zone

Includes

- Clear Creek
- Cow Creek
- Bear Creek
- Battle Creek

Category	Target	Action	Species of Benefit
Streamflow	Increase flow in Cow Creek by 25 to 50 cfs, corresponding to the natural seasonal runoff pattern, and maintain 25 to 75 cfs during October	Increase flow in Cow Creek by purchasing water from willing sellers or implementing a conjunctive ground-water program.	
	Increase flow in Clear Creek to 150 to 200 cfs from October 1 to May 31 and to 100 to 150 cfs from June 1 to September 30	Develop a cooperative program to improve flow in Clear Creek by increasing releases from Clair Hill Whiskeytown Dams.	
	Augment flow in Battle Creek by 25 to 50 cfs	Augment flow in Battle Creek by 25 to 50 cfs	
	Augment flow in Bear Creek by 10 to 20 cfs	Increase Bear Creek flow by purchasing water from willing sellers or providing alternative sources of water to diverters during important fish passage periods in spring and fall.	
	Justification: *The streams in the North Sacramento Valley Ecological Zone provide extremely valuable habitat for spring-run chinook salmon and steelhead trout. One of the key attributes of streamflow in this ecological zone is providing for successful upstream passage of adult fish. Water is diverted from the streams in this zone during periods that impair upstream passage conditions and prevent fish from reaching important oversummering or spawning habitats. Acquiring water from willing sellers and implementing programs to provide alternative sources of water during important periods are direct approaches to solving this problem. For example, natural flow in Bear Creek is often less than the combined water rights of diverters, resulting in total dewatering of the creek in the valley reach during critical periods for chinook salmon.*		
Natural Sediment Supply	Maintain existing levels of erosion and gravel recruitment in streams of the North Sacramento Valley Ecological unit and, where necessary, supplement gravel recruitment through adaptive management and monitoring	Cooperatively develop appropriate land use plans that allow the natural recruitment of sediments to streams in the North Sacramento Valley Ecological Zone.	

Category	Target	Action	Species of Benefit
	Increase existing levels of erosion and gravel recruitment in Clear Creek by 25 to 50 tons per year	gravel quality and quantity in lower Clear Creek to maintain high-quality spawning conditions for fall-run and late-fall-run chinook salmon by evaluating the addition of 5,000 to 10,000 cubic yards annually as needed. Evaluate the need to acquire or relocate existing mining operations. Alter McCormick Dam so that it no longer serves as a sediment trap.	
	Increase existing levels of erosion and gravel recruitment in Cow Creek by 5 to 10 tons per year	Develop a cooperative program to protect existing gravel and bedload movement in Cow Creek to maintain and increase future spawning gravel and sediment input to the Sacramento River by 5 to 10 tons per year by evaluating the need or opportunity to acquire or relocate existing gravel mining operations.	
Stream Meander	Create a more defined stream channel in the lower 8 miles of Clear Creek to facilitate fish passage	Develop a cooperative program to improve lower Clear Creek by maintaining flow connection with the Sacramento River and by regrading the channel and controlling vegetative encroachment.	
	Justification: *Gravel deposits in Clear and Cow Creeks are essential to maintaining spawning and rearing habitats of spring-run and fall-run chinook salmon, steelhead trout, and other native fishes. Whiskeytown Dam and extensive gravel extraction in the lower section of Clear Creek continue to reduce the amount of gravel transport to near zero; Cow Creek has only a limited natural supply and has been adversely affected by gravel mining in its lower reach near the Sacramento River. Although small, Cow Creek provides an important source of sediments to the Sacramento River, particularly for the 8- to 10-mile reach between its confluence with the river and the mouth of Cottonwood Creek.* *The Clear Creek stream meander belt is the area in which natural bank erosion and floodplain and sediment bar accretions occur. Natural stream meander belts in alluvial systems function dynamically to transport and deposit sediments and provide transient habitats important to algae, aquatic invertebrates, and fish, as well as surfaces that are colonized by natural vegetation that support wildlife. The flow regime in Clear Creek has recently been improved by adding supplemental water under provisions of the CVPIA. This improved flow will assist in reactivating or reestablishing the natural stream channel. Because of low flow releases from Whiskeytown Lake in the past, vegetation has encroached into the lower 3 miles of the active stream channel on Clear Creek, prevented meander, and fixed stream sediments so that they no longer contribute to sediment load or provide substrate for fish spawning.*		

Category	Target	Action	Species of Benefit
Natural Floodplain and Flood Processes	Increase and maintain the Clear Creek floodplain in conjunction with stream meander corridor restoration	Develop a cooperative program, consistent with flood control requirements, to evaluate the feasibility of altering stream channel configuration in the lower reach of Clear Creek to increase the areal extent of floodplains inundated during high flow periods.	
	Reestablish natural floodplain and stream channel meander in the lower 8 miles of Clear Creek	Acquire flood-plains by direct purchase or easement from willing sellers.	
	Justification: *Floodplain inundation is a secondary ecosystem process related to water and sediment flow through the Sacramento-San Joaquin Basin in combination with geomorphology. Floodplain inundation is the seasonal flooding of floodplain habitats, including riparian and riverine aquatic habitats. Flooding of these lands provides important seasonal habitat for fish and wildlife and provides sediment and nutrients to both the flooded lands and aquatic habitats that receive the returning or abating floodwater. The flooding also shapes the plant and animal communities in the riparian, wetland, and upland areas subject to flooding. Opportunities to restore or enhance this process are possible by changing landscape features, geomorphology, and seasonal distribution of flow volume through the system.*		
Upper Watersheds	Restore the upper watershed processes	Reduce excessive fire fuel loads in the upper watersheds	
		Improve forestry management practices, including timber harvest, road building and maintenance, and livestock grazing practices.	
		Develop a watershed management plan.	
	Justification: *Improved watershed processes will restore and maintain seasonal water runoff patterns, water yield, and water quality and reduce sediment load to downstream storage reservoirs (reducing storage capacity and improving water quality). Healthier watersheds will also provide ancillary benefits to upper watershed habitats and species.*		
Riparian and Riverine Aquatic	Develop a cooperative program to establish riparian habitat zones along streams in the North Sacramento Valley Ecological Zone through conservation easements, fee acquisition, or voluntary landowner measures	Develop a cooperative program to establish, restore, and maintain riparian habitat on Clear Creek through conservation easements, fee acquisition, or voluntary landowner cooperation.	

Category	Target	Action	Species of Benefit
		Encourage the development of long-term measures in the comprehensive watershed management plan to further improve water temperatures. Develop a cooperative approach with counties and local agencies to implement land use management that protects riparian vegetation along the streams and develop programs to restore lost riparian vegetation.	
		Cooperatively negotiate long-term agreements with local landowners to maintain and restore riparian communities along the lower reaches of Cow, Bear, and Battle Creeks.	
	Justification: *Many species of fish and wildlife in the North Sacramento Valley Ecological Zone depend on or are closely associated with riparian habitats. Of all the habitat types in California, riparian habitats support the greatest diversity of wildlife species. Degradation and loss of riparian habitat have substantially reduced the habitat area available for associated wildlife species. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions.*		
Water Diversions	Reduce or eliminate conflicts between the diversion of water and chinook salmon and steelhead populations at all diversion sites on Battle Creek	Develop a cooperative approach to improve conditions for anadromous fish in Battle Creek by installing fish screens at four diversions on the North Fork, three diversions on the South Fork, and one diversion on the mainstem, or acquire water rights to eliminate the need for diversion and screening.	
		Improve the survival of adult salmon and steelhead in Battle Creek by installing a rack at the head of Gover Diversion Canal to prevent straying.	
	Reduce or eliminate conflicts between the diversion of water and chinook salmon and steelhead populations at all diversions on Clear Creek	Acquire water rights on Clear Creek at the McCormick Dam to eliminate the need for diversion.	

Category	Target	Action	Species of Benefit
	Justification: *Diversion, storage, and release of water in the Clear and Battle Creek watersheds directly affect fish and other aquatic organisms and indirectly affect habitat, foodweb production, and species abundance and distribution. Diversions cause consumptive loss of water, nutrients, sediment, and organisms. Seasonal and daily patterns of water released from storage may affect habitat, water quality, and aquatic organism survival. In both Clear and Battle Creeks, water diversion and water diversion structures have caused direct mortality by removing juvenile fish from the population. Water diversion also reduces the quantity and quality of stream habitats and the resiliency of fish populations. Where possible, it is more desirable to acquire water rights and eliminate the diversion than to install positive-barrier fish screens.* *Coleman National Fish Hatchery receives its water supply directly from Battle Creek. Because of past incidences of disease at the hatchery, adult salmon and steelhead were blocked from ascending the creek to prevent disease contamination of the hatchery water supply. Restoring naturally spawning fish in the upper watershed will be limited until water can be supplied to the hatchery in a manner that will not contribute to disease outbreaks.*		
Dams, Reservoirs, Weirs, and Other Structures	Work with landowners and diverters on Cow Creek to reduce the adverse effects of 13 seasonal diversion dams in South Cow Creek, 10 diversion dams in Old Cow Creek, two diversion dams in North Cow Creek, and one diversion dam in Clover Creek that are barriers to migrating chinook salmon and steelhead. This would allow access to 100% of the habitat below any natural bedrock falls	Improve passage conditions on Cow Creek by acquiring water rights from willing sellers, removing diversions, or providing alternative sources of water during important periods.	
	Work with landowners and diverters on Bear Creek to reduce the adverse effects of dewatering the stream channel at seasonal diversion dams, which results in no passage for migrating chinook salmon	Improve passage and habitat conditions in Bear Creek by acquiring water rights from willing sellers, evaluating the removal of diversion dams, or providing alternative sources of water during important periods.	
	Work with landowners, diverters, and other state or federal agencies managing Battle Creek to improve fish passage	Develop a cooper-ative program to upgrade or replace existing fish ladders or evaluate the removal of diversion dams and other impediments to passage.	
	Work with landowners and diverters on Clear Creek to improve fish passage between its mouth and Whiskeytown Dam	Develop a cooperative program to improve fish passage on Clear Creek by upgrading or replacing the fish ladder at McCormick Dam.	

Category	Target	Action	Species of Benefit
	Reduce or eliminate conflicts in Battle Creek that require excluding anadromous fish from the upper section to protect the Coleman National Fish Hatchery water supply	Develop an alternative or disease-free water supply for Coleman National Fish Hatchery to allow naturally spawning salmon and steelhead access to the full 41-mile reach of Battle Creek above the Coleman National Fish Hatchery weir.	
	Justification: *Dams and their associated reservoirs block fish movement, alter water quality, remove fish and wildlife habitat, and alter hydrological and sediment processes. Fish passage in the North Sacramento Valley Ecological Zone is impaired in Clear, Cow, Bear, and Battle Creeks by a variety of permanent and seasonal dams used to divert water for irrigation or power production. Other human-made structures may block fish movement or provide habitat or opportunities for predatory fish and wildlife, which could be detrimental to fish species of special concern, such as spring-run chinook salmon and steelhead, as well as the other stocks of chinook salmon. Improved fish passage will allow anadromous fish to reach the habitat they require to oversummer or to spawn in good health, which will increase their chances of successfully spawning.*		
Land Use	Protect, restore, and maintain ecological functions and processes in the Clear, Cow, Bear, and Battle Creek watersheds by eliminating conflicts between land use practices and watershed health	Work with landowners, land management agencies, and hydropower operators to facilitate watershed protection and restoration and increase the survival of chinook salmon and steelhead in Battle, Clear, Bear, and Cow Creeks by implementing land use plans that establish, restore, and maintain riparian habitats and create buffer zones between the creek and developments or other land use activities, such as livestock grazing.	
		Develop a cooper-ative program to install 100,000 to 150,000 feet of fencing in the Cow Creek watershed to protect the riparian corridor from livestock grazing.	
	Justification: *Land uses in the North Sacramento Valley Ecological Zone stress ecosystem processes, functions, habitats, and aquatic and terrestrial organisms. Land uses that may be harmful include urban and industrial development, land reclamation, water conveyance facilities, livestock grazing, and agricultural practices. Locally developed comprehensive watershed management plans will provide the most readily usable structure to protect and restore ecological and resource values consistent with broad ecosystem restoration.*		

Cottonwood Creek Ecological Management Zone

Category	Target	Action	Species of Benefit
Streamflow	During summer and fall, more closely emulate the seasonal streamflow pattern, so that flows are sufficient for chinook salmon holding and spawning in most year types by providing up to 20 to 50 cfs. These flows can mobilize and transport sediments, allow upstream and downstream fish passage, create point bars, and contribute to stream channel meander and riparian vegetation succession	Augment summer and fall flow in Cottonwood Creek by purchasing water from willing sellers and developing alternative supplies.	
	Justification: *The streams in the Cottonwood Creek Ecological Zone provide extremely valuable habitat for spring-run chinook salmon and steelhead trout and for fall-run chinook salmon in some years. One of the key attributes of streamflow in this ecological zone is to provide for successful upstream passage of adult fish and fish spawning. In some years, flows are insufficient to provide fish passage or recede too quickly after fish spawn and expose or dewater redds containing incubating eggs or sac fry. In addition, flow in Cottonwood Creek is the power that drives many ecological functions and processes linked to stream channel morphology, sediment transport and gravel recruitment, riparian communities, and fish habitat.* *Instream flow needs on Cottonwood Creek should be subject to focused research to determine if the proposed flow increase of 20 to 50 cfs is appropriate.*		
Natural Sediment Supply	Maintain existing levels of erosion and gravel recruitment in streams in the Cottonwood Creek Ecological Zone, and provide for increasing the transport of these sediments to the Sacramento River by an average of 30,000 to 40,000 tons per year	Cooperatively develop and implement a gravel management program for Cottonwood Creek. The program would protect and maintain important ecological processes and functions related to sediment supply, gravel recruitment, and gravel cleansing and transport. This would involve working with state and local agencies and gravel operators to protect spawning gravel and enhance recruitment of spawning gravel to the Sacramento River in the valley sections of Cottonwood Creek.	
		Cooperate with the aggregate resource industry to relocate existing gravel operations on Cottonwood Creek to areas outside of the active stream channel.	

Category	Target	Action	Species of Benefit
	Repair and rehabilitate spawning gravels in 10 to 20 miles of the lower South Fork and mainstem of Cottonwood Creek	In the short term, develop a cooperative program to rip and clean or reconstruct important salmon spawning riffles on the South Fork Cottonwood Creek and on lower Cottonwood Creek below the South Fork.	
	Justification: *Gravel deposits in the lower South Fork and in the mainstem below the South Fork are essential to maintaining spawning and rearing habitats of spring-run and fall-run chinook salmon, steelhead trout, and other native fishes. Historically, Cottonwood Creek was one of the most important sources of gravel to the Sacramento River. Since Shasta Dam was completed in the 1940s, Cottonwood Creek has become the single largest contributor of sediments. Improving and maintaining sediment sources and transport capabilities of this stream are essential components necessary to restore and maintain the ecological health of the Sacramento River.* *Gravel transport is the process whereby flows carry away finer sediments that fill gravel interstices (i.e., spaces between cobbles). Gravel cleansing is the process whereby flows transport, grade, and scour gravel. Gravel transport and cleansing by flushing most of the fines and the movement of bedload (the load of material carried downstream in the streambed by flow) are important to maintaining the amount and distribution of spawning habitat in the Cottonwood Creek basin. Although these processes have been greatly reduced or altered as a result of human activities, they can be restored and maintained by changing water flow and sediment supplies, removing stressors, or directly manipulating channel features and stream vegetation. Gravel deposits in the lower South Fork and in the mainstem below the South Fork have been adversely affected by sedimentation from upstream sources in the watershed. Mechanical means will be used infrequently to free excessive quantities of fine sediments from the gravel substrates until upstream sources of sediment have been reduced or eliminated through watershed management and restoration.*		
Stream Meander	Preserve or restore the 50- to 100-year floodplain and existing channel meander characteristics of streams in the Cottonwood Creek Ecological Zone, particularly in low-gradient areas throughout the lower 20 miles where most deposition occurs and where stream channel meander is most pronounced	Cooperatively evaluate reestablishing the floodplain along the lower reach of Cottonwood Creek, and evaluate constructing setback levees to reactivate channel meander in areas presently confined by levees.	
		In the short term, develop a cooperative program to mechanically create a more defined stream channel in lower Cottonwood Creek. This would facilitate fish passage by minimizing water infiltration through the streambed and maintaining flow connectivity with the Sacramento River until natural meander returns.	
	Justification: *Stream meander belts are the area in which natural bank erosion and floodplain and sediment bar accretions occur along stream courses. Natural stream meander in Cottonwood Creek functions dynamically to transport and deposit sediments and provide transient habitats important to algae, aquatic invertebrates, and fish. Meander also creates surfaces that are colonized by natural vegetation that support wildlife. Cottonwood Creek is a nondammed tributary and a significant source of sediment to the Sacramento River. To maintain the creek's natural stream channel and fluvial dynamic processes and to provide long-term resilience for its watershed and stream channel processes in the Sacramento River, Cottonwood Creek should be fully restored and protected.*		

Category	Target	Action	Species of Benefit
Natural Floodplain and Flood Processes	Develop a cooperative program to identify opportunities to allow Cottonwood Creek to seasonally inundate its floodplain.	Conduct a feasibility study to determine means by which to increase floodplain interactions on lower Cottonwood Creek.	
		Minimize adverse effects of permanent structures such as bridges on floodplain processes.	
	Justification: *Natural functioning floodplain processes on Cottonwood Creek are equally important with stream meander and natural sediment supply. A conceptual model of these interactions needs to be developed to further understand the dynamic structure of Cottonwood Creek and to allow the design and implementation of future actions to protect and restore these important ecological functions.*		
Upper Watershed	Restore upper watershed processes	Reduce excessive fire fuel loads in upper watersheds.	
		Improve forestry management practices, including timber harvest, road building and maintenance, and livestock grazing practices.	
		Cooperatively evaluate the development of a watershed management program that could contribute to improved runoff patterns in the Upper Cottonwood Creek Ecological Unit.	
	Protect, restore, and maintain the Cottonwood Creek watershed by eliminating conflict between land use practices and watershed health	Cooperatively work with landowners and federal land management agencies to facilitate watershed protection and restoration and reduce siltation to improve holding, spawning, and rearing habitats for salmonids.	
		Develop a cooperative program to implement improved fencing, grazing, and other land management practices on private and national forest lands, and encourage local counties to adopt stronger grading and road building ordinances to control erosion.	

