Chapter 5

Fisheries

Chapter 5. Fisheries

INTRODUCTION

The study area for Alternatives 4 through 8 includes portions of the Sacramento River and American River basins and the Delta similar to the project areas considered in the 1997 DEIR/EIS, which provides a detailed discussion of fishery resources in the project areas. This information is summarized briefly below.

AFFECTED ENVIRONMENT

Since the 1997 DEIR/EIS was released, three additional fish species have been listed as threatened under the federal Endangered Species Act. These new listings are:

- Central Valley steelhead Evolutionarily Significant Unit (ESU) (63 FR 11481, March 9, 1998).
- Splittail (64 FR 5963, February 8, 1999).
- Central Valley spring-run chinook salmon ESU (64 FR 50394, September 6, 1999).

Spring-run chinook salmon was also listed as threatened under the California Endangered Species Act on February 5, 1999. In addition, the Delta has been designated as critical habitat for steelhead and spring-run chinook salmon under the federal act (65 FR 7764, February 16, 2000). Impacts on these species were fully evaluated in the 1997 DEIR/EIS.

Summary of Fishery Resources

This section summarizes information from the 1997 DEIR/SEIS regarding fisheries in Folsom Reservoir, the lower American River, Sacramento River, Shasta and Trinity lakes, and the Delta. Information on water temperatures in the lower American River, an important assessment variable for fisheries, is also provided. The discussion focuses on legally protected species, including chinook salmon, steelhead, delta smelt, and splittail.

Folsom Reservoir

Folsom Reservoir's fishery includes both warmwater and coldwater species. Important warmwater game species include black bass (largemouth and smallmouth bass), sunfish, and catfish (Table 5-1). Coldwater species include rainbow trout and landlocked sockeye salmon (kokanee). Annual hatchery plants of subcatchable- and catchable-size rainbow trout sustain a seasonal (primarily winter and spring) trout fishery.

Apart from the low productivity of human-made reservoirs overall, water level fluctuations generally are considered the most significant environmental factor influencing reservoir fish productivity. Folsom Reservoir typically fluctuates more than 60 feet annually, resulting in direct and indirect effects on reservoir fish populations. Reservoir drawdowns during late spring and summer can adversely affect the reproductive success of littoral (nearshore) spawners (e.g., bass, sunfish) by disrupting spawning activity, dewatering nests, or exposing nests to wave action. Reproductive success may also be adversely affected by coldwater intrusion resulting from rising reservoir levels during spring.

Declining water levels also can reduce the extent of suitable littoral habitat available for spawning and rearing. Generally, fish production increases with greater reservoir surface area and water level stability during sensitive spawning and early rearing periods.

Thermal stratification of Folsom Reservoir during summer and fall provides important coldwater habitat for salmonids. Little or no successful salmonid spawning is believed to occur in Folsom Reservoir.

Table 5-1. Fish Species of Folsom Reservoir and the Lower American River

Common Name	Scientific Name	Folsom Reservoir	Lower American River
Steelhead/rainbow trout	*Oncorhynchus mykiss*	X	X
Kokanee (sockeye salmon)	*Oncorhynchus nerka*	X	
Chinook salmon	*Oncorhynchus tshawytscha*		X
Brown trout	*Salmo trutta*	X	X
American shad	*Alosa sapidissima*		X
Threadfin shad	*Dorosoma petenense*	X	X
White sturgeon	*Acipenser transmontanus*		X
Pacific lamprey	*Lampetra tridentata*		X
River lamprey	*Lampetra ayresi*		X
Goldfish	*Carassius auratus*	X	X
Common carp	*Cyprinus carpio*	X	X
California roach	*Hesperoleucus symmetricus*		X
Hitch	*Lavinia exilicauda*		X
Hardhead	*Mylopharodon conocephalus*		X
Golden shiner	*Notemigonus crysaleucas*	X	
Sacramento blackfish	*Orthodon microlepidotus*		X
Fathead minnow	*Pimephales promelas*		X
Splittail	*Pogonichthys macrolepidotus*		X
Sacramento pikeminnow	*Ptychocheilus grandis*		X
Speckled dace	*Rhinichthys osculus*		X
Sacramento sucker	*Catostomus occidentalis*	X	X
White catfish	*Ictalurus catus*	X	X
Black bullhead	*Ictalurus melas*	X	X
Brown bullhead	*Ictalurus nebulosus*	X	X
Channel catfish	*Ictalurus punctatus*	X	X
Largemouth bass	*Micropterus salmoides*	X	X
Smallmouth bass	*Micropterus dolomieui*	X	X
Warmouth	*Lepomis gulosus*	X	X
Bluegill	*Lepomis macrochirus*	X	X
Redear sunfish	*Lepomis microlophus*	X	X
Green sunfish	*Lepomis cyanellus*	X	X
White crappie	*Pomoxis annularis*	X	X
Tule perch	*Hysterocarpus traski* ssp.		X
Inland silverside	*Menidia beryllina*		X
Threespine stickleback	*Gasterosteus aculeatus*		X
Wakasagi	*Hypomesus nipponensis*	X	
Riffle sculpin	*Cottus gulosus*		X
Prickly sculpin	*Cottus asper*		X

Lower American River

Background

Many species of game and nongame fish are found in the lower American River (Table 5-1). Anadromous species include chinook salmon, steelhead, striped bass, American shad, and Pacific lamprey. Resident game fish include rainbow trout, largemouth bass, smallmouth bass, sunfish, and catfish. Common nongame species include Sacramento sucker, Sacramento pikeminnow, tule perch, and riffle sculpin. Protected species that may occur in the lower American River, as well as the Sacramento River, are the delta smelt, splittail, winter-run chinook salmon, spring-run chinook salmon, and steelhead. Information on chinook salmon, steelhead, striped bass, American shad, splittail, and Delta smelt is provided below.

The aquatic environment and fish fauna of the lower American River have been altered substantially from prehistoric conditions by several factors, including construction of early dams at various points along the river, construction of Folsom and Nimbus dams in the 1950s, regulation of river flows, and introduction of nonnative species. The construction of Folsom and Nimbus dams, as well as earlier dams, blocked access and inundated much of the historical salmon and steelhead spawning and rearing habitat above the dam sites. Anadromous species are now limited to the lower 23 miles of the American River from Nimbus Dam to the confluence with the Sacramento River. Upstream reservoir operations modified the seasonal flow extremes of the lower American River before Folsom and Nimbus dam construction, resulting in higher discharges during summer and fall and lower discharges during winter and spring. Water temperature regimes have also been altered by the operation of Folsom and Nimbus dams. The effects of these changes are discussed later.

Fishery resources of the lower American River also are subjected to relatively rapid flow fluctuations, resulting from the operation of Folsom Reservoir to meet Delta water quality standards and CVP water contract obligations. Flow fluctuations can cause adverse effects during the chinook salmon and steelhead incubation and juvenile rearing periods. Lowering river levels can cause mortality of eggs and larvae by exposing redds (nests), reducing flow rates through the redds, or increasing water temperatures. Rapid flow fluctuations during the early rearing period can trap juveniles in isolated pools and backwaters, where they are subjected to elevated water temperatures, low dissolved oxygen levels, and high predation rates. The most critical stranding problems in the lower American River occur when flows are reduced below 1,500 cfs following a rapid flow increase (McEwan 1991). Other potential adverse effects of flow fluctuations on fish populations include reduced production of aquatic food organisms, rapid changes in physical habitat conditions, and loss of temperature stratification in pools.

Nimbus Salmon and Steelhead Hatchery, which is operated by CDFG, was completed in 1955 to compensate for salmon and steelhead losses caused by construction of Folsom and Nimbus dams. The hatchery produces smolt-size fall-run chinook salmon and yearling steelhead, which are transported and released directly into the Sacramento–San Joaquin River estuary. Waters released from Nimbus Dam that exceed 56°F have historically caused mortality to chinook salmon eggs taken at the hatchery. Exposure of chinook incubated eggs and juveniles to temperature stress at the hatchery has been reduced in part by delaying the take of eggs and releasing juveniles directly into the Delta (Sacramento Area Flood Control Agency et al. 1994). Reared steelhead and chinook salmon eggs also have been transported to hatcheries on the Feather and Mokelumne Rivers to avoid mortality during summer and fall, since conditions on these rivers are generally more favorable.

Flow Requirements

Hodge Decision Flows. As discussed in detail in the 1997 DEIR/EIS, in Environmental Defense Fund et al. v. East Bay Municipal Utility District, Alameda County Case No. 425,955, the court conditioned EBMUD's right to take delivery of its contract entitlement to periods when certain instream flow requirements, aimed at protecting public trust values in the lower American River, were met. The Hodge Decision (1990) requires that flows of 2,000 cfs from October 15 through February, 3,000 cfs from March through June, and 1,750 cfs from July through October 14 be met before EBMUD can take delivery of water from the FSC (Table 5-2). These flows were based on input from CDFG, USFWS, EBMUD, and the County of Sacramento and fall within the ranges recommended by these agencies. The court decision reserved jurisdiction if new evidence supports adjustments of the recommendations. EBMUD has been contributing to the Hodge Decision studies of fisheries by collecting data at six to eight locations along the lower American River. These data have been used to calibrate the temperature record used for the impact assessment (Appendix D of the 1997 DEIR/EIS).

Fisheries Resources

The primary management species and most economically important fish species in the lower American River are fall-run chinook salmon, steelhead, American shad, and striped bass. Splittail is also known to occur in the lower American River. Species life history, habitat requirements, and distribution are described below. The potential occurrence of other special-status species in the lower American River is also described.

The water temperature requirements for fall-run chinook salmon and steelhead are discussed in Appendix D of the 1997 DEIR/EIS.

Chinook Salmon. Chinook salmon produced in the American River substantially contribute to the sport and commercial salmon fisheries of California. Commercial catches of American River-produced chinook salmon averaged about 120,000 fish annually in 1967–1981 (USFWS 1985). On average, ocean and river sport anglers land another 60,000 fish (Mills and Fisher 1993). The 1967–1991 annual spawning escapement of American River-produced chinook salmon (i.e., adults not captured by commercial and sport fisheries that return to the lower American River to spawn) averaged 41,000 fish.

Chinook salmon are anadromous, migrating to sea as juveniles and returning to fresh water to spawn as adults. The lower American River is known to support fall-run chinook salmon only. Adult chinook salmon enter the American River in September and October and may continue to arrive through January. Spawning usually extends from October to January, with peak spawning in November. Nearly all chinook salmon in the lower American River spawn in the upper seven miles of the river (Vyverberg et al. 1996). Chinook salmon production in the lower American River is supplemented by hatchery-reared fish originating from the Nimbus Salmon and Steelhead Hatchery. Estimates of the hatchery contribution to annual adult returns range from 33 percent to 80 percent (Dettman and Kelley 1987, Cramer et al. 1990).

Chinook salmon females deposit their eggs in redds, which they excavate in the gravel bottom. The eggs are fertilized by one or more males. Chinook salmon eggs generally hatch in six to nine weeks, and yolk-sac larvae remain in the gravel several more weeks. The time of fry emergence generally extends from mid-December through mid-April. A large percentage of young chinook salmon less than 50 millimeters (mm) long (fry) migrate out of the lower American River immediately or soon after emergence in late winter and early spring (Snider and Titus 1995). The remaining fry continue to rear and emigrate as juveniles in April, May, and June. Fish that remain in the river are believed to have higher survival rates than early migrating fry because of their larger size during emigration (Rich and Leidy 1985). However, fish that emigrate as fry may also provide an important contribution to the gene pool in years when the Delta provides better conditions than the lower American River.