Category	Target	Action	Species of Benefit
	Justification: *Resolving conflicts regarding land use in the Cottonwood Creek Ecological Zone must stress ecosystem processes and functions, habitats, and aquatic and terrestrial organisms. Land use activities that may be harmful include urban and industrial development, land reclamation, water conveyance facilities, livestock grazing, and agricultural practices.* *Improved watershed processes will maintain and restore seasonal water runoff patterns, water yield, and water quality and reduce sediment load to downstream storage reservoirs (reducing storage capacity and improving water quality). Healthier watersheds will also provide ancillary benefits to upper watershed habitats and species.*		
Riparian and Riverine Aquatic Habitats	Develop a cooperative program to establish a continuous 130-mile riparian habitat zone along upper and lower Cottonwood Creek and its tributaries through conservation easements, fee acquisition, or voluntary landowner measures	Develop a cooperative program to establish, restore, and maintain riparian habitat on Cottonwood Creek through conservation easements, fee acquisition, or voluntary landowner cooperation.	
		Encourage the development of long-term measures in the comprehensive watershed management plan to further improve water temperatures. Develop a cooperative approach with counties and local agencies to implement land use management to protect riparian vegetation along the streams. Develop programs to restore lost riparian vegetation.	
		Cooperatively negotiate long-term agreements with local landowners to maintain and restore riparian communities along the lower reaches of Cottonwood Creek.	
	Justification: *Many species of wildlife in the Cottonwood Creek watershed depend on or are closely associated with riparian habitats. Of all the habitat types in California, riparian habitats support the greatest diversity of wildlife species. Degradation and loss of riparian habitat have substantially reduced the habitat area available for associated wildlife species. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions.*		

Colusa Basin Ecological Management Zone

This zone includes:

- Stony Creek
- Elder Creek
- Thomes Creek
- Colusa Basin.

Category	Target	Action	Species of Benefit
Streamflow	Maintain the existing seasonal runoff patterns that mobilize and transport sediments, allow upstream and downstream resident fish passage, and contribute to riparian vegetation succession.	Refer to programmatic actions listed under Upper Watershed Health.	
	Justification: *Colusa Basin Ecological Zone streams provide several features that are important within the ecological zone and for adjacent zones. Major ecological processes and functions that are driven by flow include gravel recruitment, transport, deposition, and cleansing. Stony, Thomes, and Elder creeks can provide sediment for transport to the Sacramento River and habitat in the Sacramento River for chinook salmon and other aquatic species. Maintaining and improving the ecological health of streams in the Colusa Basin Ecological Zone will require maintaining existing runoff patterns and eliminating other stressors such as invasive exotic plants (arundo and tamarisk) that constrain ecological processes.*		
Natural Sediment Supply	Maintain the sediment available for transport during storms and seasonal flow events in Thomes Creek	Maintain sediment transport in Thomes Creek by continuing to monitor aggregate extraction activities to ensure sediment is available for delivery to the Sacramento River.	
	Maintain the quantity of sediment transported from Elder Creek to the Sacramento River	Maintain sediment transport in Elder Creek by continuing to monitor aggregate extraction activities to ensure sediment is available for delivery to the Sacramento River	
	Justification: *Sand and gravel extraction activities on the streams in the Colusa Basin Ecological Zone are conducted in compliance with local and state regulations. The tributaries are important sediment sources for the Sacramento River. Sediments contribute to several important ecological functions and are required for specific habitats, particularly chinook salmon and steelhead habitats. Black Butte Dam on Stony Creek has eliminated natural gravel recruitment to the lower stream reach. The feasibility of protecting Stony Creek, its stream and riparian corridor, and its contribution of sediment to the Sacramento River should be evaluated.*		

Category	Target	Action	Species of Benefit
Natural Floodplain and Flood Processes	Establish a desirable sediment deposition level in the Colusa Basin	Improve the Colusa Basin sediment deposition capacity by working with local landowners to develop an integrated plan consistent with flood-control requirements.	
	Justification: *Floodplain processes include the natural floodwater and sediment detention and retention process whereby flows and sediment are retained within the floodplains. Retaining and detaining water and sediment in basin floodplains are controlled primarily by flow patterns and channel geomorphology, and secondarily by soils and plant communities.*		
Upper Watersheds	Develop locally initiated programs to restore upper watershed processes	Reduce excessive fire fuel loads in upper watersheds.	
		Improve forestry management practices, including practices relating to timber harvest, road building and maintenance, and livestock grazing.	
		Develop a watershed management plan for Thomes Creek.	
		Develop a watershed management plan for Elder Creek.	
		Develop a watershed management plan for Stony Creek.	
	Justification: *Improved watershed processes will maintain and restore seasonal runoff patterns, water yield, and water quality and reduce sediment load to downstream storage reservoirs (reducing storage capacity and improving water quality). Healthier watersheds will also provide ancillary benefits to upper watershed habitats and species.*		
Riparian and Riverine Aquatic Habitats	Protect and maintain riparian vegetation along Stony Creek, Elder Creek, and the Colusa Basin Ecological Unit channels and sloughs where possible. This will provide cover and other essential habitat requirements for native resident fish species and wildlife	Develop a cooperative program to protect or rehabilitate riparian vegetation, where possible.	
	Justification: *Healthy riparian corridors along creeks, sloughs, and channels, including those in the Colusa Basin Ecological Unit, provide essential cover, shade, and food for spawning, rearing, and migrating native resident fishes, and a wide variety of wildlife, neotropical birds, and other terrestrial species.*		

Category	Target	Action	Species of Benefit
Contaminants	Reduce the adverse effects of herbicides, pesticides, fumigants, and other agents that are toxic to fish and wildlife in the Colusa Basin Ecological Zone	Work with local agricultural interests and water districts implement and evaluate a contaminant effects study.	
	Justification: *Contaminants from point and nonpoint sources affect water quality and survival of fish, waterfowl, and the aquatic foodweb. Contaminants may cause severe toxicity and organism mortality or long-term, low-level toxicity that affects species' health and reproductive success.*		
Invasive Riparian Plants	Eradicate arundo and tamarisk in watersheds where they have only small population, then concentrate on eradicating satellite populations extending beyond major infestations, and finally, reduce and eventually eliminate the most extensive populations.	Develop a cooperative pilot study to control arundo (false bamboo) and tamarisk (salt cedar) in streams within the Colusa Basin Ecological Zone.	
	Justification: *Invasive riparian and salt marsh plants have become sufficiently established in some locations to threaten the health of the Bay-Delta ecosystem. The riparian and salt marsh plants that pose the greatest threats to aquatic ecosystems are those that directly or indirectly affect rare native species, decrease foodweb productivity, and reduce populations of desired fish and wildlife species.* *Factors that relate to the degree of influence invasive riparian and salt marsh plants have on the Bay-Delta include additional introductions from gardens and other sources, and ground disturbances and hydrologic regimes that create favorable conditions for their establishment.* The effects of arundo's ability to alter ecosystem processes may be profound. It is far more susceptible to fire than native riparian species. *However, although it recovers from fires, most native vegetation does not, leading to increased postfire dominance by arundo. By increasing sedimentation after establishing in stream channels, arundo stabilizes islands, hinders braiding and shifting patterns in stream channel movement, and prevents native stream channel vegetation from establishing. An example of this can be seen at Stony Creek in northern California. Because arundo has a vertical structure, it does not overhang water like native riparian vegetation. The result is less shade over water, providing less cover, increased water temperatures, and altered water chemistry, all conditions that can harm fish and other existing aquatic organisms and ultimately change the aquatic species composition.* *Tamarisk is widespread in California rivers; however, an accurate assessment of the extent and rate of spread of the weed is unknown. Like arundo, more survey mapping is needed to determine the extent of tamarisk, the levels of threat posed by the weed, the best time to safely control it, and a prioritized strategy for removing it.*		

Butte Basin Ecological Management Zone

This zone includes:

- Paynes Creek
- Antelope Creek
- Mill Creek
- Deer Creek
- Big Chico Creek
- Butte Creek
- Butte Sink.

Category	Target	Action	Species of Benefit
Streamflow	Increase spring and fall flow in Paynes Creek	Develop a cooperative approach to increase flow in Paynes Creek by acquiring water from willing sellers or by developing alternative supplies.	
	Increase flow in Antelope Creek during October 1 through June 30	Develop a cooperative approach to increase flow in Antelope Creek. This involves acquiring water from willing sellers or providing alternative water supplies to diverters during the upstream and downstream migration of adult and juvenile spring- and fall-run chinook salmon and steelhead trout.	
	Increase the flow in Mill Creek	Develop a cooperative approach to increase flow in the lower 8 miles of Mill Creek. This involves acquiring water from willing sellers or by providing alterative water supplies to diverters during the upstream migration of adult salmon and steelhead.	
	Increase flow in the lower 10 miles of Deer Creek	Develop a cooperative approach to increase flow in the lower section of Deer Creek. This involves innovative means to provide alternative supplies during the upstream migration of adult spring-run and fall-run chinook salmon and steelhead trout.	
	Increase flow in Butte Creek	Develop a cooperative approach to increase flow in Butte Creek by acquiring water from willing sellers.	

Category	Target	Action	Species of Benefit
	Maintain a minimum year-round flow of 40 cfs in Butte Creek between the Centerville Diversion Dam and the Centerville Powerhouse	Develop a cooperative program with PG&E to maintain a minimum flow in Butte Creek below the Centerville Diversion Dam.	
	Justification: *The streams in the Butte Basin Ecological Zone provide extremely valuable habitat for spring-run chinook salmon and steelhead trout. One of the key attributes of streamflow in this ecological zone is providing for successful upstream passage of adult fish. In addition, flow is the power that drives many ecological functions and processes linked to stream channel morphology, riparian communities, and fish habitat. Many of the diversions on these streams are for agricultural purposes, and alternative water supplies during important periods could permit flow to remain in the creek while alternative sources are provided. The lower watersheds of many of these streams are being subdivided, and additional demands are being placed on the limited water supplies and instream flows. Two important periods are during the upstream migration of adult spring-run chinook salmon and the downstream migration of yearling spring-run chinook salmon and steelhead, which typically occurs in late winter and early spring. Water diversions often shorten the migration season, when streamflows naturally decline. This is the period when supplemental or alternative water supplies could be best used.*		
Natural Sediment Supply	Develop a cooperative program to replenish spawning gravel in Big Chico Creek. Especially target stream reaches that have been modified for flood control so that there is no net loss of sediments transported through the Sycamore, Lindo Channel, and Big Chico Creek split	Assist in the redesign and reconstruct the flood control box culvert structures on Big Chico Creek near the Five-Mile Recreation Area to allow the natural downstream sediments transport	
	Develop a cooperative program to improve fall-run chinook salmon spawning habitat in the lower 8 miles of Mill Creek	Develop a cooper-ative program to improve chinook salmon spawning habitats in lower Mill Creek by reactivating and maintaining natural sediment transport processes.	
	Improve spawning gravel and gravel availability in Butte Creek	Develop a cooper-ative program to improve spawning habitat in Butte Creek by maintaining natural sediment transport processes.	
	Justification: *Gravel transport and deposition processes in Butte Basin Ecological Zone streams are essential. These processes maintain spawning and rearing habitats of spring-run and fall-run chinook salmon, steelhead trout, and other native fishes. Opportunities to maintain and restore gravel recruitment are possible by manipulating natural processes and controlling or managing environmental stressors that adversely affect gravel recruitment.*		

Category	Target	Action	Species of Benefit
Stream Meander	Preserve or restore the 50- to 100-year floodplains along the lower reaches of streams in the Butte Basin Ecological Zone, and construct setback levees to reactivate channel meander in areas presently confined by levees	Cooperatively evaluate whether a more defined stream channel in the lower 10 miles of Antelope Creek would facilitate fish passage by minimizing water infiltration through the streambed and maintaining flow connection with the Sacramento River.	
	Justification: *Stream meander belts are the areas in which natural bank erosion and floodplain and sediment bar accretions occur along streams. Natural stream meander belts in alluvial areas of the Butte Basin Ecological Zone function dynamically. They transport and deposit sediments and provide transient habitats important to aquatic invertebrates and fish. They also provide and maintain surfaces that are colonized by natural vegetation that supports wildlife. The lower valley stream reaches in this ecological zone serve as important migratory corridors to the upper watersheds for spring-run chinook salmon and steelhead and provide spawning substrate for fall-run chinook salmon.*		
Upper Watersheds	Restore upper watershed processes	Reduce excessive fire fuel loads in upper watersheds.	
		Improve forestry management practices, including timber harvest, road building and maintenance, and livestock grazing practices.	
		Develop a watershed management plan.	
	Justification: *Improved watersheds processes will maintain and restore seasonal water runoff patterns, water yield, and water quality and reduce sediment load to downstream storage reservoirs (reducing storage capacity and improving water quality). Healthier watersheds will also provide ancillary benefits to upper watershed habitats and species.*		
Riparian and Riverine Aquatic Habitat	Develop a cooperative program to restore and maintain riparian habitat along the lower 10 miles of Mill Creek	Develop a cooperative program to restore and maintain riparian habitat along Mill Creek by acquiring conservation easements or by voluntary landowner participation.	
	Develop a cooperative program to restore and maintain riparian habitat along the lower 10 miles of Deer Creek	Develop a cooperative program to restore and maintain riparian habitat along Deer Creek by acquiring conservation easements or by voluntary landowner participation.	
	Develop a cooperative program to restore and maintain riparian habitat along Big Chico Creek	Cooperate with local landowners to encourage revegetation of denuded stream reaches and to establish, restore, and maintain riparian habitat on Big Chico Creek.	

Category	Target	Action	Species of Benefit
	Develop a cooperative program to restore and maintain riparian habitat along Butte Creek	Cooperate with local landowners to encourage revegetation of denuded stream reaches and to establish, restore, and maintain riparian habitat on Butte Creek.	
	Justification: *Many wildlife species, including several listed as threatened or endangered under the State and federal Endangered Species Acts (ESAs), and several special-status plant species in the Central Valley, depend on or are closely associated with riparian habitats. Riparian habitats support a greater diversity of wildlife species than all other habitat types in California. Riparian habitat degradation and loss have substantially reduced the habitat area available for associated wildlife species. This habitat loss has reduced water storage, nutrient cycling, and foodweb support functions.*		
Water Diversions	Improve the survival of chinook salmon and steelhead in Butte Creek by helping to install positive-barrier fish screens	Improve the survival of juvenile chinook salmon and steelhead in Butte Creek by helping to the install screened portable pumps as an alternative to the Little Dry Creek diversion.	
		Increase the survival of juvenile chinook salmon and steelhead in Butte Creek by helping local interests to install positive-barrier fish screens at the Durham-Mutual Diversion Dam.	
		Increase the survival of juvenile chinook salmon and steelhead in Butte Creek by helping local interests to install positive-barrier fish screens at Adams Dam.	
		Increase the survival of juvenile salmon and steelhead in Butte Creek by helping local interests to install positive-barrier fish screens at Gorrill Dam.	
		Increase the survival of juvenile salmon and steelhead in Butte Creek by evaluating the need to install a positive-barrier fish screen at White Mallard Dam.	
		Increase the survival of juvenile salmon and steelhead in the Sutter Bypass by evaluating the need to install positive barrier fish screens on diversions	
	Justification: *Diverting, storing, and releasing water in the watershed directly affects fish, aquatic organisms, and nutrient levels in the system and indirectly affects habitat, foodweb production, and species abundance and distribution. Diversions cause water, nutrient, sediment, and organism losses. Seasonal and daily water release patterns from storage may affect habitat, water quality, and aquatic organism survival. Flood control releases into bypasses also cause adult and juvenile fish stranding.*		

Category	Target	Action	Species of Benefit
Land Use	Protect, restore, and maintain ecological functions and processes that create habitats for species that depend on the Delta, and reduce or eliminate stressors that impair their survival	Develop a cooperative program with landowners, land management agencies, and hydropower operators to facilitate watershed protection and restoration. The program would increase the survival of chinook salmon and steelhead in Paynes, Antelope, Mill, Deer, Big Chico, and Butte Creeks by implementing land use plans. These would establish, restore, and maintain riparian habitats and create buffer zones between the creek and developments or other land use activities, such as livestock grazing.	
	Justification: *Land use in the Butte Basin Ecological Zone may stress ecosystem processes, functions, habitats, and aquatic and terrestrial organisms. Land use activities that may be harmful include urban and industrial development, land reclamation, water conveyance facilities, livestock grazing, and agricultural practices. Locally developed comprehensive watershed management plans will provide the most readily usable structure to protect and restore ecological and resource values consistent with broad ecosystem restoration.*		
Dams, Reservoirs, Weirs, and Other Structures	Improve chinook salmon and steelhead survival in Antelope Creek by developing a cooperative program to reduce the use of seasonal diversion dams by 50% during the late spring, early fall, and winter	Develop a cooperative program to evaluate the reduced use of seasonal diversion dams that may be barriers to migrating chinook salmon and steelhead in Antelope Creek by acquiring water rights or providing alternative sources of water	
	Develop a cooperative program to improve the upstream passage of adult chinook salmon and steelhead in Big Chico Creek by providing access to 100% of habitat located below natural barriers	Repair or reconstruct the fish ladders in Big Chico Creek to improve the upstream passage of adult spring-run chinook salmon and steelhead trout.	
		Repair the Lindo Channel weir and fishway at the Lindo Channel box culvert at the Five Mile Diversion to improve upstream fish passage.	
	Develop a cooperative approach to ensure unimpeded upstream passage of adult spring-run chinook salmon and steelhead in Mill Creek	Cooperatively develop and implement an interim fish passage corrective program at Clough Dam on Mill Creek until a permanent solution is developed cooperatively with the landowners.	