Winter-run chinook salmon, designated an endangered species under the federal and state Endangered Species Acts, may occur in the lower American River. USFWS has raised concern regarding the potential occurrence of winter-run chinook salmon in the lower American River, citing evidence that juvenile chinook salmon in the winter-run size range (greater than 80 mm fork length) were caught by CDFG in 1992 in the American River above the

Table 5-2. Suggested Flow Requirements for the Lower American River by Agency for the Maintenance and/or Enhancement of Chinook Salmon

Agency	Time Period	Flow Requirement
California Department of Fish and Game (IFIM data interpretation)[a, b]	October 15–February	1,750–4,000
	March–June	3,000–6,000
	July–October 15	1,500
U.S. Fish and Wildlife Service (IFIM study)[a, c]	October 15–December	1,750–2,000
	January–March	1,250
	April–June	1,750–2,000
East Bay Municipal Utility District[d]	October 15–December	1,500–2,000
	January–March 15	1,250–30,000
	March 16–May 15	750–1,250
	May 16–June	2,000
County of Sacramento Necessary flows (flows necessary for the protection of instream and public trust values)[a]	October	2,500
	November	3,000
	December	3,500
	January–March	4,000
	April–May	4,500
	June	4,000
Hodge Decision flows[e]	October 15–February	2,000
	March–June	3,000
	July–October 14	1,750

[a] California State Water Resources Control Board 1988a.
[b] California Department of Fish and Game 1986.
[c] U.S. Fish and Wildlife Service 1985.
[d] Kelley et al. 1995.
[e] Hodge Decision (1990).

IFIM = Instream Flow Incremental Methodology

backwater influence of the Sacramento River (McInnis pers. comm.). Although these fish were in the predicted size range for winter-run chinook salmon, overlap in the sizes of different chinook salmon races makes accurate identification difficult (USFWS 1997a). Therefore, the potential exists for winter-run juveniles to temporarily enter the lower American River for additional rearing before continuing their seaward migration. Based on the general timing of rearing and downstream migration in the lower Sacramento River, winter-run chinook salmon may occur in the lower American River from October through May, with the greatest potential from December through April. The designated critical habitat of winter-run chinook salmon does not include the American River.

Steelhead. Steelhead are an important component of the sport fishery of the lower American River. Although current estimates of the annual steelhead run size are unavailable, run sizes in 1971–1972 and 1973–1974 were estimated at 19,583 and 1,274, respectively (McEwan 1991).

Adult steelhead that are two to four years old return from the ocean and enter the lower American River from October through May, with peak numbers in January and February. Limited feeding occurs while adults are between December and April. A small fraction of the adults survives spawning and returns to the ocean between April and June.

Like chinook salmon, female adult steelhead deposit their eggs in excavated redds. Egg incubation generally extends from December through May. Fry emergence usually occurs in April and May but can extend into June. After emergence, juveniles spend one to two years in the river before migrating to the ocean. Emigration typically occurs in March.

Because of low natural production, most adult steelhead returning to the lower American River are of hatchery origin (Snider and Gerstung 1986). Poor steelhead production is exacerbated by several factors in the lower American River. Nearly all the historical spawning and rearing habitat for steelhead in the American River was blocked by Nimbus Dam. High water temperature in summer and fall also is a major limiting factor for natural steelhead production. Water temperatures frequently exceed optimal levels for rearing at Nimbus Salmon and Steelhead Hatchery during July through October. Habitat conditions for juvenile steelhead are more degraded downstream of the hatchery, where water temperatures are even higher due to atmospheric warming (McEwan 1991).

Splittail. Reduced Delta outflow, water diversions, entrainment in diversions, dams, introduced aquatic species, loss of wetlands and shallow water habitats, and drought conditions appear to have contributed to the decline in splittail distribution and abundance (USFWS 1993).

Splittail are freshwater fish but are capable of withstanding moderate levels of salinity. Adult splittail move into upstream freshwater areas to spawn primarily during February through April. Migration patterns are not defined clearly, but spawning may be associated with rising temperatures and long periods of daylight in spring (Daniels and Moyle 1983). Splittail prefer to spawn over flooded streambanks and aquatic vegetation. Juveniles migrating upstream to spawn. Spawning occurs

rear in quiescent areas, moving to open water as summer progresses (Wang 1986). A temperature of 68°F is considered optimal for spawning and early rearing.

Adult splittail have been captured in the lower American River, but no information is available on splittail use of the river for spawning and rearing. During larval splittail surveys in April 1995, CDFG caught larval splittail in the Yolo and Sutter bypasses and in the lower Sacramento River, but none were caught in the American or Feather Rivers or in the Sacramento River above the Sutter Bypass (Baxter pers. comm.).

Delta Smelt. Delta smelt are found primarily in the Sacramento–San Joaquin River Estuary, although they may move as far upstream as the American River confluence during their spawning migration. The potential exists for delta smelt to occur in the lowermost reaches of the American River; however, field surveys indicate that their occurrence is rare. Declines in delta smelt abundance led to the listing of the species as threatened in 1993 under the federal Endangered Species Act (58 FR 12854, March 5, 1993).

Delta smelt are euryhaline (i.e., adapted to a wide salinity range) (Moyle et al. 1992). Except for spawning adults and recently hatched larvae and juveniles, delta smelt primarily inhabit the region of the estuary with salinities between 0.45 and 4.4 parts per thousand (ppt) (California Department of Water Resources and U.S. Bureau of Reclamation 1993). The location of this region varies from year to year depending on the volume of freshwater outflows, but it is generally in the western Delta and Suisun Bay. Delta smelt have been collected in the Sacramento River as far upstream as Verona, near the mouth of the Feather River, and in the San Joaquin River as far upstream as Mossdale (Wang 1991). Their normal downstream limit appears to be the western Suisun Bay, but they are sometimes washed into San Pablo Bay during high outflows. The entire Delta and Suisun Bay have been identified as critical habitat for delta smelt (59 FR 852, January 6, 1994). The critical habitat does not extend into the American River above the confluence with the Sacramento River.