Category	Target	Action	Species of Benefit
	Develop a cooperative program to improve the upstream passage of adult spring-run chinook salmon and steelhead in Butte Creek to allow access to 100% of the habitat below the Centerville Head Dam	Increase the opportunity for the successful upstream passage of adult spring-run chinook salmon and steelhead on Butte Creek by developing a cooperative program to evaluate the feasibility of removing diversion dams, providing alternative sources of water, or constructing new high-water-volume fish ladders.	
		Improve chinook salmon and steelhead survival and passage in Butte Creek by cooperatively developing and evaluating operational criteria and potential modifications to the Butte Slough outfall.	
		Increase chinook salmon survival in Butte Creek by cooperatively helping local interests to eliminate stranding at the drainage outfalls in the lower reach.	
	Justification: *Dams and their associated reservoirs block fish movement, alter water quality, remove fish and wildlife habitat, and alter hydrological and sediment processes. Other human-made structures may block fish movement or provide habitat or opportunities for predatory fish and wildlife, which could be detrimental to fish species of special concern.*		

Feather River/Sutter Basin Ecological Management Zone

This zone includes:

- Feather River
- Yuba River
- Bear River
- Honcutt Creek
- Sutter Bypass.

Category	Target	Action	Species of Benefit
Streamflow	More closely emulate the seasonal streamflow pattern in the Feather River by providing March flow events of 4,000 to 6,000 cfs in dry years, 6,000 to 8,000 cfs in below-normal years, and 8,000 to 10,000 cfs in above-normal years. Provide or maintain flows that mobilize and transport sediments, allow upstream and downstream fish passage, create point bars, and contribute to stream-channel meander and riparian vegetation succession. In addition, provide minimum flows recommended by DFG (1993). Flows will be provided only if they are less than or equal to Oroville Reservoir inflow	Develop a cooperative program to evaluate the benefits of supplemental Feather River flows to ecological processes and riparian and riverine aquatic habitats.	
	Evaluate the potential benefits to increased salmon and steelhead production in the Feather River of releasing 2,500 cfs from Oroville Dam during September through May and 1,100 cfs during June through August in wet and normal years, and 1,700 cfs during September through May and 800 cfs during June through August in dry years	Develop a cooperative program to supplement Feather River flows with water acquired from new water sources, water transfers, and willing sellers in accordance with applicable guidelines or negotiated agreements.	

D-059249

Category	Target	Action	Species of Benefit
	Supplement flows in the Yuba River with March flow events of 2,000 to 3,000 cfs in dry years and 3,000 to 4,000 cfs in normal years to improve conditions for all chinook salmon, steelhead, and American shad life stages. In addition, provide minimum flows recommended at Marysville by DFG (1993). See table below. Flows will be provided only if inflow to Englebright and New Bullards Bar Reservoirs is sufficient to meet the flow requirements	Supplement flows in the Yuba River below Englebright Dam with water acquired from new water sources, water transfers, and willing sellers, consistent with applicable guidelines or negotiated agreements to provide flows recommended by DFG (1993) to improve conditions for all of chinook salmon and steelhead life stages.	
	Supplement flows in the Bear River to improve conditions for all chinook salmon and steelhead life stages. Provide a flow event of 300 to 500 cfs in dry years. See table below for recommended minimum streamflows	Supplement flows in the Bear River with water acquired from new water sources, water transfers, and willing sellers consistent with applicable guidelines or negotiated agreements to provide flows that will improve conditions for all chinook salmon and steelhead life stages.	
	Justification: *The streams in the Feather River/Sutter Basin Ecological Zone provide extremely valuable habitat for spring-run chinook salmon and steelhead trout. Key benefits of streamflow in this ecological zone are successful upstream of adult fish passage and downstream passage of juvenile fish. In addition, flow drives many ecological functions and processes linked to stream-channel morphology, riparian communities, and fish habitat.* *Supplementing flows on the Yuba River by acquisition of water from willing sellers depends on whether or not there are any willing sellers. Findings from a detailed hydrologic and operations assessment of the Yuba River system to develop water-year-type-specific instream flow recommendations indicate that, with the exception of wet years, insufficient water would be available within the system to always meet the recommended flows (Beak 1996). In years when flow augmentation is required, a decision will have to be made regarding use of acquired water in the spring to either meet DFG's recommendation of 1,000 cfs at Marysville during the April-June period, or to use this water to 1) provide higher flows and , therefore, greater thermal protection to steelhead during July-September, or 2) supplement flows during the October-December period to benefit fall-run chinook salmon spawning.* *Studies conducted in the lower Yuba River during 1976-1978 revealed that the lower Yuba River is not a season-long nursery area for American shad (Meinze 1979). That may reflect drought condition during part of the study period but the study did reveal that newly hatched shad fry are rapidly transported downstream and into the Feather River. Larvae are swept out by currents before they grow large enough to maintain their position in the river. Juvenile shad spend several weeks to several months in the Feather and Sacramento rivers and in the Delta, which is considered the primary rearing habitat for American shad (Painter et al. 1977, Painter et al. 1979, Meinze 1979, SWRCB 1992). Consequently, higher spring flows in the lower Yuba River may provide minimal increased benefits for young shad.*	

Category	Target	Action	Species of Benefit
Natural Sediment Supply	Maintain existing erosion and gravel recruitment levels in tributaries that sustain an adequate level of gravel recruitment, or restore desirable levels by directly manipulating and augmenting gravel supplies where the natural fluvial process has been interrupted by dams or other features that retain or remove the gravel supply	Evaluate spawning gravel quality in areas used by chinook salmon in the Feather River. If indicated, renovate or supplement gravel supplies to enhance substrate quality by importing 4,000 to 8,000 tons of additional gravel below the hatchery as conditions require.	
		Evaluate spawning gravel quality in areas used by chinook salmon in the Yuba River. If indicated, renovate or supplement gravel supplies to enhance substrate quality	
		Evaluate the quality of spawning gravel in areas used by chinook salmon in the Bear River. If indicated, renovate or supplement gravel supplies to enhance substrate quality	
	Justification: *Gravel transport is the process whereby flows carry away finer sediments that fill gravel interstices (i.e., spaces between cobbles). Gravel cleansing is the process whereby flows transport, grade, and scour gravel. Gravel transport and cleansing, by flushing most fines and moving bedload, are important processes to maintain the amount and distribution of spawning habitat in the Sacramento-San Joaquin River basin. Human activities have greatly reduced or altered these processes. Opportunities to maintain and restore these processes include changing water flow, sediment supplies, and basin geomorphology; removing stressors; or manipulating channel features and stream vegetation directly. Gravel deposits in Feather River/Sutter Basin Ecological Zone streams are essential to maintain spring- and fall-run chinook salmon, steelhead trout, and other resident native fish spawning and rearing habitats. Opportunities to maintain and restore gravel recruitment include manipulating natural processes and controlling or managing environmental stressors that adversely affect recruitment.*		
Stream Meander	Preserve and expand the stream-meander belts in the Feather, Yuba, and Bear Rivers by adding a cumulative total of 1,000 acres of riparian lands to the meander zones	Acquire riparian and meander-zone lands by purchasing them directly or acquiring easements from willing sellers, or provide incentives for voluntary efforts to preserve and manage riparian areas on private land.	
		Build local support for maintaining active meander zones by establishing a mechanism whereby property owners would be reimbursed for lands lost to natural meander processes.	
		Develop a cooperative program to improve opportunities for natural meander by removing riprap and relocating other structures that impair stream meander.	

Category	Target	Action	Species of Benefit
	Justification: *Preserving and improving the stream-meander belts in the Feather River/Sutter Basin Ecological Zone will ensure that this important natural process is maintained. Typically, these reaches are important for spawning and rearing salmon and steelhead. A natural meander process will provide near-optimal habitat for spawning (through gravel recruitment), rearing (channel configuration, cover, and foodweb), and migration. There is limited potential for natural channel migration in narrowly leveed sections. Overall, the program must be consistent with flood control requirements and in the longer term, should reduce need for future flood control efforts by using natural system resilience and flood control characteristics.*		
Natural Floodplain and Flood Processes	Restore and improve opportunities for rivers to seasonally flood their floodplain	Conduct a feasibility study to construct setback levees in the Feather, Yuba, and Bear lower river floodplains.	
		Restore, as needed, stream channel and overflow basin configurations within the floodplain.	
		Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes.	
		Develop a floodplain management plan for the Feather River.	
		Develop a floodplain management plan for the Yuba River.	
		Develop a floodplain management plan for the Bear River.	
		Develop a floodplain management plan for the Sutter Basin and Sutter Bypass.	
	Justification: *Setback levees will provide greater floodplain inundation, room for stream meander, and more riparian forest and seasonal wetland habitats along the lower rivers. Channel configuration adjustments may be necessary to accelerate natural floodplain habitat restoration and to restore and maintain configurations that may not occur naturally due to remaining constraints from new setback levees. Permanent structures, such as bridges and diversions dams, can interrupt and impair natural floodplain processes and habitat development and succession. Thus, it may be necessary to remove or rebuild some structures or require continuing maintenance or mitigations to minimize their effects.*		
Stream Temperatures	Improve water quality conditions in the Feather, Yuba, and Bear Rivers to benefit anadromous fish	Develop and use a temperature model as a tool for managing the Feather River.	

Category	Target	Action	Species of Benefit
		Develop a cooperative program to identify and remove physical and water quality barriers in the Feather River that impede access for white and green sturgeon to spawning habitat, or facilitate passage around these barriers.	
		Develop a cooperative approach to operating reservoirs in the Yuba River watershed to provide adequate water temperatures for anadromous fish.	
		Develop a cooperative program to maintain mean daily water temperatures below 65°F for at least 1 month from April 1 to June 30 for American shad spawning in the Feather River. This is consistent with actions to protect chinook salmon and, steelhead and, when hydrologic conditions are adequate, to minimize adverse effects on water-supply operations.	
		Evaluate whether improving water temperature control with shutter configuration and present coldwater pool management at New Bullards Bar Dam on the Yuba River are effective. Modify the water release outlets at Englebright Dam if these improvements are effective.	
		Develop a cooperative program to maintain mean daily water temperatures below 65°F for at least 1 month from April 1 to June 30 for American shad spawning in the Yuba River. This is consistent with actions to protect chinook salmon and steelhead and, when hydrologic conditions are adequate, to minimize adverse effects on water-supply operations.	
		Develop a cooperative approach to providing adequate water temperatures in the Bear River (see table below) for all chinook salmon and steelhead life stages.	

Category	Target	Action	Species of Benefit
	Justification: *Aquatic species have very specific water temperature requirements that vary by stage in their life cycles. Water temperatures are typically high during the late summer and early fall, when water management flexibility below the major reservoirs is typically limited. Water temperatures should be addressed through integrated water and temperature management programs that seek to conserve cool water reservoir pools for release later in the summer.* *Operating to provide specific water temperatures at the appropriate times in systems where aquatic resources have differing temperature requirements can be difficult. In situations where water temperature requirements may conflict, water temperature operations should first address the needs of native species and then introduced species. On the Feather and Yuba rivers, the water temperature requirements of anadromous salmonids (chinook salmon and steelhead) have priority. After their temperature needs are met, then the temperature requirements of American shad can be addressed.*		
Upper Watersheds	Restore upper watershed processes	Reduce excessive fire fuel loads in upper watersheds.	
		Improve forest management practices, including practices relating to timber harvest, road building and maintenance, and livestock grazing.	
		Develop a watershed management plan.	
	Justification: *Improving watershed processes will maintain and restore seasonal runoff patterns, water yield, and water quality and reduce sediment load to downstream storage reservoirs (consequently reducing storage capacity and improving water quality). Healthier watersheds will also benefit upper watershed habitats and species.*		
Riparian and Riverine Aquatic Habitat	Provide conditions for riparian vegetation growth along river sections in the Feather River/Sutter Basin Ecological Zone	Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Yuba River.	
		Evaluate the benefits of restoring stream-channel and riparian habitats on the Yuba River, including creating side channels to serve as spawning and rearing habitats for salmonids.	
		Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Feather River.	
		Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Bear River.	

Category	Target	Action	Species of Benefit
	Justification: *Many wildlife species, including several listed as threatened or endangered under the State and federal Endangered Species Acts and several special-status plant species in the Central Valley, depend on or are closely associated with riparian habitats. Riparian habitats support a greater wildlife species diversity than all other habitat types in California. Riparian habitat degradation and loss has substantially reduced the habitat area available for associated wildlife species. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions.* *Improving low- to moderate-quality shaded riverine aquatic habitat will benefit juvenile chinook salmon and steelhead by improving shade, cover, and food. Wildlife in this ecological zone will also benefit from improved habitat. Protecting and improving shaded riverine aquatic habitat may involve changes in land use that will require the consensus of local landowners and local, State, and federal agencies. Limitations on land suitable or available for restoration will require establishing priorities, with efforts directed at acquiring high-priority, low-cost sites first.*		
Water Diversions	Improve the survival of juvenile anadromous fish in the Yuba River by installing, upgrading, or replacing fish screens	Develop a cooperative program to improve screening device efficiency in the Yuba River at the Hallwood-Cordua water diversion, and construct screens at the Brown's Valley water diversion and other unscreened diversions.	
		Evaluate the need to improve the efficiency of the fish-screening device and bypass at the Brophy-South Yuba Diversion on the Yuba River.	
	Improve the survival of juvenile anadromous fish in the Bear River by installing, upgrading, or replacing fish screens	Develop a cooperative program to evaluate and screen diversions in the Bear River to protect all anadromous fish life stages.	
	Improve the survival of juvenile anadromous fish in the Feather River by installing, upgrading, or replacing fish screens	Develop a cooperative program to evaluate and screen diversions in the Feather River to protect all anadromous fish life stages.	
	Justification: *Water diversion, storage, and release in the watershed directly affect fish, aquatic organisms, and nutrient levels in the system and indirectly affect habitat, foodweb production, and species abundance and distribution. Unscreened diversions cause direct mortality to young fish; the level of mortality is likely influenced by the number of young fish present, diversion size, and diversion timing.*		

Category	Target	Action	Species of Benefit
Dams, Reservoirs, Weirs, and Other Structures	Increase adult and juvenile anadromous fish passage in the Yuba River by providing access to 100% of the available habitat below Englebright Dam	Develop a cooperative program to improve anadromous fish passage in the Yuba River by removing dams or constructing fish ladders, providing passage flows, keeping channels open, eliminating predator habitat at instream structures, and constructing improved fish bypasses at diversions.	
		Facilitate passage of spawning adult salmonids in the Yuba River by maintaining appropriate flows through the fish ladders or modifying the fish ladders at diversion dams.	
		Conduct a cooperative study to determine the feasibility of removing Englebright Dam on the Yuba River to allow chinook salmon and steelhead access to historical spawning and rearing habitats.	
	Improve chinook salmon and steelhead passage in the Bear River by providing access to 100% of the available habitat below the SSID diversion dam	Improve chinook salmon and steelhead passage in the Bear River by negotiating with landowners to remove or modify culvert crossings on the Bear River.	
	Justification: *Dams and their associated reservoirs block fish movement, alter water quality, remove fish and wildlife habitat, and alter hydrologic and sediment processes. Other structures may block fish movement or provide habitat or opportunities for predatory fish and wildlife, which could be detrimental to fish species of special concern.*		
Land Use	Protect, restore, and maintain ecological functions and processes in the Feather, Yuba, and Bear River watershed by eliminating conflicts between land use practices and watershed health	Work with landowners, land management agencies, and hydropower facility operators to protect and restore the watershed.	
		Work with landowners, land management agencies, and hydropower facility operators to increase chinook salmon and steelhead survival in the Feather, Yuba, and Bear Rivers and the Sutter Basin. Implement land use plans that establish, restore, and maintain riparian habitats and create buffer zones between the streams and developments or other land use activities, such as livestock grazing	

Category	Target	Action	Species of Benefit
	Justification: *Land use in the Feather River/Sutter Basin Ecological Zone may stress ecosystem processes, functions, habitats, and aquatic and terrestrial organisms. Potentially harmful land use include urban and industrial development, land reclamation, construction and use of water-conveyance facilities, livestock grazing, and agricultural practices. Locally developed, comprehensive watershed management plans will provide the most readily usable structure for protecting and restoring ecological and resource values consistent with broad ecosystem restoration.*		

American River Basin Ecological Management Zone

This zone includes:

- American Basin
- Lower American River.