Lower American River Water Temperature

Seasonal water temperatures in the lower American River have been altered substantially by Folsom and Nimbus reservoir operations. Water temperatures often exceed optimal levels for chinook salmon spawning in fall and for juvenile salmon and steelhead during spring and summer, especially in dry and critically dry water years. High summer water temperatures in the lower American River severely limit natural production of steelhead, which reside in fresh water for a full year or more before migrating to the sea. Significant reductions in Folsom Reservoir storage in dry and critically dry water years can cause water temperatures to exceed suitable levels for chinook salmon egg survival in October and November under current conditions, adversely affecting both natural and hatchery production. Reclamation has attempted to maintain 65°F at Watt Avenue over the past 2 years.

The temperature of water released from Folsom Reservoir into the lower American River is influenced by storage volume in Folsom Reservoir and by the elevation at which water is drawn into the power plant. The intake elevation to the power plant is controlled by panels on the trashrack. Operation of the panels and associated effects on release temperatures are described in Appendix D of the 1997 DEIR/EIS. Approximately 3 miles below Folsom Dam, the river enters Lake Natoma. Lake Natoma is relatively small (8,000-acre-feet capacity) but is large enough to allow water temperatures to stratify in spring and summer. Water is released from the bottom of Lake Natoma, but some of the release water is pulled from the upper elevations of the lake, so that release temperatures may be slightly warmer than bottom temperatures.

Generally, Folsom Reservoir release temperatures are cool, and water temperature tends to increase as the water flows down the lower American River. Folsom Reservoir release temperatures in fall and early winter, however, may be warmer relative to ambient air temperatures, and water temperatures may slightly decrease at lower flows as water flows down the river.

Before 1990, water temperature data were collected from three locations in the lower American River: Nimbus Salmon and Steelhead Hatchery (water drawn from the middle elevations of Lake Natoma), the U.S. Geological Survey (USGS) Fair Oaks gauge (1962 to 1978), and Fairbairn WTP (1984 to 1997). Since 1990, however, additional data have been collected by CDFG, Beak Consultants, and EBMUD at several additional locations along the river.

Recent temperature measurements from Hazel Avenue indicate that the hatchery temperatures are a good approximation of Lake Natoma release temperatures. For any particular month, the historical hatchery temperatures show a range of 8–13°F, with the coolest temperatures representing conditions that might be expected when Folsom Reservoir storage and flow through Lake Natoma are high.

During spring and summer, downstream water temperatures are higher than those near Nimbus Dam and may be more likely to be detrimental to some fish life stages. The longest record of temperatures measured downstream of the Hazel Avenue Bridge has been at Fairbairn WTP (1984–1997). Temperature measurements in the river at Fairbairn WTP (by Beak Consultants in 1990–1991) and at H Street (by EBMUD in 1991–1994) indicate that treatment plant temperatures are generally similar to river temperatures, although the plant temperatures are occasionally higher. The range of monthly temperature variations is approximately 10°F. Peak temperatures, historically reached in August, range from approximately 67°F to 77°F.

Downstream temperature measurements made in 1992 and 1993 show that water temperatures may continue to increase from H Street to the mouth of the river at the I-5 bridge.

Nimbus Salmon and Steelhead Hatchery

Nimbus Salmon and Steelhead Hatchery was completed in 1955 to compensate for salmon and steelhead trout losses caused by the construction of Folsom and Nimbus dams. The hatchery produces smolt-size fall-run chinook salmon and yearling steelhead, which are transported and released directly into the Sacramento–San Joaquin River Estuary. Waters released from Nimbus Dam that exceed 56°F have historically caused mortality to chinook salmon eggs taken at the hatchery. Exposure of chinook salmon eggs and salmon and steelhead juveniles to unsuitable temperatures at the hatchery has been reduced in part by delaying the take of eggs and releasing juveniles directly into the Delta (Sacramento Area Flood Control Agency et al. 1994). Reared steelhead also have been transported to hatcheries on the Feather and Mokelumne Rivers to avoid mortality during summer and fall.

Sacramento–San Joaquin Delta

The Delta provides important migration, spawning, and nursery habitats for numerous anadromous and resident fish species. Anadromous species use or depend on the Delta for some portion of their life cycle. The Estuary is the primary habitat for several euryhaline species, including the delta smelt. Special-status species that occur in the Delta include winter- and spring-run chinook salmon, steelhead, delta smelt, green sturgeon, and Sacramento splittail.

Delta environmental conditions depend primarily on the physical structure of Delta channels, volume of freshwater inflow, Delta Cross Channel operations, within Delta diversions (including Delta export pumping, small agricultural diversions, and others), and tidal fluctuations. These conditions determine Delta flow patterns, total Delta outflow to San Francisco Bay, and the location of the entrapment zone, which in turn influence fish distribution and survival through a variety of mechanisms related to water temperature, predation, food production and availability, physical habitat conditions, entrainment in Delta exports and diversions, competition with introduced fish and invertebrates, and pollutant levels.

Sacramento River

The Sacramento River between Keswick Dam and the Delta supports a diverse assemblage of anadromous and resident fish. Anadromous species include four runs of chinook salmon (fall-, late-fall-, winter-, and spring-run), steelhead, striped bass, American shad, white and green sturgeon, and Pacific lamprey. Chinook salmon and steelhead runs in the upper Sacramento River have declined substantially during the last 30 years. The winter-run chinook salmon, which has had record low run sizes in recent years, is designated an endangered species under the federal and state Endangered Species Acts. Resident game and nongame species in the Sacramento River include most of the species common to the lower American River (Table 5-1).

Factors affecting fish populations in the Sacramento River include fish passage problems at Red Bluff Diversion Dam; unfavorable water temperatures during incubation, rearing, and emigration phases; altered river hydrology; entrainment losses at water diversions; habitat loss associated with levee and bank stabilization projects; predation; toxic discharges; harvest; and reduced supply of salmon spawning gravel.