Category	Target	Action	Species of Benefit
Streamflow	Develop and implement an ecologically based streamflow regulation plan for the American Basin creeks and lower American River. The lower American River should meet the recommended minimum flows and flow targets for the lower American River. Lower American River flow events should be coordinated with similar flows that occur naturally in the Sacramento Valley and with storage releases from Shasta and Oroville Reservoirs	Provide target flows by modifying CVP operations and acquiring water as needed from willing sellers, with consideration given to reservoir available carryover storage and flows needed to meet needs determined by the water temperature objective	
		Develop and implement a comprehensive watershed management plan for the American Basin and lower American River to protect the channel (e.g., maintain flood control capacity and reduce bank erosion) and preserve and restore the riparian corridor. Upper watershed health should be improved by reducing the potential for wildfire and implementing other watershed improvement practices to protect streamflows, stream channel morphologies, spawning gravel condition, and riparian habitats, and minimize sediment input to the stream.	
		Acquire water from willing sellers to augment river flow during dry years to provide fishery benefits.	
	Minimize flow fluctuations below Nimbus Dam that can dewater salmonid redds and reduce survival of juvenile anadromous fishes from stranding and/or isolation from the main channel	Complete on-going collaborative efforts to develop flow ramping criteria and operationally implement these criteria to reduce adverse affect of flow fluctuations on lower American River fishery resources.	

Category	Target	Action	Species of Benefit
	Provide flows of suitable quality water that more closely emulate natural annual and seasonal streamflow patterns in American Basin watersheds	Enter into agreements with water districts and wetland managers to provide return flows of high quality water from irrigated agriculture and seasonal wetlands to the American Basin.	
		Enter into agreements with landowners and water districts to limit diversions of natural flows from creeks to improve stream flows.	
		Limit diversion of natural stream flows from American Basin creeks into irrigation canals and ditches by providing other sources of water or through purchase of water rights from willing sellers.	
	Justification: *Natural streamflow patterns are important in maintaining geomorphology of watersheds, as well as riparian and floodplain vegetation along stream banks. Streamflow is also essential for the well being of valley wetlands and for upstream passage of adult anadromous fish, spawning, successful rearing, and downstream migration of juveniles. In addition, streamflows influences stream channel morphology, riparian communities, and fish habitat.* *Base flows and flow events will be provided by releasing water from Folsom Reservoir, reducing diversions from the American River. Flood-control releases from Folsom Reservoir that occur during winter and spring months are beneficial in sustaining gravel recruitment, transport and cleaning processes. Late non-flood control releases during the winter and/or early-spring period flow will be maintained at levels events of sufficient magnitude to attract and sustain adult steelhead and American shad spawning runs. Moreover, spring and early summer flows will be maintained at levels that provide sufficient physical space for improve transport of juvenile salmon, steelhead, and shad rearing as well as favorable downstream migration conditions. Both high-level flood-control releases and lower base-flow releases from reservoir storage during winter and spring will be managed within the operational constraints of the reservoir to sustain riparian habitats and sustain gravel recruitment, transport, and cleansing processes. Sufficient minimum flows are necessary to maintain adequate conditions for adult holding, spawning, egg incubation, and juvenile rearing and migration, especially because these functions must now occur below Nimbus Dam. The target minimum flows (Table 1) are consistent with historic and unimpaired flows for the American River in dry and normal years that, in some years, may not occur under the present level of project development and operation.*		

Category	Target	Action	Species of Benefit
	Opportunity to succeed in providing optimum, rather than minimum, flows will rely on collaborative efforts that include stakeholder groups such as the American River Water Forum, State and federal agencies, and local governments. Developing a long-term water management plan for the American River will meet a diversity of needs, including providing streamflows needed to maintain ecological processes and functions; maintaining habitats; and supporting restoration of chinook salmon, steelhead, and other anadromous and resident fish populations below Nimbus Dam. This plan may involve options presently being considered by the American River Water Forum, including diverting water from near the mouth of the river or at the Fairbairn Water Treatment Plant, rather than from Nimbus Dam, or Fairbairn Water Treatment Plant to meet the needs of water users. Opportunities for adjusting seasonal streamflow and carryover storage patterns to benefit fish and lower American River habitats, while maintaining other beneficial uses, will be explored. These opportunities may include acquiring water rights from willing sellers or developing supplemental supplies (e.g., conjunctive use and/or recycled water programs). *The target level of the flow events must be implemented conservatively because of the potential impact on water supply. If a flow event equal to or greater than the target flow has not taken place during uncontrolled releases from Folsom Dam by March, then supplementing base flows or augmenting small, natural flow events or reservoir spills with additional reservoir releases is the only means to provide the necessary flows. Such releases would be allowed only if an equivalent or greater inflow to Folsom Lake occurs.* *March through May is the logical period during which to provide such flow events because this is the period when natural flow events occurred historically in dry and normal years, and because opportunities for such flow to occur naturally as a function of normal project operation would have passed. Forecasts regarding the water-year type (dry or normal) would also be available by February or March and will be used as the basis for decisions that balance fishery flows with water-supply needs.* *The March flow event would be expected to travel unimpaired to the Delta because few if any diversions from the American and Sacramento Rivers occur during March. (Note that additional flow events are prescribed for the Feather and Sacramento Rivers in March, which will further enhance Sacramento River flows below the confluence with the American River.) A March flow event would also help satisfy Delta outflow requirements. Further, the prescribed flow event in late April and early May would add to flow events prescribed from the Mokelumne, Stanislaus, Tuolumne, and Merced Rivers to the south, which together will also satisfy Delta outflow requirements.* *These prescribed flows cannot usurp individual water rights established subject to California law. ERPP does not include any adjudication or involuntary reallocation of water rights.* *Managing for appropriate seasonal flow regimes in the lower American River and American Basin creeks will restore and sustain anadromous and resident fish populations, help promote natural channel formation processes, establish and maintain riparian vegetation, and will sustain numerous foodweb functions. Minimum flows also attract adult steelhead and fall-run chinook salmon during fall and winter.*		

Category	Target	Action	Species of Benefit
Natural Sediment Supply	Maintain, improve, or supplement gravel recruitment and natural sediment transport in the lower American River and American Basin watersheds to maintain natural ecological processes linked to stream channel maintenance, erosion and deposition, maintenance of fish spawning areas, and the regeneration of riparian vegetation	Monitor spawning gravel conditions in the lower American River and American Basin watersheds, and identify specific sites where mechanical cleaning or gravel introductions would be beneficial to enhance or increase gravel spawning habitat.	
		Implement a pilot study to assess the benefits of mechanical cleaning to improve gravel permeability.	
		Develop a collaborative program to investigate erosion, bedload movement, sediment transport, and depositional processes and their relationship to the formation of point bars and riparian regeneration in the lower American River and American Basin watersheds.	
	Justification: *Gravel is an essential element of spawning and rearing habitats for salmon, steelhead trout, and other native fishes. Gravel supplies are not thought to currently limited salmonid production in the lower American River but may become limiting in the near future, especially in the area immediately below Nimbus Dam. Some gravel is provided naturally when the river cuts into dredger tailings during high flows; however, this input is not sufficient to maintain high-quality spawning habitat for the target levels of naturally produced fall-run chinook salmon and steelhead. Gravel recruitment can be supplemented by providing additional gravel for the river to capture under its controlled flow regime.* *The Lower American River Technical Team reported that the availability of spawning habitat does not appear to be an immediate problem as there are adequate amounts of appropriately sized gravel in the river; and there is a large amount of gravel along the banks and in the bars of the lower American River that provide sources for gravel recruitment.* *Simply adding gravel to the stream channel may not improve spawning conditions because an impermeable clay lens under the deposited gravel could limit upward percolation and, therefore, fish use for spawning., and other site-specific habitat characteristics. Hence, the specific river location were gravel deposition occurs will largely dictate the benefits to fishery resources of deposition gravel.* *Natural sediment supply from the watershed above Folsom Dam has been eliminated. The long-term adverse effects of this have not been adequately investigated. Lack of sediment recruitment from the upper watersheds, ranging from fine sands to cobbles, may adversely influence the structural characteristics of the stream channel, impair riparian and riverine aquatic habitats, and reduce habitat complexity required by anadromous and resident fish species. Investigations into these issues will provide additional insight into finer resolution of long-term opportunities to improve the ecological health of the American River.* *The sediment regimes of American Basin creeks have not been investigated. However, because these streams do not have dams on them, natural sediment supplies are probably available. The condition of the watershed and spawning habitats in the upper watersheds of Coon Creek, Auburn Ravine, and Dry Creek should be investigated.*	

Category	Target	Action	Species of Benefit
Natural Floodplain and Flood Processes	Maintain the existing stream meander configuration along the American River between Nimbus Dam and the Sacramento River	Maintain a stream meander configuration along the lower American River by working with involved parties to develop a floodplain management program consistent with flood control needs. These parties include the Corps, the California Reclamation Board, the Sacramento Area Flood Control Agency, the Lower American River Task Force, and the American River Water Forum.	
		Where possible, maintain mainstem and side channel habitats typical of a natural river that provide salmon and steelhead spawning and rearing habitat.	
	Restore natural stream meanders in the floodplains of American Basin creeks	Where possible within flood control constraints, restore natural meander belts along the lower creeks through setback of levees or removal of bank protection, or other physical structures impeding a natural meander process.	
	Maintain and enhance floodplain overflow areas in the lower American River and floodplain of the American Basin	Setback levees in the floodplains of creeks and canals of the American Basin.	
		Protect existing overflow areas from future reclamation.	
		Develop floodway detention basins in the floodplains of the American Basin to temporarily store floodwaters	
		Enter into agreements with willing landowners and irrigation districts to set back levees and allow floodplain processes such as stream meander belts.	
		Expand existing floodplain overflow basins by obtaining easements of titles from willing sellers of floodplain lands.	
		Reduce or eliminate gravel mining from active stream channels.	

Category	Target	Action	Species of Benefit
	Justification: *Natural river floodplain processes permit natural stream-channel development that supports for riparian vegetation and provides spawning and rearing habitat for chinook salmon and steelhead. Natural stream processes in alluvial systems transport and deposit sediments; provide transient habitats important to algae, aquatic invertebrates, and fish; and provide surfaces colonized by natural vegetation that support wildlife. Overbank flooding is an important regenerative process needed to maintain riparian forests and woodlands. In addition, much of the nutrient input is derived from infrequent overbank flooding of the riparian/floodplain zone. Opportunities to restore floodplains and flood processes along the lower American River are constrained by the flood control requirements provided by Folsom Dam and the levee system throughout in the lower river reach. Adaptive management including focused research and monitoring will be important elements to guide the level to which floodplain processes can be maintained and restored in the lower American River. These processes are closely linked to maintaining and restoring the riparian corridor which supports a variety of aquatic and terrestrial species.* *Remnant effects of devastating dredger mining along the American River also hinder natural stream-channel processes. Because of these constraints, artificial means are necessary to maintain natural stream-channel processes that will provide the habitats needed by salmon and steelhead normally created by these processes.* *In the American Basin project levees channel flows in lower creeks into the NCC and NEMDC, which carry floodwaters to the Sacramento River. Levees along the lower creeks typically fail to hold back water as water backs up at the Sacramento River. Widening the floodplain and setting back levees along the NCC, NEMDC, and lower creeks provides more flood carrying capacity and a more natural floodplain process that would promote riparian and wetland habitat development.*		
Stream Temperature	Maintain lower American River water temperatures in the spawning and rearing reach between Arden Bar and Nimbus Dam at or below 60°F beginning as early in October as possible, based on annual coldwater pool availability Maintain lower American River water temperatures in the upper portion of the reach between Nimbus Dam and Sunrise Bridge and in the upper portions of Coon Creek, Doty Creek, Auburn Ravine, and Secret Ravine in the American Basin below 65°F from spring through fall	Optimally manage Folsom Reservoir's coldwater pool via real-time operation of the water-release shutters to provide the maximum equitable thermal benefits to lower American River steelhead and chinook salmon throughout the year, within the constraints of reservoir coldwater pool availability.	
		Reconfigure Folsom Dam shutters to improve management of Folsom Reservoir's coldwater pool and maintain better control over the temperature of water released downstream.	
		Install a temperature control device at the urban water intakes at Folsom Dam. Doing so would facilitate diverting water at elevations above 317 ft (msl), which would preserve the reservoir's cold water pool for releases to the lower American River.	

Category	Target	Action	Species of Benefit
		Investigate opportunities to improve the manner in which the water-release shutters at Folsom Dam are physically installed, removed, and maintained annually, as well as opportunities to improve their efficiency in releasing water from desired elevations.	
		Evaluate the potential for creating side-channels thermal refuges for juvenile steelhead rearing over-summer in the lower American River. Such habitat could provide habitat slightly cooler than peak daytime river temperatures.	
		Evaluate options to reduce releases of warmer surface waters of Lake Natomas through the turbines at Nimbus Dam into the lower American River. Options may include a temperature curtain in the lake near the turbine intakes. Operations of Nimbus Dam during occasional spill events should also be evaluated to minimize the release of warm surface waters from Lake Natomas.	
		temperatures as necessary in upper watersheds of Coon Creek, Auburn Ravine, and Dry Creek, including such measures as pumping ground water, enhancing riparian vegetation, reducing drainage inputs of warm water from agriculture and urban runoff, and supplementing creek flows with diversions of waters from the Bear and American River Basins.	

Category	Target	Action	Species of Benefit
	Justification: *SAFCA used an iterative modeling approach to develop a monthly target release temperature regime on the Lower American River (as part of the DEIR/EIS for P.L. 101-514 CVP Water Supply Contracts). This effort developed a monthly target release temperature regime that mitigated project-related potential water temperature impacts of steelhead and also reduces average annual early life stage mortality for chinook salmon. Modeling analyses revealed that managing Folsom Reservoir's coldwater pool in this alternative manner would: (1) provide water temperatures during the July through September period that would be lower than those realized under the Base Case condition, thereby providing more favorable conditions for over-summering juvenile steelhead; and (2) reduce average annual early life stage losses of chinook salmon caused by elevated Lower American River water temperature during September, October, and November.* *Improved operation of the water-release shutters configuration at Folsom Dam can reduce the temperature of water released into the lower American River. Improved temperatures of water released from Folsom Dam and improved channel habitats are needed to provide adequate over-summer rearing habitat for juvenile steelhead. Releases from Folsom Reservoir's coldwater pool are also required to provide adequate spawning temperatures for fall-run chinook salmon in October and November. However, the low end-of-year storage levels allowed in Folsom Reservoir currently for flood-control purposes will make temperature control for salmon spawning difficult in late summer and early fall of most water-years.* *While managing the cold-water pool in Folsom Lake is a priority for maintaining cool water temperatures in the lower American River, lessor but significant benefits can also attained by managing releases from Nimbus Dam. Surface waters (top several feet) of Lake Natomas can heat up to 5 to 10°F from late spring through early fall. Water released into the lower American could be 1 to 2°F lower if warmer surface waters were not included in releases. Because summer temperatures often reach near or above 65°F, 1 to 2°F additional heating is significant. On rare occasions when water from Lake Natomas spills from the spillways rather than coming from the turbines, an even greater proportion of warmer surface waters from the lake can be released to the river.* *The upper watersheds of the American Basin have historically provided sufficiently cool water to sustain naturally produced rainbow trout/steelhead through the summers. Protecting and enhancing remaining cool water habitat is an essential element of restoring steelhead to these watersheds.* *To some degree, high water temperatures in summer and fall in the lower American River are natural; in part, they are a consequence of impaired stream-channel configurations that do not provide shaded side channels with cool groundwater flows. Coldwater releases from the dams and improved channel habitats are needed to provide adequate over-summer rearing habitat for juvenile steelhead.*		
Upper Watershed	Reduce excessive fire fuel loads in the upper watersheds of the American Basin and American River	Remove excess fuels including diseased trees, brush, and slash that would contribute to unnaturally hot fires in the watersheds.	
		Improve forestry management practices, including practices relating to timber harvest that contribute to increasing fuel levels in watersheds.	

Category	Target	Action	Species of Benefit
	Improve management practices in upper watersheds relating to road building and maintenance, and livestock grazing	Develop a watershed management plan to improve watershed management practices.	
	Justification: *Improved watershed processes will maintain and restore seasonal runoff patterns, water yield, and water quality and reduce sediment load to downstream storage reservoirs (reducing storage capacity and improving water quality). Healthier watersheds will also provide ancillary benefits to upper watershed habitats and species, and reduce the risks of wildfire that would be devastating to habitat, wildlife, and public and private property.*		
Riparian and Riverine Aquatic Habitat	Establish and/or maintain a sustainable continuous, sustainable corridor of riparian habitat along the lower American River and American Basin creeks	Develop riparian corridor restoration and management plans for the American Basin and lower American River.	
		Protect riparian habitat along water courses of the American Basin.	
		Plant riparian vegetation along water courses of the American Basin.	
		Reduce land use practices such as livestock grazing and watering along stream channels of the American Basin that cause degradation of riparian habitat.	
	Enhance shaded riverine aquatic habitat in American Basin creeks and drainage canals and ditches and along the lower American River	Terminate or modify current programs that remove woody debris from the river and creek channels.	
		Restore side-channels along the lower American River to provide additional riparian corridors for increasing fish and wildlife habitat.	
		Improve levee management practices to protect and enhance riparian and SRA habitat.	
	Justification: *Many species of wildlife, including several species listed as threatened or endangered under the State and federal Endangered Species Acts and several special-status plant species in the Central Valley, are dependent on or closely associated with riparian habitats. These habitats support a greater diversity of wildlife species than all other habitat types in California. Degradation and loss of riparian habitat have substantially reduced the habitat area available for associated wildlife species. In addition, loss of this habitat has reduced water storage and has altered nutrient cycling, and foodweb support functions.* *Controlled flows, lack of gravel recruitment, stream-channel confinement by the flood control system, and remnant dredger tailings limit the possible extent of a natural riparian corridor along the lower American River. Constructing and maintaining restored riparian habitats would improve the habitat needed by fish and wildlife dependent upon the river ecosystem.*		

Category	Target	Action	Species of Benefit
Water Diversions	Reduce losses of juvenile salmon and steelhead in the lower American River and American Basin creeks due to entrainment at water intakes structures	Upgrade the fish screens at the Fairbairn Water Treatment Plant to comply with DFG and NMFS fish screening criteria.	
		Screen diversions from the NCC, NEMDC, Dry Creek, Coon Creek, and Auburn Ravine that operate during times when salmon and steelhead juveniles would be present.	
	Justification: *Diversion, storage, and release of water directly affect fish, aquatic organisms, and nutrient levels in the system and indirectly affect habitat, foodweb productivity, and the abundance and distribution of species. Diversions cause consumptive loss of water, nutrients, sediment, and organisms juvenile anadromous fishes of management concern. Hence, reducing such losses will contribute to increasing anadromous fish populations of the Central Valley.*		
Levees, Bridges, and Bank Protection	Reduce the adverse affect of levees and bank protection on aquatic and terrestrial species and their habitats along the lower American River and American Basin canals and creeks	Identify locations in the lower American River and American Basin creeks and canals where existing revetments could be modified to incorporate habitat features such as scalloped embayments and associated hard points, multi-stage bench areas, SRA habitat, and other features to aid in preservation and/or reestablishment of both berm and bank vegetation	
	Justification: *Riprap reduces the ability of vegetation to colonize river banks and, thereby reduces shading of river waters, decreases insect production and availability to fishes, reduces habitat complexity and diversity, and reduces instream cover.*		

Yolo Basin Ecological Management Zone

This zone includes:

- Cache Creek
- Putah Creek
- Willow Slough
- Solano unit.

Category	Target	Action	Species of Benefit
Streamflow	More closely emulate natural seasonal patterns in Cache and Putah Creeks by providing additional flows, when available from existing water supplies . Flows in the Yolo Bypass would be supplemented, as needed ,by the Colusa basin drain through the Knights Landing Ridge Cut Canal, extending the Tehama-Colusa Canal, and the Sacramento River through the Freemont weir. Supplemental flows may be needed in fall if water temperature and flow in the lower Yolo Bypass are insufficient for passage from Cache Slough to upstream areas in the Sacramento River. Supplemental flows may be needed in winter and spring to sustain downstream migrating juvenile salmon and steelhead on their journey through the Yolo Bypass to the Delta. Supplemental flows would be needed along with irrigation water from spring to fall to sustain native fish, wetlands, and riparian habitats in channel sloughs of the Yolo Bypass	Develop a cooperative program to provide water for summer flows in Cache Creek to maintain riparian vegetation by developing new conjunctive supplies, including groundwater. Develop a cooperative program to provide water for the target flows in Putah Creek from additional Lake Berryessa releases or reductions in water diversions at Solano Diversion Dam and in the creek downstream of the dam. Water would be obtained from willing sellers, water transfers, and by developing new supplies, including groundwater. Cooperatively evaluate the feasibility of providing water for the upper Yolo Bypass portion of the Cache Creek Unit by redirecting water from Colusa basin drain through the Knights Landing Ridge Cut Canal, an extension of the Tehama-Colusa Canal, and the Sacramento River through the Grays Bend-Old River-Freemont weir complex.	

Category	Target	Action	Species of Benefit
	Justification: *Supplemental summer flows proposed in Cache Creek would sustain newly established riparian vegetation and provide refuge for native resident fish. Flows from the Colusa basin drain, Tehama Colusa Canal extension, and the Sacramento River are necessary to provide sufficient flow in the Yolo Bypass during the spring through fall irrigation season to sustain native fish, wetlands, and riparian habitat; additional supplemental flow may be needed during the late-fall through early spring salmon and steelhead migration season. These flows will sustain salmon and steelhead using the Yolo Bypass route to and from the upper Sacramento River watersheds.* *Flow in this area would pass south along both sides of the Yolo Bypass, merging with any supplemental Cache and Putah Creek flows along the west side of the Yolo Bypass. A weir or screen will be placed at the Knights Landing Ridge Cut Canal outlet to keep salmon and steelhead from migrating upstream into the Colusa basin drain. Fish passage facilities will be constructed at the Grays Bend-Old River-Freemont weir complex to allow migrating adult salmon and steelhead moving upstream through the Yolo Bypass toward upper Sacramento River basins to enter the Sacramento River. Downstream migrating juvenile salmon and steelhead will not be discouraged from moving from the Sacramento River into the Yolo Bypass, because conditions should be optimal for rearing and migrating on their way to the Delta.*		
Natural Sediment Supply	Restore gravel recruitment in Cache and Putah Creeks to meet the needs of spawning fish, maintain natural stream channel meanders and bar formation where consistent with flood protection and adjoining land uses, and match existing rates of downstream displacement	Develop a cooperative program to supplement gravel recruitment below Solano Diversion Dam as needed to replace natural gravel recruitment interrupted by the diversion dam.	
		Develop a cooperative program to supplement gravel in areas downstream of the diversion dams where other structures or gravel mining have interrupted the gravel recruitment process.	
	Justification: *Gravel recruitment has been severely interrupted in Putah Creek from dam construction. Replacement is necessary below the dam to sustain fish rearing habitat, feasible stream meander, and riparian corridors.*		
Natural Floodplain and Flood Processes	More closely emulate natural stream channel configurations in Cache Creek and Putah Creek, as well as in channels and sloughs of the upper Yolo Bypass, consistent with flood control requirements	Cooperatively evaluate the feasibility of modifying the cross sections and channel configurations in Cache and Putah Creeks to provide a more natural configuration, while maintaining consistency with flood control requirements and minimizing impacts to adjoining established land uses.	
	Increase overbank flooding potential to floodplains, where feasible and consistent with flood protection, to support a desirable vegetation succession process	Evaluate oppor-tunities to provide flow to Yolo Bypass from Colusa basin drain, extending the Tehama-Colusa Canal, and Sacramento River (through Freemont weir) in dry and normal water years, as well as normally occurring overflow in wetter years. Allow flows to flood the Yolo Bypass floodplain	

Category	Target	Action	Species of Benefit
	Increase the area of flooding to the **active** Cache and Putah Creek floodplains during the wet season, where feasible and consistent with flood protection	Evaluate the feasibility of developing floodplain overflow areas in the lower Cache and Putah Creek floodplains. Such areas would include sloughs and creek channels, setback levees, and wetlands, where feasible and consistent with flood protection.	
	Establish a desirable level of floodwater retention potential by expanding, where feasible and consistent with flood protection, the floodplain area of the Yolo Bypass, lower Cache Creek, and lower Putah Creek, and by developing off-channel water storage facilities	Cooperatively evaluate the feasibility of reoperating and modifying the Yolo basin to increase its capacity for floodwater detention and sediment retention by reconfiguring levees, channels, and other physical constraints to large-volume flow events.	
	Justification: *Overbank flooding is a regular occurrence in the Yolo Bypass in flood years. Proposed actions will provide this valuable process in dry and normal water years when no flooding of the Bypass would normally occur. Flooding in the Bypass sustains wetlands and provides for the transfer of considerable amounts of nutrients and organic materials to the Delta and Bay, where it serves the valuable purpose of contributing to the estuarine foodweb. Developing floodplain overflow areas* and off-channel water storage facilities *along lower Cache and Putah Creeks will help reduce flood damage, provide supplemental flows during the summer, and improve fish, riparian, and wetland habitats, and further contribute nutrients and organic materials to the Bay-Delta foodweb.* *Natural floodplain overflow basins and off-channel water storage facilities serve to store sediment, nutrients, and water, making them available for other uses and to the rivers at other times. The subsurface water and sediment flow and nutrient retention also help form and maintain riparian habitats, which provide spawning and rearing habitat for native resident fish during higher water periods.* *Successful restoration of the Yolo Basin streams will minimally require considerable stream channel reconfiguration. The intent is to restore channels to configurations that can be retained in a natural state by the proposed flows, natural erosion and sedimentation processes, riparian vegetation succession, and gravel-sediment regimes (patterns), where feasible with flood protection and adjoining land uses.*		

Category	Target	Action	Species of Benefit
Riparian and Riverine Aquatic Habitat	Restore riparian vegetation along Cache Creek, Putah Creek, and Yolo Bypass and Solano Ecological Unit channels and sloughs, where possible, to provide cover and other essential habitat requirements for native resident fish species and wildlife	Develop a cooperative program to restore riparian vegetation, where possible. Develop a cooperative program to protect existing riparian corridors along creeks, streams, sloughs, and channels connecting to the Delta. Develop a cooperative program to plant riparian vegetation and provide for early development until it becomes naturally self-sustaining. Develop a cooperative control program for non-native riparian plants, where necessary, to promote development of healthy natural riparian corridors.	
	Justification: *Healthy riparian corridors along creeks, sloughs, and channels, including those in the Yolo Bypass, provide essential cover, shade, and food for spawning, rearing, and migrating native resident fishes and other wildlife.*		
Water Diversions	Screen all diversions in the Yolo Bypass channels and sloughs	Develop a cooperative program to construct a weir or screen at the lower end of the Knights Landing Ridge Cut Canal to keep adult salmon and steelhead from migrating upstream into the Colusa basin drain Evaluate the feasibility of screening diversions in the Yolo Bypass with positive-barrier fish screens	
	Prevent adult salmon and steelhead stranding in the Yolo Bypass during their upstream migrations	Evaluate the feasibility of constructing fish passage facilities at the Grays Bend-Old River-Freemont weir complex at the upper end of the Yolo Bypass	
	Justification: *Reducing loss of juvenile salmon, steelhead, native resident fishes, nutrients, organic debris, and aquatic invertebrates is essential to restoring salmon, steelhead and native resident fish populations to the Yolo Bypass. Unscreened diversions are a significant threat to downstream migrating juvenile salmon and steelhead in late winter and early spring, and to oversummer rearing steelhead in upstream rearing areas. Salmon and steelhead populations from the upper Sacramento River watersheds will benefit from reduced stranding losses in the Yolo Bypass.*		

Category	Target	Action	Species of Benefit
Dams, Reservoirs, Weirs, and Other Structures	Improve fish passage between the Delta and spawning grounds in the upper watersheds	Evaluate the feasibility of constructing fish passage facilities at the Grays Bend-Old River-Freemont weir complex at the upper end of the Yolo Bypass.	
	Justification: *During floods, large numbers of adult late-fall-, winter-, and spring-run chinook salmon, as well as winter- and spring-run steelhead from the upper Sacramento River watersheds, migrate upstream through the Yolo Bypass. As floodwaters recede, some of these fish are delayed or stranded behind the Freemont weir. Additional releases from the Colusa basin drain and Freemont weir will further aggravate this existing problem. Ensuring fish passage into upper Sacramento River watersheds from the Yolo Bypass is essential to restoring these wild salmon and steelhead runs to the Sacramento River basin.*		
Gravel Mining	Protect, enhance, and restore natural gravel recruitment within the active floodplain and remnant gravel pits	Develop a cooperative program to incorporate remnant gravel pits into active creek floodplains to increase the channel area and restore natural channel configurations, while providing for the maintenance of flood capacity and protection of adjoining land uses.	
	Justification: *There are remnant gravel mining effects in lower Cache and Putah Creeks. Restoring the natural channels by integrating remnant pits with the active floodplain will ensure that juvenile native resident fish are not stranded in ponds and exposed to the unnatural levels of predatory fish that reside in these ponds. Increasing the width and variation of the channel in those areas altered by former gravel mining operations will restore gravel recruitment to the river and allow for the development of more natural and stable stream channels and riparian habitat.*		
Invasive Riparian Plant Species	Reduce populations of invasive non-native plant species that compete with the establishment and succession of native riparian vegetation along Cache Creek and Putah Creek. This will help to reestablish native riparian vegetation in floodplains, increase SRA cover for fish, and increase habitat values for riparian-associated wildlife	Develop a cooperative program to monitor the distribution and abundance of non-native plants and develop cooperative control programs as needed.	
	Justification: *Non-native plant species, such as false bamboo and salt cedar, can undermine riparian habitat value to fish and wildlife, as well as the natural plant succession that contributes to the physical character of the riparian corridors.*		

Eastside Delta Tributaries Ecological Management Zone

This zone includes:

- Cosumnes River
- Mokelumne River
- Calaveras River.

Category	Target	Action	Species of Benefit
Streamflow	For the Cosumnes River, where a natural streamflow pattern presently exists with natural winter and spring streamflows, the target is to maintain or restore natural summer and fall base flows	Improve summer and fall base flows on the Cosumnes River by developing new water supplies along the river and by purchases from willing sellers. Cooperatively develop a program to minimize or eliminate unpermitted water diversions on the Cosumnes River, and review water allocation for the entire basin. Cooperatively develop a groundwater replenishment program to raise the water table in the Cosumnes River floodplain.	
	The target for the Mokelumne River is to provide conditions to maintain the fishery and riparian resources in good condition by implementing and evaluating the flow regime in the Principles of Agreement (POA) for Mokelumne River. The POA provides increased flows below Camanche Dam beyond present requirements, which will benefit the fishery and riparian resources of the lower Mokelumne River	Provide target flows for Mokelumne River storage releases, but only if there are sufficient inflows into storage reservoirs and carryover storage to meet target levels. The additional water would be obtained by developing new water supplies within the Central Valley basin, water transfers, and from willing sellers. Maintain or enhance summer and fall base flows on the Mokelumne River by developing new water supplies and by purchases from willing sellers.	

Category	Target	Action	Species of Benefit
	The target also is to provide enhanced streamflows below Woodbridge Dam by providing minimum flows recommended by DFG in dry years: 200 cfs from November 1 through April 14; 250 cfs from April 15 through April 30; 300 cfs in May; and 20 cfs from June 1 through October 31. In normal years, minimum flows should be 250 cfs from October 1 through October 14; 300 cfs from October 15 through February 29; 350 cfs during March; 400 cfs during April; 450 cfs during May; 400 cfs during June; 150 cfs during July; and 100 cfs during August and September. In wet years, minimum flows should be 300 cfs from June 1 through October 14; 350 cfs from October 15 through February 29; 400 cfs in March; and 450 cfs during April and May	Cooperatively evaluate the potential for minimizing water supply impacts by replacing the diversions at Woodbridge with other Delta diversions. Cooperatively develop a program to minimize or eliminate unpermitted water diversions on the Mokelumne River.	
	A flow event should be provided in late April or early May, averaging 500 to 1,000 cfs in dry years, 1,000 to 2,000 cfs in normal years, and 2,000 to 2,500 cfs in wet years	Develop a cooperative feasibility study of opportunities to provide spring flow events.	
	For the Calaveras River, where the natural streamflow has been greatly altered, streamflows should be enhanced below New Hogan Dam by the minimum flows recommended by DFG	Provide target flows for the Calaveras River from storage releases, but only if there are sufficient inflows into storage reservoirs and carryover storage to meet target levels. The additional water would be obtained by developing new water supplies within the Central Valley basin, water transfers, and from willing sellers.	
		Cooperatively develop a program to minimize or eliminate unpermitted water diversions on the Calaveras River.	
		Cooperatively evaluate the potential for resizing criteria at New Hogan Reservoir on the Calaveras River to yield additional water for instream flow needs while maintaining or improving flood control requirements.	

Category	Target	Action	Species of Benefit
		A flow event should be provided in late February or early March, averaging 100 to 200 cfs in dry years, 300 to 400 cfs in normal years, and 600 to 800 cfs in wet years. Such flows would be provided only when inflows to New Hogan Reservoir are at these levels	
	Justification: *Inadequate instream flows have been identified as a limiting factor for anadromous fish and other aquatic resources in the eastside Delta tributary streams. For example, the Cosumnes River receives most of its water from rainfall due to the low elevation of its headwaters and the lower reaches of the river are often dry until the fall rains occur. As a result, adult fish must await the runoff following rains in late October and November before ascending to the spawning areas between Michigan Bar and Sloughhouse. Although there are no water storage reservoirs on the Cosumnes River, there are 157 registered appropriative water rights (U.S. Fish and Wildlife Service 1995). Most water is diverted from the first rains in the fall through early summer, coinciding with instream flow needs for fall-run chinook salmon. USFWS recommended an evaluation of instream flow requirement to ensure adequate flows for all life stages of all salmonids.* *DFG (1993) recommended revised minimum flow schedules for the lower Mokelumne River. In 1996, the Principles of Agreement was signed between EBMUD and the resource agencies. The POA provides significantly improved fish flows for the Mokelumne River (including higher minimum flows below Camanche Dam) and gainsharing for additional flows between EBMUD and the environment. It incorporates a broader ecosystem approach for managing the Mokelumne River resources.*		
Natural Sediment Supply	On the Mokelumne River below Camanche Dam, provide annual supplementation of 1,200 to 2,500 cubic yards of gravel into the active stream channel to maintain quality spawning areas and to replace gravel that is transported downstream	Develop a cooperative program to evaluate, implement, and monitor sediment supplementation on the Mokelumne River, consistent with adaptive management.	
	On the Calaveras River, provide for the annual recruitment of 500 to 1,000 cubic yards of gravel into the active stream channel	Cooperatively develop a program to protect all existing gravel recruitment sources to the rivers.	
		Develop a cooperative program to supplement gravel with artificial introductions.	
		Develop a cooperative program with the aggregate (sand and gravel) resource industry to improve extraction activities within the Mokelumne River floodplain	
	Restore gravel transport and cleaning processes to attain sufficient high quality salmon spawning habitat in each of the three streams for target population levels	Develop a cooperative program to provide late winter or early spring flow events, as needed, to establish appropriate flushing/channel maintenance flows.	