Shasta and Trinity Lakes

Like Folsom Reservoir, both Shasta and Trinity lakes contain both warmwater and coldwater fish species. Important warmwater game species include black bass, sunfish, and catfish. Coldwater species include rainbow trout and kokanee. Annual hatchery plants of subcatchable- and catchable-size rainbow trout sustain a seasonal (primarily winter and spring) trout fishery similar to that of Folsom Reservoir. As for the Folsom Reservoir, water level fluctuations in these reservoirs generally are considered the most significant environmental factor influencing reservoir fish productivity.

Releases from various CVP reservoirs are conducted to maintain Delta flow conditions established for the protection of Delta water quality and estuarine species. If storage at Folsom Reservoir is maintained to enhance habitat conditions in the lower American River, releases from other CVP reservoirs, including Shasta and Trinity lakes, would increase.

Cosumnes River

The Cosumnes River, a tributary to the Mokelumne River, contains more than 20 fish species, including steelhead and splittail (Michney 1973 and San Joaquin Valley Drainage Program 1990). The extent to which splittail use the Cosumnes River is unknown; however, splittail are not likely to move upstream much past the segment of river that is tidally influenced, downstream of the pipeline crossing. Spawning habitat for chinook salmon exists within the 15-mile stretch between Sloughhouse and Latrobe (Westgate 1958), 5 to 10 miles upstream of the pipeline crossing of the Cosumnes River.

ENVIRONMENTAL CONSEQUENCES

Impact Assessment Methodology

Chapter 3, "Hydrology and Water Supply," describes the PROSIM 99 modeling approach used in this REIR/EIS. Please refer to that chapter for a detailed explanation of the hydrologic modeling on which this impact assessment is based.

Significance Criteria

For fisheries resources, a 10 percent or greater change in the frequency of a particular impact relative to baseline conditions was used to identify a potentially significant impact. Any changes less than 10 percent were not considered further and were assumed to have no effect or a less-than-significant effect. This 10 percent change was used as a threshold criterion for impact significance because:

- The natural variation in hydrologic conditions is substantially larger than hydrologic changes associated with the alternatives.
- A 10 percent change was considered a reasonable threshold for identifying the potential for population-level effects (e.g., changes in numbers of fish).
- An environmental change that occurs 10 percent of the time or more was considered large enough to substantiate a conclusion that an adverse or beneficial effect is significant, given the quantity and quality of available fisheries data and the precision and accuracy of available impact assessment tools.
- Environmental impact assessments typically establish quantitative "significance" thresholds in the 10 percent range.

Additionally, the hydrologic analysis indicated that there are several instances in which environmental conditions associated with reservoir storage and river flows would improve under the alternatives, compared to baseline conditions. The application of the 10 percent significance criterion provides a balanced evaluation of the environmental effects by taking into consideration the frequency of both adverse and beneficial changes.

The evaluation of significance for potential impacts was based on professional judgment and on available information for the species under consideration. Changes in the magnitude of the predicted changes were also considered in the evaluation.

In general, impacts on anadromous fish in the lower American River were considered significant if any of the following would occur:

- The frequency of simulated mean monthly flows equal to or greater than Hodge Decision or AFRP flows was reduced by 10 percent or more.
- A temperature increase of at least 1°F would occur at least 10 percent of the time in months when baseline temperatures are likely to exceed acceptable levels for the evaluation species and life stages.
- Flow reductions would result in substantial reductions in populations of sport,

commercial, and special-status fish species due to entrainment, handling, or predation losses at the intake facility.

- Construction activities would result in substantial delays in migration, avoidance by fish of important habitat, or direct or indirect mortality caused by toxic spills or prolonged increases in turbidity and sedimentation.

Impacts on fisheries resources in other geographic areas were considered significant if any of the following would be likely to occur:

- A substantial decrease in the frequency of flooding of vegetated habitat during the spawning and rearing periods of warmwater reservoir species.
- A substantial increase in the number of months that nest flooding or dewatering thresholds would be exceeded during the primary spawning period of warmwater reservoir species.
- A substantial reduction in the availability and amount of coldwater habitat available to coldwater reservoir species (impacts were considered significant if simulated monthly reservoir elevations decreased by at least 5 percent or 10 percent [depending on baseline storage] at least 10 percent of the time relative to baseline conditions).
- Substantial reductions in the frequency of Delta outflows and exports that meet or exceed Delta outflow and export standards (California State Water Resources Control Board 1995) and/or substantial changes in the location of the 2 ppt isohaline (X2).
- Substantial reductions in habitat in the upper Sacramento River as a result of reductions in the frequency of flows that meet or exceed minimum flow requirements established for winter-run chinook salmon.
- Substantial reductions in habitat in the lower Sacramento River as a result of reductions in the frequency and magnitude of flows.

Assessment of the supplemental alternatives' effects on fish species and their habitats is essentially identical to the approaches and methodologies used in the 1997 DEIR/EIS. In addition to the impact assessment tools used in that document, the results of additional analyses using Reclamation's temperature model and salmon mortality model are also reported below.

Impacts Found to Be Less Than Significant

Impact: Impacts on Warmwater Fish Habitat in Folsom Reservoir. The 1997 DEIR/EIS found this impact to be well below the significance threshold. Based on modeling conducted for Alternatives 4 through 8, impacts on warmwater fish habitat would be similar to, but slightly less than, those reported in the 1997 DEIR/EIS (Table 5-3). Changes would range from a 1 percent increase to 3 percent decrease in habitat depending on the alternative and criteria. As discussed in the 1997 DEIR/EIS, this impact is less than significant. No mitigation is required.

Impact: Loss of Coldwater Reservoir Fish Habitat in Folsom Reservoir. The 1997 DEIR/EIS found this impact to be well below the significance threshold. Based on modeling conducted for Alternatives 4 through 8, impacts on coldwater fish habitat would be similar to, but slightly less than, those reported in the 1997 DEIR/EIS. Changes for all alternatives would be a 3 percent decrease in habitat (Table 5-4). As discussed in the 1997 DEIR/EIS, this impact is less than significant. No mitigation is required.