Category	Target	Action	Species of Benefit
		Facilitate fine sediment transport by restoring, as necessary, the river channel configuration so that it is consistent with planned flow regime and available sediment supply.	
		Develop a cooperative program to improve the flexibility of upstream reservoir management to minimize fine sediment inputs to the lower Mokelumne and Calaveras Rivers.	
		Develop a cooperative evaluation of mechanically cleaning spawning gravel at selected sites in lower Mokelumne and Calaveras Rivers.	
		Develop a cooperative program on the Cosumnes River to relocate sand and gravel extraction activities to areas beyond the natural stream meander corridor	
	Restore channel gradient and stream profile in the Cosumnes River between Twin Cities Road and Highway 16	Develop a cooperative program to assess the feasibility of reversing head cutting and stream channel incision in the Cosumnes River.	

Category	Target	Action	Species of Benefit
	Justification: *Recruitment of suitable salmonid spawning gravel below Camanche Dam on the Mokelumne River is minimal. Most gravel present is in the small range of the preferred sizes used by spawning chinook salmon. Targeted levels are to maintain processes linked to sediment supply, stream channel meander, and riparian and riverine aquatic habitat. This program will be subject to adaptive management, focused research, and monitoring, and thus is considered short-term until a more detailed evaluation is completed.* *Flood stage for the lower Mokelumne River is 5,000 cfs. Preliminary data suggest that spawning-sized gravel for adult salmonids (DFG 1991, Bjorn and Reiser 1991) do not begin moving in the lower Mokelumne River until flows of 3,000 cfs or more are reached (Envirosphere 1988). Even at 5,000 cfs (flood stage), the larger gravel does not move. Significant impacts occur to property along the lower Mokelumne River at flows above 2,500 cfs. It would not be practical to place supplemental gravel along the entire reach of the lower Mokelumne River because numerous roads would have to be constructed for access. The environmental impact of these roads would negate any benefit from the addition of spawning gravel. Therefore, a gravel supplementation program on the Mokelumne River would have to be long-term and gravel injected at the upper end. The development of an addition gravel injection site lower in the river might be beneficial.* *Flow regulation has reduced the frequency and magnitude of high flow events in the lower Mokelumne River. Due to the reduction in high flows and excessive input of fine sediments, sediments accumulate in salmonid spawning gravel and degrade habitat. BioSystems (1992) reported that over 70% of the substrate samples taken in 1991 and 1992 from chinook salmon redds contained amounts of fine sediment less than 0.48 mm in diameter, which is detrimental to egg survival (Chapman 1988). The need for salmonid spawning gravel restoration is also identified by DFG (1993) and USFWS (1997).* *Gravel supplementation programs should be subject to adaptive management, monitoring, and focused research. The frequency and amount of supplemental gravel will vary greatly from year to year. Physical monitoring can record observable changes in the size and distribution of gravel, while biological monitoring can record use of new gravel by anadromous fish and invertebrates. Focused research is needed to calculate annual bedload movement, gravel quality, infiltration, and intragravel water quality.* *Mechanical means to clean gravel should be evaluated. This could be a focused research project. Due to water quality constraints and the presence of juvenile anadromous and other fish species, the window for gravel cleansing may be short. This concern should be included in the feasibility analysis.*		
Natural Floodplain and Flood Processes	Restore and improve opportunities for rivers to seasonally inundate their floodplain	Conduct a feasibility study to construct setback levees in the Mokelumne River floodplain in the area from Elliot Road to Woodbridge and from Woodbridge to the mouth, including the Mokelumne forks below the river's mouth.	
		Restore, as needed, stream channel and overflow basin configurations within the floodplain.	
		Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes	
		Develop a floodplain management plan for the Mokelumne River.	

Category	Target	Action	Species of Benefit
		Develop a floodplain management plan for the Calaveras River.	
		Develop and implement a cooperative program to evaluate the feasibility of reconnecting the Cosumnes River to its historical floodplain in areas where the river has become entrenched.	
		Cooperatively develop and implement a feasibility study on the Cosumnes River to identify opportunities to improve sediment transport, stream meander, and maintain the natural flow pattern.	
	Justification: *Setback levees will provide greater floodplain inundation, room for stream meander, and greater amounts of riparian forest and seasonal wetland habitats along the lower rivers. Channel configuration adjustments may be necessary to accelerate restoration of natural floodplain habitats and to restore and maintain configurations that may not occur naturally due to remaining constraints from new setback levees. Permanent structures, such as bridges and diversions dams, can interrupt and impair natural floodplain processes and habitat development and succession, thus requiring removal of the structures, rebuilding, or some continuing maintenance or mitigative efforts to minimize their effects. Some reaches of the Cosumnes River upstream of Twin Cities Road have become entrenched and even setback levees will not raise the level of the river bed to the point where the historical floodplain is again functional. This requires a feasibility analysis to identify causes of the stream channel degradation and identification of potential remedial measures.*		
Stream Temperatures	Maintain mean daily water temperatures at or below levels suitable for all life stages of fall-run chinook salmon and steelhead	Cooperatively evaluate the feasibility of releasing sufficient instream flows to improve temperature conditions for key resources in the Mokelumne and Calaveras Rivers.	
		Establish minimum pool size at New Hogan Reservoir to ensure cold-water releases into the Calaveras River.	
		Cooperatively develop reservoir and stream temperature models for the Calaveras River to identify potential for water temperature improvement.	
		Manage Pardee and Camanche Reservoirs through October to maintain a cold water volume of 28,000 af when Pardee Reservoir volume exceeds 100,000 af	

Category	Target	Action	Species of Benefit
	Justification: *Water temperatures in the lower Mokelumne, Calaveras, and Cosumnes Rivers are often at stressfully high levels for fall-run chinook salmon early in the spawning run, and again in the spring when young salmon are migrating downstream to the Delta. The problem is especially acute downstream of Camanche Dam, where water temperature depends on release temperature, prevailing weather conditions, and flow rate. From April to mid-October, the closure of Woodbridge Dam and subsequent filling of Lake Lodi results in the slowing of flow, allowing the water to warm. Differences in water temperature between Camanche and Woodbridge Dams have been measured up to 16.2 °F during dry years (Walsh et al. 1992). Higher flow, colder water, and riparian woodlands may reduce this water heating during the fall upstream spawning run and spring downstream migration of young to the Delta.* *Releases of Pardee Reservoir water into Camanche Reservoir should coordinated to maximize the effectiveness of the Camanche coldwater pool. Timely releases of cold water from Pardee Reservoir can extend the period and increase the value of coldwater releases from Camanche Reservoir.* *Water temperatures in the Calaveras River are closely associated with instream flows, reservoir release schedules, and pool size at New Hogan Reservoir (U.S. Fish and Wildlife Service 1993). Temperatures often exceed stressful or lethal levels for chinook salmon migration, spawning, egg incubation, and rearing. An improved temperature regime could be achieved by maintaining a minimum pool at New Hogan Reservoir and adequate instream flow releases (U.S. Fish and Wildlife Service 1993). The appropriate minimum pool size needs to be determined. Reservoir and stream temperature computer models are also needed to identify the potential for maintaining suitable water temperatures for chinook salmon and to weigh the conflict between coldwater releases and loss of carryover storage necessary to provide coldwater releases later in the season or the following year(s).* *Riparian woodlands along all three rivers are essential for shade to minimize heating of the rivers. This is especially important along the Cosumnes River, because there is no source of cold reservoir bottom water as there is below Camanche and New Hogan Reservoirs.*		
Upper Watershed	Restore upper watershed processes that maintain or improve water quality and quantity	Reduce excessive fire fuel loads in upper watersheds using natural processes.	
		Improve forestry management practices, including timber harvesting, road building and maintenance, and livestock grazing.	
		Develop a watershed management plan for the Cosumnes River Watershed upstream of Michigan Bar	
		Develop a watershed management plan for the Calaveras River Watershed upstream of New Hogan Dam	
		Cooperatively develop a watershed health monitoring program	

Category	Target	Action	Species of Benefit
	Justification: *Improved watershed processes will maintain and restore seasonal water runoff patterns, water yield, and water quality and reduce sediment load to downstream storage reservoirs (reducing storage capacity and improving water quality). Healthier watersheds will also provide supplemental benefits to upper watershed habitats and species.*		
Riparian and Riverine Aquatic Habitat	Restore a minimum of 1,240 acres of self-sustaining or managed diverse natural riparian habitat along the Mokelumne River, and protect existing riparian habitat	Develop a cooperative program to restrict further riparian vegetation removal, and establish riparian corridor protection zones.	
		Develop a cooperative program to implement riparian restoration activities.	
		Encourage improved land management and livestock grazing practices along stream riparian zones.	
		Purchase streambank conservation easements from willing sellers to widen riparian corridors.	
		Develop a cooperative program to restore riparian woodlands along the entire Mokelumne River.	
	Restore a minimum of 1,240 acres of self-sustaining or managed diverse, natural riparian habitat along the Calaveras River, and protect existing riparian habitat	Develop a cooperative program to restrict further riparian vegetation removal. Establish riparian corridor protection zones along all three rivers.	
		Develop a cooperative program to implement riparian restoration activities.	
		Encourage improved land management and livestock grazing practices along stream riparian zones.	
		Purchase streambank conservation easements from willing sellers to widen riparian corridors.	
		Develop a cooperative program to restore riparian woodlands along the entire Calaveras River.	
	Restore a minimum of 1,240 acres of self-sustaining or managed diverse, natural riparian habitat along the Cosumnes River, and protect existing riparian habitat	Develop a cooperative program to restrict further riparian vegetation removal, and establish riparian corridor protection zones.	
		Develop a cooperative program to implement riparian restoration activities.	

Category	Target	Action	Species of Benefit
		Encourage improved land management and livestock grazing practices along stream riparian zones.	
		Purchase streambank conservation easements from willing sellers to widen riparian corridors.	
		Develop a cooperative program to restore riparian woodlands along the entire Cosumnes River.	
	Justification: *The DFG is developing a strategy to establish a stream corridor protection zone on the Cosumnes River to prevent incompatible land use from affecting existing salmonid habitat. Riparian vegetation along the lower Mokelumne River is diminishing (U.S. Fish and Wildlife Service 1993), however, EBMUD and the Natural Resources Conservation Service are developing a strategy for establishing a stream corridor protection zone on the lower Mokelumne River. In many areas, there is no regeneration along the relatively thin riparian corridor (California Department of Fish and Game 1991). Riprapping long sections of streambank has reduced tree growth and decreased stream shading, resulting in increased stream temperatures (East Bay Municipal Utility District 1994). Bankside erosion has potentially affected salmonid production in several areas where livestock grazing is permitted.*		
Water Diversions	Install fish screens representing the best available technology and operational constraints, as necessary, to minimize losses in diversions that limit the recovery of fish populations	Consolidate diversions, seek alternative water sources, and install a permanent fish screen at North San Joaquin Conservation District diversion on the lower Mokelumne River.	
		Improve fish screens and the fish bypass system at Woodbridge Dam on the lower Mokelumne River.	
		Evaluate the feasibility of installing state-of-the-art screens on small pump diversions.	
		Develop a cooperative program to operate temporary screens at diversions where juvenile salmon rear or during seasons when they pass the diversion site.	
		Consolidate and install screens on diversions in the Cosumnes River.	

Category	Target	Action	Species of Benefit
	Justification: *On the lower Calaveras River, most of the existing diversions are not screened or are inadequately screened (California Department of Fish and Game 1993). Nearly all water in the river is diverted, especially in the summer and fall of drier years. During the winter and spring, unscreened diversions between the spawning areas and the river mouth are a potential threat to juvenile salmon.* *Stockton East Water District has an appropriative water right to divert up to 100 cfs from the Calaveras River. This diversion is currently unscreened. There are several other unscreened diversions along the river. It is probable that juvenile salmon losses occur during years when chinook salmon enter and spawn in the Calaveras River (California Department of Fish and Game 1993).* *On the lower Mokelumne River, more than 90 pumps withdraw water from the river between Camanche Dam and the Delta. Few, if any, are screened to prevent fish entrainment (BioSystems 1992). The Woodbridge Irrigation District (WID) diversion at Woodbridge Canal allows juvenile chinook salmon and steelhead losses, because the screen does not meet present DFG criteria for approach velocity and mesh size, nor does it effectively screen the opening of the diversion (California Department of Fish and Game 1993). North San Joaquin Water Conservation District is the second largest diversion below Camanche Dam; temporary fish screens were installed in 1993 (U.S. Fish and Wildlife Service 1995).* *Most Cosumnes River diversions are unscreened and likely entrain juvenile salmonids (U.S. Fish and Wildlife Service 1995).* *Screening or eliminating diversions from areas where juvenile salmon are rearing or actively migrating will increase production of naturally produced juvenile salmon from these three streams.*		
Dams, Reservoirs, Weirs, and Other Structures	Improve anadromous fish passage at dams and diversion structures	Develop a cooperative program to evaluate the need for passage improvements at small dams on the lower Cosumnes River.	
		Cooperatively improve fish passage at WID diversions and Lake Lodi on the lower Mokelumne River.	
		Cooperatively isolate the City of Lodi's Recreational Lake Lodi on the lower Mokelumne River to improve adult salmon and steelhead passage and juvenile fish survival.	
		Develop a cooperative program to provide fish passage at temporary irrigation dams in the Calaveras River, Mormon Slough, and the Stockton Diverting Canal.	
		Develop a cooperative program to install fish passage facilities at Bellota Weir, Clements Dam, and Cherryland Dam on the Calaveras River, and provide passage flows.	

Category	Target	Action	Species of Benefit
	Justification: *Small flashboard dams and some illegal dirt and gravel dams exist on the lower portions of the three rivers (U.S. Fish and Wildlife Service 1997). These dams may impede up- and downstream chinook salmon migration. On the lower Mokelumne River, Woodbridge Dam and the WID diversion may kill fish or delay downstream migrating juvenile salmonids and upstream passage of adult salmonids. DFG (1993) and USFWS (1997) recommended evaluating improvements to the existing fishway on Woodbridge Dam.* *The channels that carry Calaveras River water, and are migratory routes for salmon below Bellota Dam, include the original Calaveras River stream channel, Mormon Slough, and the Stockton Diverting Canal (into which drains Mormon Slough) (California Department of Fish and Game 1993). In some years, typically in March, partial or complete blockage of the adult salmon migration coincides with the annual placement of approximately 30 temporary irrigation dams in these channels. Fish are prevented from reaching the deep holding pools and spawning gravel above Bellota and are subjected to poaching below the flashboard dams. Reclamation Board Permit No. 7594 (August 27, 1971) requires that some of the flashboards and slide gates be removed from the channel prior to November 1 of each year and not replaced before April 15. Two of the diversion structures, Clements Dam and Cherryland Dam, have been identified as barriers to salmon movement and require fish passage facilities. The Bellota Dam (weir) has also been known to block upstream salmon migrants at flows below approximately 200 cfs (California Department of Fish and Game 1982). In some years, salmon have been observed in the tidewater reach, apparently unable to move upstream at lower flows. Juvenile salmon have trouble finding the downstream outlets to the dam and fish ladder.*		
Invasive Riparian Plant Species	Reduce the adverse effects of invasive riparian plants on native species and ecosystem processes, water quality and conveyance systems, and major rivers and their tributaries	Develop and implement a coordinated control program to reduce or eliminate invasive plant species from the riparian corridor along the Cosumnes, Mokelumne, and Calaveras Rivers.	
	Justification: *Non-native plant species, such as Arundo, also known as giant reed or false bamboo, can be highly invasive, fast-growing plants that outcompete and displace native riparian vegetation. These plants restrict water flow, increase sedimentation, and form large debris piles in streams and rivers. Arundo has been introduced into the watersheds of the Eastside Delta Tributary Ecological Zone. Its presence is impairing existing riparian communities and will likely hinder riparian corridor restoration. Riparian regeneration programs will require a coordinated approach to controlling invasive or non-native species through public education and chemical, biological, and mechanical methods.*		
Predation and Competition	Reduce predation level on juvenile salmonids below Woodbridge Dam on the lower Mokelumne River	Develop a cooperative program to modify the stream channel and rebuild the Woodbridge Dam fish passage and diversion screening facilities. This will help minimize losses of downstream migrating salmon and steelhead, while maintaining other important functions.	
		Modify and improve the fish bypass discharge at Woodbridge Dam.	

Category	Target	Action	Species of Benefit
	Justification: *High spring flows attract striped bass, American shad, and squawfish to the base of Woodbridge Dam on the lower Mokelumne River. Studies suggest that a significant proportion of the juvenile salmon smolt production in the Mokelumne River basin may be lost to predation (Boyd 1994, East Bay Municipal Utility District 1994). Juvenile salmon must first pass the reservoir, then the dam, and then the predators concentrated immediately below the dam (striped bass and American shad are unable to ascend the ladder and move upstream; therefore, they tend to gather in large numbers below the dam).*		
Contaminants	Restore and maintain water quality in Camanche Reservoir on the Mokelumne River	Support EBMUD in developing operating procedures at Pardee and Camanche Reservoirs that optimize water quality below Camanche Dam.	
		Support implemen-tation of the cooperative agreement for the long-term remediation of Penn Mine contamination.	
	Reduce the input of nonpoint source contaminants into the Mokelumne River	Develop an integrated program to coordinate and minimize agricultural pesticide and herbicide use in areas that drain into the Mokelumne River.	
	Justification: *Poor water quality has been identified by USFWS (1997) as a limiting factor affecting fall-run chinook salmon and steelhead in the Mokelumne River. USFWS (1995) stated that managing Camanche Reservoir elevations and Pardee Reservoir inflows have not consistently provided suitable water quality to the Mokelumne River Fish Facility and to the lower river. Occurrences of low dissolved oxygen, elevated hydrogen sulfide, and elevated heavy metal levels have been documented, occasionally resulting in fish kills. Presently, reservoir operations have successfully maintained the Camanche release water quality to the lower Mokelumne River. Recently, EBMUD and others have adopted a long-term plan to remediate Penn Mine contamination. The final EIR/EIS has been completed and a Restoration Plan adopted by EBMUD, CVRWQCB, CSM, and federal ESA*		

San Joaquin River Ecological Management Zone

Category	Target	Action	Species of Benefit
Streamflow	Manage flow releases from tributary streams to provide adequate upstream and downstream passage of fall-run and late-fall-run chinook salmon, rainbow trout, and steelhead and spawning and rearing habitat for American shad, splittail, and sturgeon from the Merced River confluence to Vernalis	Develop a cooperative program to purchase water from willing sellers or develop alternative sources of water.	
	Manage flow releases from Friant Dam to Gravelly Ford to maintain sustainable populations of resident native fish	Evaluate the feasibility of increasing flows below Friant to restore terrestrial and aquatic habitats for fish and wildlife including anadromous salmonids.	
	Justification: *Flows in the major eastside tributaries to the San Joaquin River (Stanislaus, Tuolumne, and Merced Rivers) are controlled by releases from foothill storage reservoirs (New Melones, New Don Pedro, and New Exchequer reservoirs, respectively). Flows from the mainstem San Joaquin River are controlled by Friant Dam. The significant reduction in outflow from the San Joaquin River caused by water development in the basin has significantly reduced production of chinook salmon in the basin. Increasing base-flow releases from the tributary reservoirs would increase habitat in the mainstem San Joaquin River for rearing and for upstream and downstream migration of fall-run and late-fall-run chinook salmon, rainbow trout, and steelhead and for spawning and rearing habitat of American shad, white and green sturgeon, and splittail from the Merced River confluence to Vernalis.* *Escapement of chinook salmon in the San Joaquin River basin appears to be strongly improved by high April through June flows at Vernalis and low exports during the year of outmigration (California Department of Fish and Game 1992, 1993; Carl Mesick Consultants 1994). Based on this relationship, the USFWS (1995) recommended base flows for Vernalis by water-year type to meet the goals of the Anadromous Fish Restoration Program.* *Flows from Friant Dam to Gravelly Ford should be managed to maintain native resident fish populations until an evaluation of the potential to restore anadromous salmonids is completed.* *Natural stream-meander belts in alluvial systems transport and deposit sediments and provide transient habitats important to algae, aquatic invertebrates, and fish, as well as substrates (surfaces on which plants and animals can live) for colonization by riparian vegetation.*	
Stream Meander	Restore and maintain a defined stream-meander zone on the San Joaquin River between Vernalis and the mouth of the Merced River	Develop a cooperative strategy to acquire or obtain easements on floodplain and riparian land.	

D-059285

Category	Target	Action	Species of Benefit
	Justification: *Preserving and improving the stream meander belt below the mouth of the Merced River will ensure that this important natural process is maintained in the San Joaquin River. This reach is important for migrating and rearing salmon and steelhead and other anadromous and resident fish species. A natural meander process will provide excellent habitat for spawning (through gravel recruitment), rearing (channel form, cover, and foodweb), and migration. The stream channel meander program must be consistent with flood control requirements and, in the longer term, should reduce the need for future flood control efforts by using natural system resilience and flood control characteristics.*		
Natural Floodplain and Flood Processes	Restore floodplain-river interactions in the San Joaquin River between Vernalis and the mouth of the Merced River	Develop a cooperative program to evaluate the potential for levee deauthorization, levee removal, or levee setbacks.	
		Develop a cooperative strategy to acquire or obtain easements or ownership of floodplain along the lower San Joaquin River.	
	Justification: *Setback levees will provide more floodplain flooding, room for stream meander, and more riparian forest and seasonal wetland habitats along the lower San Joaquin River. Channel form adjustments may be necessary to accelerate restoration of natural floodplain habitats and to restore and maintain configurations that may not occur naturally due to remaining constraints from the new setback levees. Permanent structures such as bridges and diversions dams can interrupt and impair natural floodplain processes and habitat development and succession, thus requiring removal of the structures, rebuilding, or some continuing maintenance or mitigation to minimize their effects.* *Major flood flows along the San Joaquin River periodically exceed flow capacity within the river levees, causing local and regional flooding. Even lesser flows can result in seepage damage to levees and lands adjacent to the floodway. The U.S. Army Corps of Engineers investigated the potential for a demonstration project for distributing peak flood flows over land on wildlife refuges adjacent to the river. A previous analysis of the West Bear Creek Floodplain Restoration Project was a joint effort by the U.S. Fish and Wildlife Service and the California Department of Water Resources using the San Joaquin Basin Action Plan interagency agreement and the San Joaquin River Management Program funding. Recently, the CALFED Category III restoration program provided funding to the USFWS to conduct a feasibility study for this floodplain restoration program.*		
Stream Temperatures	Manage reservoir releases and other factors to provide suitable water temperatures for important resources from the Merced River confluence to Vernalis	Evaluate the feasibility of releasing sufficient instream flows to improve the temperature regime for important resources.	
		Evaluate the use of upstream temperature control devices and reservoir management options to reduce water temperatures during critical periods	

Category	Target	Action	Species of Benefit
		Develop a cooperative program to evaluate the potential for restoring riparian vegetation to reduce water temperatures.	
		Develop a cooperative program to evaluate the impact of discharge returns on stream temperature.	
	Justification: *Water temperatures in the mainstem San Joaquin River between the Merced River confluence and Vernalis in the fall and spring often exceed stressful or lethal levels for upstream and downstream migrating fall-run chinook salmon. High temperatures are thought to delay migration in the fall (DFG 1992) and increase mortality of rearing and outmigrating juveniles in the spring (DFG 1993). When the Vernalis flow is 5,000 cfs. or less in May, water temperatures are at levels of chronic stress. Maintenance of improved base flows in the fall and spring will increase survival of up and downstream migrating chinook salmon.*		
Riparian and Riverine Aquatic Habitat	Restore 50 stream miles of diverse, self-sustaining riparian community	Develop a cooperative program to restrict further removal of riparian vegetation.	
		Develop a cooperative program to restore riparian habitat.	
		Improve land management and livestock grazing practices along streams and riparian zones.	
	Justification: *Because of high-flow-event reduction, stream channelization, livestock grazing, gravel extraction, and direct loss of habitat to agriculture and urban development; the extent of riparian vegetation along the mainstem San Joaquin River has been significantly reduced. Before they were disturbed, riparian forests were an important component of the mosaic of habitats in the San Joaquin Valley, providing habitat for a variety of native wildlife species. The riparian community provides nutrients and woody debris to the aquatic system, along with shade and increased bank stability. The importance of restoring riparian habitat has been identified by DFG (1993) and USFWS (1997).*		
Water Diversions	Reduce entrainment of fish and other aquatic organisms into diversions by 50%, by volume, from the Merced River confluence to Vernalis	Develop a cooperative approach to install state-of-the-art fish screens at El Solyo, Patterson, and West Stanislaus Irrigation District diversions.	
		Develop a cooperative program to evaluate the feasibility of installing state-of-the-art screens on small and medium-sized diversions.	
	Eliminate the loss of adult fall-run chinook salmon straying into the San Joaquin River upstream of the Merced River confluence	Continue annually installing a temporary weir on the San Joaquin River immediately upstream from the confluence with the Merced River to block adult salmon migration.	

Category	Target	Action	Species of Benefit
	Justification: *Three large water diversions are between the Merced River confluence and Vernalis on the mainstem San Joaquin River: El Solyo, West Stanislaus, and Patterson Irrigation District diversions. Fish screens were installed at these diversions in the late 1970s; however, because of the scarcity of returning salmon, the inappropriate design and inefficiency of the screens, and the high cost of maintenance; the screens were abandoned within a few years. Together, these diversions can withdraw a significant portion of the mainstem riverflow, particularly during dry water years. Irrigation diversions take place during the juvenile salmon outmigration. In addition, many, small or medium-sized diversions are on this reach of the San Joaquin River.* *In recent years, drainage practices in western Merced County have increased agricultural return flows from Salt and Mud Sloughs into the mainstem San Joaquin River. These flows attract significant numbers of adult salmon into the sloughs and, subsequently, into irrigation canals where no spawning habitat is available (DFG 1993). In fall 1991, 31% of the run in the San Joaquin River basin is estimated to have strayed into westside canals. In the late 1980s, DFG established an adult trapping station at Los Banos Wildlife Refuge at which eggs were taken for rearing at the Merced River Fish Facility. In fall 1992, DFG installed a temporary electrical barrier across the mainstem San Joaquin River immediately upstream from the confluence with the Merced River; this was extremely effective in blocking fish passage into the westside irrigation canals. Since then, a temporary weir has been installed at the site annually, and this has also been effective in blocking passage.*		
Levees, Bridges, and Bank Protection	Set back 10 miles of levees along the San Joaquin River between the Merced River confluence and Vernalis where feasible to reestablish the hydrologic connectivity between these channels and natural floodplains	Develop a cooperative strategy to evaluate the potential for levee deauthorization or relocation. Develop a cooperative program to acquire or obtain easements on floodplain and riparian land needed to meet restoration goals.	
	Justification: *Natural stream meander belts in alluvial systems function to transport and deposit sediments and provide transient habitats important to algae, aquatic invertebrates, and fish, as well as providing substrates for colonization by riparian vegetation. Setting back levees along the San Joaquin River encourages natural stream meander and flooding processes*		
Land Use	Restore the fine sediment regime, maintaining the balance between fine sediment input and transport from the system	Develop a cooperative program to improve land management and livestock grazing practices along streams and riparian zones and reduce streambank erosion and sediment input.	
		Develop a cooperative program to remove fine sediments from the stream channel.	
		Facilitate transport of fine sediments by restoring the balance between river channel configuration, flow regime, and sediment supply.	
	Justification: *Land use and livestock grazing practices adjacent to the San Joaquin River have increased streambank erosion and fine sediment input from historical levels. Accumulating fine sediments have caused channel buildup. Improving land use and livestock grazing practices along the mainstem San Joaquin River and tributaries will reduce streambank erosion and the input of fine sediments.*		

Category	Target	Action	Species of Benefit
Contaminants	Reduce losses of fish and wildlife from use of pesticides, hydrocarbons, heavy metals, and other pollutants in the basin	Provide additional funding to enforce State laws regarding point- and nonpoint-source pollution.	
		Develop a cooperative program to strengthen water quality standards as needed.	
		Work with local landowners and State and federal agencies to improve land management practices to reduce contaminant input.	
		Evaluate the use of real-time releases from tile drainage.	
	Justification: *Poor water quality resulting from point- and nonpoint-source discharge of toxic chemicals and other pollutants may affect anadromous fish survival in the San Joaquin River basin. Drainage practices in western Merced County result in highly saline and pollution-laden agricultural return flows from Salt and Mud Sloughs into the mainstem San Joaquin River above the confluence with the Merced River. Contaminant input from this area also affects water quality in the downstream Sacramento-San Joaquin Delta Ecological Zone.*		

East San Joaquin Basin Ecological Management Zone

This zone includes:

- Stanislaus River
- Tuolumne River
- Merced River.

Category	Target	Action	Species of Benefit
Streamflow	Maintain the following base flows in the Stanislaus River below Goodwin Dam: ■ in critical, dry, and below-normal years, minimum flows should be 200 to 300 cfs, except for a flow event of 1,500 cfs for 30 days in April and May, ■ in above-normal years, minimum flows should be 300 to 350 cfs, except for 800 cfs in June and 1,500 cfs in April and May, and ■ in wet years, minimum flows should be 300 to 400 cfs, except for 1,500 cfs from April through June.	Develop a cooperative approach to coordinate flow releases to attain target levels.	
	Provide the following 10-day spring flow events on the Stanislaus River: 2,500 to 3,000 cfs in late April or early May in normal years and 3,000 to 4,000 cfs in wet years. Such flows would be provided only when inflows to New Melones Reservoir are at these levels	Develop a cooperative approach to coordinate flow releases to attain target levels.	

Category	Target	Action	Species of Benefit
	Maintain the following base flows in the Tuolumne River below Don Pedro Dam: ■ in critical and below years, flow release should be 50 cfs from June through September, 100 cfs from October 1-15, 150 cfs from October 16-May 31, plus an 11,091 acre-foot outmigration pulse flow, ■ in median critical dry years, flow release should be 50 cfs from June through September, 100 cfs from October 1-15, 150 cfs from October 16- May 31, plus a 20,091 acre-foot outmigration pulse flow, ■ in intermediate critical dry years, flow release should be 50 cfs from June through September, 150 cfs from October 1-15, 150 cfs from October 16- May 31, plus a 32,619 acre-foot outmigration pulse flow, ■ in median dry years, flow release should be 75 cfs from June through September, 150 cfs from October 1-15, 150 cfs from October 16- May 31, plus a 37,060 acre-foot outmigration pulse flow, ■ in intermediate dry-below normal years, flow release should be 75 cfs from June through September, 180 cfs from October 1-15, 180 cfs from October 16- May 31, plus a 35,920 acre-foot outmigration pulse flow and a 1,676 acre-foot attraction pulse flow, ■ in median below normal years, flow release should be 75 cfs from June	Develop a cooperative approach to coordinate flow releases to attain target levels.	

Category	Target	Action	Species of Benefit
	Maintain the following base flows in the Merced River below Lake McClure: ■ in dry years, minimum instream flows at Shaffer Bridge should be 15 cfs from June through October 15, 60 cfs from October 16 through October 31 and January through May, and 75 cfs in November and December, and ■ in normal years, minimum instream flows at Shaffer Bridge should be 25 cfs from June through October 15, 75 cfs from October 16 through October 31 and January through May, and 100 cfs in November and December.	Develop a cooperative approach to coordinate flow releases to attain target levels.	
	Provide the following 10-day spring flow events on the Merced River: 1,000 to 1,500 cfs in late April or early May in dry years, 2,000 to 2,500 cfs in normal years, and 3,000 to 4,000 cfs in wet years. Such flows would be provided only when inflows to Lake McClure are at these levels	Develop a cooperative approach to coordinate flow releases to attain target levels.	
	Justification: *Flows in the Stanislaus, Tuolumne, and Merced Rivers are controlled by releases from foothill storage reservoirs (New Melones, New Don Pedro, and New Exchequer Reservoirs, respectively). Improving base flows would increase habitat for spawning, rearing, and migration of salmon and steelhead. Pulse flows in spring would help to restore natural stream channel processes; gravel recruitment, cleansing, and transport; and riparian vegetation development and survival. These flows also would help to support juvenile salmon and steelhead emigration to the Delta.*		

Category	Target	Action	Species of Benefit
	In all cases, flows will continually subject to the developing aspects of adaptive management in which decisions are based on the development and evaluation of testable hypotheses. Flow recommendations are linked to water quantity and quality and in the long-term should be designed to contribute to species maintenance and restoration, improving natural or semi-natural ecological functions, and assist in promoting the sustainability of specific types of habitat important to fish, wildlife and plant communities. *Given the wide variety of past and recent flow recommendations, it is apparent that much additional information is required to better use existing water supplies to meet all the beneficial uses, with particular focus on the ecosystem requirements. The basis for ERPP flow recommendations eventually will differ significantly from flow recommendations based on the needs of chinook salmon migration, spawning, and rearing. Salmon flows will likely continue to form the core of flow needs, but from the ecosystem perspective, flows will need to meet the need of sediment transport and other channel maintenance processes as well as contribute to sustaining a diversity of aquatic, floodplain and other closely linked habitats such as seasonal wetlands and riparian forests. Still, the present recommendations for "ecosystem" flows suffer from insufficient data regarding better estimates of sediment transport and channel maintenance flows. These are very important aspects of integrating flow prescriptions with actual ecosystem restoration requirements and will require the development of testable hypotheses and the monitoring and research programs necessary to collect and evaluate data to support or refute the hypotheses.* *The recommended flow event on the Stanislaus River may be constrained in the short-term by flood control concerns below Goodwin Dam. Full implementation of the proposed flows may depend on land use changes in the floodplain that could be inundated by the flow events. The flow event is closely related to recommendations in this section regarding stream meander corridor and natural floodplains and flood processes.* *Minimum flows are necessary in the salmon and steelhead spawning and rearing areas of each of the three rivers to sustain adequate physical habitat, water temperatures, and food supply for juvenile salmon and steelhead, both of which may be year-round residents. In some cases, base flows may be higher than unimpaired flow. Such flows are necessary, because spawning and rearing habitats for juvenile salmon and steelhead, traditionally located upstream of the dams, now are located downstream.* *Flow events are recommended during spring to more closely emulate the natural spring peak-flow pattern. Such flows stimulate and support downstream juvenile salmon and steelhead migration. The spring flow will also mobilize, clean, and transport spawning gravels; create point bars and other instream habitat types; and contribute to a natural channel meandering pattern and riparian scrub and woodland habitat development and maintenance.* *DFG (1993) believes existing flow requirements are inadequate for fall-run chinook salmon migration, spawning, egg incubation, juvenile rearing, and smolt emigration on the Merced River. Adequate releases for upstream attraction of adults and spawning begin on November 1, but migration typically begins in October. The current spawning and rearing flow requirements are not the result of scientific studies and may be too low to meet spawning and rearing needs. Flows in the spawning reach during the spawning and early rearing period are further depleted by water diversions. Spring flows for smolt emigration are particularly inadequate.* *Flow targets recommended by DFG (1993) for the lower Merced River were derived from instream flow study and smolt survival data from similar drainages. Recommended flows during the spring emigration period are consistent with proposed spring outflow objectives for the basin at Vernalis on the San Joaquin River. Although the proposed flows are a significant improvement over the current flow releases, they are not the most favorable for salmon spawning, rearing, or emigration, particularly in drier years (California Department of Fish and Game 1993).*	