Impact: Reduced Fish Habitat in the Lower American River as a Result of Reduced Flows. The 1997 DEIR/EIS found this impact to be well below the significance threshold. Based on modeling conducted for Alternatives 4 through 8, effects on lower American River flows would be very similar to those reported in the 1997 DEIR/EIS (Tables 5-5 through 5-9). As reported in the 1997 DEIR/EIS, changes in the time that lower American River flows fell within a specified range were nearly always ± 2 percent. Changes in the time that flows resulting from Alternatives 2 and 3 fell outside of specified criteria for species of concern rarely exceeded –3 percent. Under Alternatives 4 through 8, changes are more limited, with most criteria showing no change or ± 1 percent. As discussed in the 1997 DEIR/EIS, this impact is less than significant. No mitigation is required.

Impact: Reduction in Suitable Habitat as a Result of Increased Water Temperature in the Lower American River. The 1997 DEIR/EIS found this impact to be well below the significance threshold. Based on modeling conducted for Alternatives 4 through 8, effects on lower American River temperatures would be very similar to those reported in the 1997 DEIR/EIS (Table 5-10). As reported in the 1997 DEIR/EIS, changes in temperatures were minor and are generally limited to the lower reaches of the river. For Alternative 4, temperature changes are reduced as compared to Alternative 2 in the 1997 EIR/EIS, when the identical temperature assessment methodology was applied to Alternative 4 as compared to the No Action Alternative. As for Alternative 3, described in the 1997 DEIR/EIS, only small temperature changes were identified for Alternatives 5 through 8.

Table 5-3. Effects of Changes in Reservoir Elevation on Warmwater Fish Habitat in Folsom Reservoir

Life Stage	Number of Months (Relevant Period)	Alternative 1, No Action: Months/ Percent[a]	Alternative 4, Scenario 1: Project Change (Months/Percent)[b]	Alternative 4, Scenario 2: Project Change (Months/Percent)[b]	Alternatives 5, 6, 7, and 8: Project Change (Months/Percent)[b]
410-Foot Surface Elevation					
Spawning/ Incubation	280	235	-2	-1	-1
	(Apr-Jul)	84%	-1%	0%	0%
Juvenile/adult rearing	840	532	-14	-12	-4
	(Oct-Sep)	63%	-3%	-2%	-1%
<2-Foot Surface Elevation Decrease					
Spawning/ Incubation	280	169	2	2	-3
	(Apr-Jul)	60%	1%	1%	-2%
<20-Foot Surface Elevation Increase					
Spawning/ Incubation	280	263	0	0	0
	(Apr-Jul)	94%	0%	0%	0%

[a] Number and percentage of months during the relevant period when the reservoir elevation is at least 410 feet, reservoir surface elevation decreases by less than 2 feet per month, or the reservoir surface elevation increases by less than 20 feet per month.

[b] Difference in the number and percentage of months during the relevant period between Alternative 1 and Alternatives 4-8 when the reservoir elevation is above or below thresholds.

Table 5-4. Effects of Changes in Reservoir Storage on Coldwater Fish Habitat in Folsom Reservoir

Life Stage	Number of Months (Relevant Period)	Alternative 4, Scenario 1 Project Change (Months/Percent)[a]	Alternative 4, Scenario 2 Project Change (Months/Percent)[a]	Alternatives 5, 6, 7, and 8 Project Change (Months/Percent)[a]
Juvenile/adult rearing	490	-16	-13	-13
	(April-October)	-3%	-3%	-3%

[a] Difference in the number and percentage of months during the relevant period between Alternative 1 and Alternatives 4-8 when reservoir storage is less than 5 or 10 percent of reservoir storage under Alternative 1.

Table 5-5. Hodge Decision and AFRP Flows (Nimbus Dam)

Flows	Number of Months (Relevant Period)	Alternative 1, No Action Months/Percent[a]	Alternative 4, Scenario 1 Project Change (Months/Percent)[b]	Alternative 4, Scenario 2 Project Change (Months/Percent)[b]	Alternatives 5, 6, 7, and 8 Project Change (Months/Percent)[b]
Hodge Decision Flows					
2,000 cfs	280	201	-1	-1	2
	(Nov-Feb)	72%	0%	0%	73%
3,000 cfs	280	148	-2	-2	2
	(Mar-Jun)	53%	-1%	-1%	1%
1,750 cfs	280	204	-2	-2	2
	(Jul-Oct)	73%	-6%	0%	-3%
AFRP Flows					
2,000 cfs	350	249	-1	-1	2
	(Oct-Feb)	71%	0%	0%	1%
3,000 cfs	280	148	-2	-2	2
	(Mar-Jun)	53%	-1%	-1%	1%
2,500 cfs	70	44	0	-1	0
	(Jul)	63%	0%	0%	0%
2,000 cfs	70	47	-1	-1	-1
	(Aug)	67%	0%	0%	0%
1,500 cfs	70	51	-3	-3	-2
	(Sep)	73%	-4%	-4%	-3%

[a] Number and percentage of months during the relevant period when the flows meet or exceed the indicated minimum flows.

[b] The difference in the number and percentage of months during the relevant period between Alternative 1 and Alternatives 4-8 when flows meet or exceed the minimum flows.

Table 5-6. Effects of Lower American River Flows on Fall-Run Chinook Salmon (Nimbus Dam)

Life Stage	Number of Months (Critical Period)	Alternative 1, No Action Months/ Percent[a]	Alternative 4, Scenario 1 Project Change (Months/Percent)[b]	Alternative 4, Scenario 2 Project Change (Months/Percent)[b]	Alternatives 5, 6, 7, and 8 Project Change (Months/Percent)[b]
Hodge Decision Flows					
Adult migration	210	148	-2	-2	0
	(Sep–Nov)	70%	-1%	-1%	0%
Spawning	210	160	-1	-1	1
	(Oct–Dec)	76%	0%	-2%	0%
Incubation	420	295	-2	-2	2
	(Oct–Mar)	70%	0%	0%	0%
Rearing/emigration	420	251	-3	-3	3
	(Jan–Jun)	60%	-1%	-1%	1%
AFRP Flows					
Adult migration	210	148	-3	-3	-1
	(Sep–Nov)	70%	-1%	-1%	0%
Spawning	210	146	0	0	1
	(Oct–Dec)	70%	0%	0%	0%
Incubation	420	281	-1	-1	2
	(Oct–Mar)	67%	0%	0%	0%
Rearing/emigration	420	251	-3	-3	3
	(Jan–Jun)	60%	-1%	-1%	1%

[a] Number and percentage of months during the critical life stage period when minimum Hodge Decision or AFRP flows are met or exceeded.