Category	Target	Action	Species of Benefit
Natural Sediment Supply	Maintain existing levels of erosion and gravel recruitment in tributaries that sustain an adequate level of gravel recruitment, or restore desirable levels by directly manipulating and augmenting gravel supplies where the natural flow process has been interrupted by dams or other features that retain or remove the gravel supply	Evaluate the feasibility and need for establishing long-term sediment augmentation programs for streams below major impoundments in the East San Joaquin Ecological Zone.	
		Evaluate spawning gravel quality in areas used by chinook salmon in the Stanislaus River. If indicated, renovate or supplement gravel supplies to enhance substrate quality by importing additional gravel as conditions require.	
		Evaluate spawning gravel quality in areas used by chinook salmon in the Tuolumne River. If indicated, renovate or supplement gravel supplies to enhance substrate quality.	
		Evaluate spawning gravel quality in areas used by chinook salmon in the Merced River. If indicated, renovate or supplement gravel supplies to enhance substrate quality	
	Justification: *Gravel transport is the process whereby flows carry away finer sediments that fill gravel interstices (spaces between cobbles). Gravel cleansing is the process whereby flows transport, grade, and scour gravel. Gravel transport and cleansing, by flushing most fines and moving bedload, are important processes to maintain the amount and distribution of spawning habitat in the Sacramento-San Joaquin River basin. Human activities have greatly reduced or altered these processes. Opportunities to maintain and restore these processes include changing water flow, sediment supplies, and basin geomorphology (earth forming process); removing stressors; or manipulating channel features and stream vegetation directly.* *A feasibility study that emphasizes the hydrologic and fluvial geomorphologic aspects of the three watershed need to be conducted early in the program to provide guidance of the development and implementation of potential sediment augmentation programs. This will require the expertise and knowledge of trained experts. It may be that gravel deposits in streams of the East San Joaquin Basin Ecological Zone are essential to maintain spawning and rearing habitats of fall-run chinook salmon, steelhead, and other native fish. Opportunities to maintain and restore gravel recruitment include manipulating natural processes and controlling or managing environmental stressors that adversely affect recruitment.*		
Stream Meander	Preserve and expand the stream-meander belts in the Stanislaus, Tuolumne, and Merced Rivers by adding a cumulative total of 1,000 acres of riparian lands in the meander zones	Acquire riparian and meander-zone lands by purchasing them directly or acquiring easements from willing sellers, or provide incentives for voluntary efforts to preserve and manage riparian areas on private land.	

Category	Target	Action	Species of Benefit
		Build local support for maintaining active meander zones by establishing a mechanism through which property owners would be reimbursed for lands lost to natural meander processes.	
		Develop a cooperative program to improve opportunities for natural meander by removing riprap and relocating other structures that impair stream meander.	
	On the Merced River between the towns of Cressey and Snelling, isolate gravel pits, reconfigure (rearrange) dredge tailings, and restore a more natural channel configuration to 5 to 7 miles of disturbed stream channel. On the Tuolumne River, between river miles (RMs) 25 and 51, isolate 15 to 30 gravel pits, reconfigure dredge tailings, and restore a more natural stream channel to 6 to 9 miles of disturbed stream channel. On the Stanislaus River, restore a more natural stream channel to 2.5 to 5 miles of disturbed stream channel	Develop a cooperative program, consistent with flood management, to restore more natural channel configurations to reduce salmonid predator habitat and improve migration corridors.	
		Work with permitting agencies to appropriately structure future gravel extraction permits. Coordinate the design and implementation of gravel pit isolation and stream channel configuration with the Corps, local water management agencies, and local governments.	
		Develop a cooperative program with the counties, local agencies, and aggregate (sand and gravel) resource industry to develop and implement gravel management programs for each of the three rivers.	
		Develop a cooperative program to implement a salmonid spawning and rearing habitat restoration program, including reconstructing channels at selected sites by isolating or filling in inchannel gravel extraction areas.	

Category	Target	Action	Species of Benefit
	Justification: *Stream meander, natural sediment supply, and floodplain and flood processes are closely linked and some of the programmatic actions under stream corridor would also be appropriate for natural sediment supply or floodplain processes. Between 1942 and 1993, approximately 6.8 to 13.6 million tons of bed material were mined from the active Merced River channel. The pits that resulted from this excavation occupy approximately 4 miles of the existing river channel between the towns of Cressey and Snelling (Kondolf et al. 1996). Restoration planning for the lower Tuolumne River has identified the need for channel reconstruction in approximately 8.5 total miles, or 42%, of the spawning reach (from RM 45.3 to RM 25.1), isolation of backwater areas at approximately 20 sites located from RM 50.3 to RM 30.1, and isolation of gravel pits from the active channel at approximately 10 locations from RM 50.0 to RM 30.5. Gravel mining was less extensive on the lower Stanislaus River, but channel improvements there are also needed.* *Stream channel restoration to isolate or reduce gravel extraction pits has been identified as an important component of a comprehensive spawning and rearing habitat improvement program in the basin (California Department of Fish and Game 1993, U.S. Fish and Wildlife Service 1995).* *Additional research or technical advice is required to better understand and develop specific projects designed to improve stream channel meander, improve sediment supplies, and to increase the benefits of the interaction of streams with their floodplains.*		
Natural Floodplain and Flood Processes	Restore and improve opportunities for rivers to inundate (flood) their floodplain on a seasonal basis	Conduct a feasibility study to construct setback levees in the Stanislaus, Tuolumne, and Merced River floodplains.	
		Restore, as needed, stream channel and overflow basin configurations within the floodplain.	
		Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes.	
		Develop a floodplain management plan for the Stanislaus River.	
		Develop a floodplain management plan for the Tuolumne River.	
		Develop a floodplain management plan for the Merced River.	

Category	Target	Action	Species of Benefit
	Justification: *Setback levees will provide greater floodplain inundation, room for stream meander, and greater amounts of riparian forest and seasonal wetland habitats along the lower rivers. Channel configuration adjustments may be necessary to accelerate restoration of natural floodplain habitats and to restore and maintain configurations that may not occur naturally due to remaining constraints from new setback levees. Permanent structures, such as bridges and diversions dams can interrupt and impair natural floodplain processes and habitat development and succession, thus requiring removal of the structures, rebuilding, or some continuing maintenance or mitigative efforts to minimize their effects.* *The present channel capacity of the Tuolumne river is about 9,000 cfs which is not large enough to meet the needs of maintaining a healthy alluvial river ecosystem. The January 1997 flood on the lower tuolumen River peaked at 60,000 cfs and provided a glimpse of the resiliency of the Tuolumne River. While the high flows damaged development in the floodplain, it also created alternate bars in the channel, recruited gravel from the banks as the river meandered, and placed large woody debris in the stream channel. As a result of the 1997 floods, the Governor's Flood Emergency Action Team Final Report (May 10, 1997) redommended that the U.S. Army Corps of Engineers conduct a study to increase the channel capacity in the Tuolumne river to convey flows up to 20,000 cfs. This would more than double the present 9,000 cfs capacity, mimic the seasonal peak to a greater degree, and provide additional ecological benefits while providing greater flexibility to manage floods. An expanded floodway on the Tuolumne river would also address the implementation objectives related to natural sediment supply, stream meander, and stream temperatures.* *Other benefits of improving the quantity of floodplains include:* ■ *increased shading and food web support,* ■ *re-establishment of stream meander, and* ■ *potential conversion of agricultural land to floodplain and the reduced need for diversion.*		
Stream Temperatures	Maintain maximum surface water temperatures on the lower Merced, Tuolumne, and Stanislaus Rivers to the downstream boundary of the salmon spawning area during fall and winter and to the mouth of the river during the spring as follows : ■ October 15 through February 15, 56°F, and ■ April 1 through May 31, 65°F.	Cooperatively evaluate the use of temperature control devices/reservoir management options to reduce water temperatures during critical periods. Evaluate the impact of irrigation returns on stream temperature.	

Category	Target	Action	Species of Benefit
	Justification: *Water temperatures in the lower rivers in fall and spring often exceed stressful or lethal levels for fall-run chinook salmon. High temperatures typically occur in drought periods, when storage levels in reservoirs have dropped sufficiently to allow warm surface waters to be included in storage releases to the lower river. Retaining water over the summer that may otherwise be released for downstream irrigation or other purpose may allow the cold water in the reservoirs to be retained through the early fall critical temperature period. Elevated temperatures are thought to delay migration and spawning (California Department of Fish and Game 1992), reduce egg survival, and increase mortality of rearing and outmigrating juveniles (California Department of Fish and Game 1993). The target temperature levels would maintain suitable habitat for chinook salmon for spawning, rearing, and outmigration throughout the lower rivers. These levels are identified in DFG (1993) and in USFWS (1995).*		
Riparian and Riverine Aquatic Habitat	Provide conditions for riparian vegetation growth along sections of rivers in the East San Joaquin Basin Ecological Zone	Purchase streambank conservation easements from willing sellers, or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Stanislaus River.	
		Evaluate the benefits of restoring aquatic and riparian habitats on the Stanislaus River, including creating side channels to serve as spawning and rearing habitats for salmonids.	
		Purchase streambank conservation easements from willing sellers, or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Tuolumne River.	
		Purchase streambank conservation easements from willing sellers, or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Merced River.	

Category	Target	Action	Species of Benefit
	Justification: *Many wildlife species, including several species listed as threatened or endangered under the State and federal Endangered Species Acts (ESA) and several special-status plant species in the Central Valley, depend on or are closely associated with riparian habitats. Riparian habitats support a greater diversity of wildlife species than all other habitat types in California. Degradation and loss of riparian habitat has substantially reduced the habitat area available for associated wildlife species. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions.* *Improving low- to moderate-quality SRA habitat will benefit juvenile chinook salmon and steelhead by improving shade, cover, and food. Other wildlife in this ecological zone will also benefit from improved habitat. Protecting and improving SRA habitat may involve land use changes that will require the consensus of local landowners and local, State, and federal agencies. Limitations on land suitable or available for restoration will require establishing priorities, with efforts directed at acquiring high-priority, low-cost sites first.* *Riparian habitat along the lower portions of the three rivers has been significantly reduced. Before the loss of habitats, riparian forests were an important component of the mosaic (mixture) of habitats in the San Joaquin Valley, providing habitat for many native wildlife species. The riparian community provides nutrient and woody debris input to the aquatic system, as well as shade and increased bank stability. To restore the riparian community along the lower rivers, further riparian vegetation removal should be restricted, improved land management and livestock grazing practices should be implemented, and a riparian restoration program should be developed and implemented. Restoration actions will need to be consistent with flood control requirements. The importance of riparian restoration was identified by DFG (1993) and USFWS (1995).*		
Water Diversions	Reduce entrainment of fish and other aquatic organisms into diversions to a level that will not impair salmon and steelhead restoration by screening 50% of the water volume diverted in the basin	Improve existing diversion screens on the lower Merced River.	
		Evaluate the feasibility of installing state-of-the-art screens on small pump agricultural diversions along the three streams.	
		Provide alternative water sources to diverters who legally divert water from spawning and rearing areas of the three streams.	
		Purchase water rights from willing sellers whose diversions entrain significant numbers of juvenile salmon or steelhead.	
	Justification: *Five medium-sized gravity riparian diversions are located in the designated salmon spawning reach of the lower Merced River between Crocker-Huffman Dam and the State Route 59 bridge. Water-powered screens and nominal bypass systems were installed on two larger diversions in the mid-1980s. Gabion-type screens without bypass systems remain on the other three diversions. In addition, DFG surveys have identified numerous small pump diversions throughout the basin, none of which are adequately screened to prevent juvenile salmon entrainment. Entrainment losses at these pump diversions are unknown. Screening 50% of the diverted water volume at diversions with greatest risk to juvenile salmon and steelhead, as determined by monitoring, will help to define further screening needs.*		

Category	Target	Action	Species of Benefit
Dams, Reservoirs, Weirs, and Other Structures	Eliminate the loss of adult fall-run chinook salmon that stray into the San Joaquin River upstream of the Merced River confluence	Develop a cooperative program to eliminate blockage of upstream-migrating fall-run chinook salmon and steelhead at temporary irrigation diversion dams erected during the irrigation season.	
		Continue annual installation of a temporary weir on the San Joaquin River immediately upstream of the confluence with the Merced River to block adult salmon migration.	
		Evaluate the need to remove temporary diversion dams that block upstream salmon and steelhead passage into spawning grounds of three streams.	
	Justification: *In recent years, drainage practices in western Merced County have increased agricultural return flows from Salt and Mud Sloughs into the mainstem San Joaquin River. These flows attract significant numbers of adult salmon into the sloughs and, subsequently, into irrigation canals, where no suitable spawning habitat is available (California Department of Fish and Game 1993). In fall 1991, an estimated 31% of the San Joaquin basin run strayed into westside canals. In the late 1980s, DFG established an adult trapping station at Los Banos Wildlife Refuge, where eggs were taken and reared at MRH. In fall 1992, DFG installed a temporary electrical barrier across the mainstem San Joaquin River immediately upstream from the confluence with the Merced River, which was highly effective in blocking fish passage into the westside irrigation canals. Since that time, a temporary weir has been installed at the site annually, which has also been effective in blocking passage.* *Temporary diversion dams are sometimes constructed in the river channel during the irrigation season. Such structures may hinder upstream salmon migration in the fall and early winter.*		
Predation and Competition	Reduce adverse effects of non-native fish species that have a significant effect on juvenile salmon production in the rivers	Eliminate gravel pits within or connected to the rivers.	
	Justification: *Introduced warmwater fish, such as largemouth and smallmouth bass, prey on juvenile salmonids rearing in the lower Merced River. Predation has been identified as a major factor contributing to the poor survival of salmon smolts emigrating from the river. Large pit areas created by inchannel gravel mining are excellent habitat for warmwater fish. Implementing a predator control program has been identified as a salmonid restoration action by USFWS (1995). Habitat improvement actions described above should help to reduce predator populations of largemouth and smallmouth bass. Other species of possible concern include striped bass, American shad, and resident rainbow and brown trout. All potentially occur in the three rivers, and all are known to feed on juvenile salmon and possibly steelhead. If any of these species becomes a problem, steps will be taken to reduce their effects.*		

Category	Target	Action	Species of Benefit
Artificial Propagation	Minimize the likelihood that hatchery-reared salmon and steelhead could stray into adjacent non-natal rivers and streams to protect naturally produced salmon and steelhead	Cooperatively evaluate the benefits of limiting stocking of MRH-reared salmon and steelhead to the Merced River.	
	Employ methods to limit straying and loss of genetic integrity of wild and hatchery-supported stocks	Rear hatchery salmon and steelhead in hatcheries on natal streams to limit straying.	
		Limit stocking of salmon and steelhead fry and smolts to natal watersheds to minimize straying that may compromise the genetic integrity of naturally producing populations.	
	Justification: *In watersheds like the San Joaquin basin, where dams and habitat degradation have limited natural spawning, some hatchery supplementation may be necessary to sustain fishery harvest at former levels and to maintain a wild or natural spawning population during adverse conditions, such as droughts. However, hatchery augmentation should be limited so it does not inhibit recovery and maintenance of wild populations. Hatchery-reared salmon and steelhead might directly compete with and prey on wild salmon and steelhead. Straying of adult hatchery fish into non-natal watersheds might also threaten the genetic integrity of wild stocks. Hatchery fish might also threaten the genetic makeup of stocks in natal rivers. Some general scientific information and theory from other river systems indicate that hatchery supplementation may limit the recovery and long-term maintenance of naturally producing salmon and steelhead populations. Further research and experimentation are necessary to determine how this issue is addressed. Long-term hatchery augmentation of healthy wild stocks may genetically undermine that stock and threaten the genetic integrity of other stocks.* *Adult straying into non-natal streams might result in interbreeding with a wild population specifically adapted to that watershed and thus lead to the loss of genetic integrity in the wild population. Releasing hatchery-reared fish into the San Joaquin River and its tributaries, other than the Merced River, could compromise the genetic integrity of wild salmon and steelhead populations.*		
Land Use	Reduce sediment erosion into streams	Develop a cooperative program to protect existing riparian habitat and improve degraded habitats, where possible, through land use actions.	
		Cooperatively evaluate the feasibility of constructing sediment retention basins to reduce fine sediment input.	
		Encourage improved land management and livestock grazing practices along stream/riparian zones to reduce streambank erosion and sediment input.	

Category	Target	Action	Species of Benefit
	Justification: *Land use and livestock grazing practices used adjacent to the lower rivers have increased streambank erosion and fine sediment input to the streams over historical levels. Fine sediments accumulate in salmonid spawning gravel and reduce habitat quality. USFWS (1995) recommended constructing sediment retention basins to reduce fine sediment input. DFG (1993) and USFWS (1995) recommend improved land management and livestock grazing practices to reduce streambank erosion and fine sediment input.*		