[b] The difference in the number and percentage of months during the critical life stage periods between Alternative 1 and Alternatives 4 through 8 when Hodge Decision or AFRP flows are met or exceeded.

Table 5-7. Effects of Lower American River Flows on Winter-Run Chinook Salmon (Nimbus Dam)					
		Alternative 1, No Action	Alternative 4, Scenario 1	Alternative 4, Scenario 2	Alternatives 5, 6, 7, and 8
Life Stage	Number of Months (Critical Period)	Months/ Percent[a]	Project Change (Months/Percent)[b]	Project Change (Months/Percent)[b]	Project Change (Months/Percent)[b]
Hodge Decision Flows					
Rearing/emigration	350	215	-2	-2	1
	(December–April)	61%	-1%	-1%	0%
AFRP Flows					
Rearing/emigration	350	215	-2	-2	1
	(December–April)	61%	-1%	-1%	0%

[a] Number and percentage of months during the critical life stage period when minimum Hodge Decision or AFRP flows are met or exceeded.

[b] The difference in the number and percentage of months during the critical life stage periods between Alternative 1 and Alternatives 4 through 8 when Hodge Decision or AFRP flows are met or exceeded.

Table 5-8. Effects of Lower American River Flows on Steelhead (Nimbus Dam)

Life Stage	Number of Months (Critical Period)	Alternative 1, No Action	Alternative 4, Scenario 1	Alternative 4, Scenario 2	Alternatives 5, 6, 7, and 8
		Months/Percent[a]	Project Change (Months/Percent)[b]	Project Change (Months/Percent)[b]	Project Change (Months/Percent)[b]
Hodge Decision Flows					
Adult migration	630	415	-4	-4	0
	(Aug–Apr)	66%	-1%	-1%	0%
Spawning	350	215	-2	-2	1
	(Dec–Apr)	61%	-1%	-1%	0%
Incubation	420	256	-2	-2	2
	(Dec–May)	61%	0%	0%	0%
Rearing	840	553	-5	-5	5
	(Oct–Sep)	66%	-1%	-1%	1%
Emigration	280	148	-2	-2	2
	(Mar–Jun)	53%	-1%	-1%	1%
AFRP Flows					
Adult migration	630	410	-6	-6	-1
	(Aug–Apr)	65%	-1%	-1%	0%
Spawning	350	215	-2	-2	1
	(Dec–Apr)	61%	-1%	-1%	0%
Incubation	420	256	-2	-2	2
	(Dec–May)	61%	0%	0%	0%
Rearing	840	539	-7	-8	1
	(Oct–Sep)	64%	-1%	-1%	0%
Emigration	280	148	-2	-2	2
	(Mar–Jun)	53%	-1%	-1%	1%

[a] Number and percentage of months during the critical life stage period when minimum Hodge Decision or AFRP flows are met or exceeded.

[b] The difference in the number and percentage of months during the critical life stage periods between Alternative 1 and Alternatives 4 through 8 when Hodge Decision or AFRP flows are met or exceeded.

Table 5-9. Effects of Lower American River Flows on Splittail (Nimbus Dam)

Life Stage	Number of Months (Critical Period)	Alternative 1, No Action	Alternative 4, Scenario 1	Alternative 4, Scenario 2	Alternatives 5, 6, 7, and 8
		Months/Percent[a]	Project Change (Months/Percent)[b]	Project Change (Months/Percent)[b]	Project Change (Months/Percent)[b]
3,500-cfs Flows					
Spawning/incubation/ rearing	210 (February-April)	126 60%	2 1%	2 1%	0 0%

[a] Number and percentage of months during the critical life stage period when 3,500-cfs flows are met or exceeded.

[b] The difference in the number and percentage of months during the critical life stage periods between Alternative 1 and Alternatives 4 through 8 when 3,500-cfs flows are met or exceeded.

Table 5-10. Percent of Months with Potential to Have at Least a 1°F Increase at Four Locations Along the American River Under Alternatives 4 through 8

	Increase		
	Alternative 4, Scenario 1	**Alternative 4, Scenario 2**	**Alternatives 5-8**
Nimbus Dam			
October	0	0	0
November	0	0	0
December	0	0	0
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
Goethe Park			
October	0	0	0
November	0	0	0
December	0	0	0
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
Fairbairn WTP			
October	0	0	0
November	0	0	0
December	0	0	0
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	0	0	0
July	0	0	0
August	1.4	1.4	0
September	1.4	1.4	0
Mouth			
October	0	0	0
November	0	0	0
December	0	0	0
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	0	0	0
July	2.9	2.9	0
August	1.4	1.4	0
September	1.4	1.4	0

For this REIR/SEIS, additional temperature modeling was conducted using the Reclamation temperature model as modified with the Automated Temperature Selection Procedure (multispecies). This temperature assessment was conducted as a verification of the approach used in the 1997 DEIR/EIS. Based on this additional modeling effort, the conclusions presented in the 1997 DEIR/EIS for Alternatives 2 and 3 (based on PROSIM 99 modeling output) are considered valid.

Reclamation's temperature model indicates that for Alternative 2, average monthly increases of 0.1°F at Nimbus would be expected in March, July, and October, while average monthly decreases of 0.1°F would be expected in January and April. The average monthly temperature would not be expected to change in the remaining seven months. Modeled temperature effects at Fairbairn WTP using Reclamation's temperature model were similar. Average monthly increases of 0.1°F would be expected in five months, with similar decreases in one month. No changes would be expected in six months. Because deliveries to EBMUD under Alternative 4 would be significantly reduced as compared to Alternative 2, and because deliveries would occur downstream at the Site 5 intake rather than at the FSC, temperature effects would be reduced as compared to the minor effects described above.

Similarly, for Alternatives 5 through 8, Reclamation's temperature model indicates that for Alternative 3, as described in the 1997 DEIR/EIS, average monthly increases of 0.1°F at Nimbus would be expected in March, April, August, and October, while average monthly decreases of 0.1°F would be expected in July and November. The average monthly temperature would not be expected to change in the remaining six months. Modeled temperature effects at Fairbairn WTP using Reclamation's temperature model were similar. Average monthly increases of 0.1°F would be expected in June and December, with similar decreases August and November. An average monthly temperature decrease of 0.3°F would be expected in July. No changes would be expected in the remaining seven months. Because deliveries under Alternatives 5 through 8 would be significantly reduced (no City and County deliveries) as compared to Alternative 3, and because deliveries would occur downstream, from the Sacramento River or Delta, rather than at the Site 5 intake, temperature effects would be reduced as compared to the minor effects described above.

In addition, Reclamation's Salmon Mortality Model was run for Alternatives 2 and 3 based on PROSIM 99 modeling output. This information indicated that Alternative 2 would be expected to increase fall-run chinook salmon mortality in the lower American River by less than 0.9 percent as compared to the No Action alternative, while Alternative 3 would result in a very minor (0.03 percent) reduction in salmon mortality. Given that Alternatives 4 through 8 would all result in a reduction in the amount of water delivered as compared to Alternatives 2 and 3, and given the extremely small magnitude of effects, the Salmon Mortality Model output for Alternatives 2 and 3 is considered representative of Alternatives 4 through 8.

All of the analyses conducted for this REIR/SEIS supports the original conclusions reached in the 1997 DEIR/EIS that only minor temperature impacts would result from implementation of any of the alternatives and that these impacts are less than signficant. No mitigation is required.

Impact: Potential Changes in Delta Habitat. As described in the 1997 DEIR/EIS, minimal to no changes in Delta outflow, exports, or location of the two ppt isohaline (X2) would result from implementation of any of the alternatives. The average monthly change in the location of X2 for all months is zero. This impact is less than significant. No mitigation is required.

Impact: Potential Reduction in Habitat in the Sacramento River and Shasta and Trinity Lakes. As discussed in the 1997 DEIR/EIS, effects on these areas were essentially not discernable. PROSIM 99 modeling of Alternatives 2 and 3 confirms this finding and, as Alternatives 4 through 8 all result in reduced demands as compared to Alternatives 2 and 3, this impact is less than significant. No mitigation is required.

Reclamation's Salmon Mortality Model was run for Alternatives 2 and 3 based on PROSIM 99 modeling output. This information indicated that Alternative 2 would be expected to increase the spring-run chinook salmon mortality in the Sacramento River by about 1.7 percent as compared to the No Action alternative, while Alternative 3 would result in an approximately 3 percent increase in spring-run chinook salmon mortality. Mortality for all other races of salmon would increase by less than 1 percent according to modeling results. Given that Alternatives 4 through 8 would all result in a reduction in the amount of water delivered as compared to Alternatives 2 and 3, and given the extremely small magnitude of effects, the Salmon Mortality Model output for Alternatives 2 and 3 is considered representative of Alternatives 4 through 8. This impact is less than significant. No mitigation is required.

Impact: Short-Term Loss of Fish Habitat near New Intake Structure. Construction of the new intake structure could result in increased turbidity, generation of noise, and potential discharge of hazardous materials into the lower American River, Sacramento River, or Delta. Increased turbidity and noise could occur as a result of installation and removal of sheet piles and other construction activities. The potential for discharge of hazardous materials would exist during the entire construction period.

Monitoring would be performed to ensure that turbidity levels stay within CVRWQCB water quality objectives. Implementation of BMPs pursuant to NPDES permit restrictions described in Chapter 4, "Water Quality," would minimize the potential for discharges of hazardous materials during construction. Noise impacts would be short term and would occur primarily as a result of installation and removal of sheet piles. This impact is less than significant because turbidity is expected to remain within the CVRWQCB objectives, BMPs would be implemented, and noise generation would occur over a short period. No mitigation is required.

Impact: Loss of Fish in the Fish Exclusion Facility. As described in Chapter 2, the intake system would conform to CDFG and NMFS requirements. Regardless of specific construction design or location, fish could be entrained at the structure because of the proposed rates of water intake.

The proposed screen design would provide protection to all life stages but eggs and larval fish. Juvenile fish of all species at risk, including salmon and steelhead, should be protected from entrainment by the small mesh size and low approach velocity at the fish exclusion facility.

Eggs and larvae of splittail and delta smelt may be present at the intakes and could be entrained. Because the lower American River is not a primary spawning area for splittail and delta smelt, under Alternative 4, the loss of eggs and larvae would be very low compared to the overall population abundance of these species.

Alternatives 5, 6, 7, and 8 would involve EBMUD taking delivery of water on the Sacramento River (Alternatives 5 through 7) or in the Delta (Alternative 8). A greater number of protected species and individuals would likely be subject to entrainment effects at these locations. The lower Sacramento River and the Delta provide passage to upstream areas for steelhead and spring-run and winter-run chinook salmon. Splittail are also known to use the lower Sacramento River for passage and spawning. The primary habitat for delta smelt is within the Delta, although the importance of Indian Slough to delta smelt is not known. In addition, the Delta is designated critical habitat for delta smelt, steelhead, and spring-run chinook salmon.

Based on this information, entrainment effects would be expected to be greater for these alternatives than for Alternative 2, 3, and 4. However, given the relatively small size of the diversion and the incorporation of appropriate fish exclusion facilities into the alternatives, these impacts are less than significant. No mitigation is required.