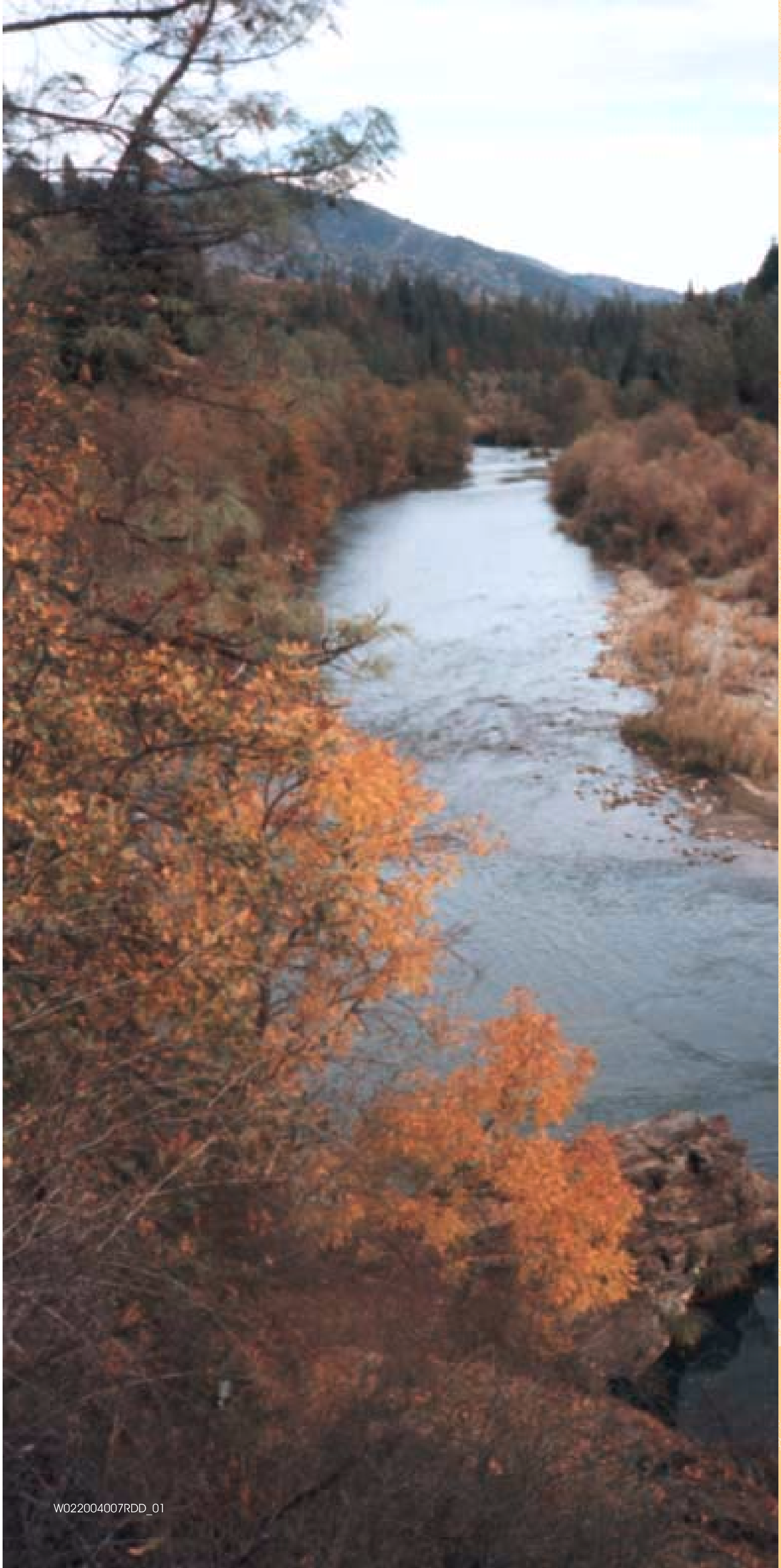
Lead Agencies:

U.S. Fish and Wildlife Service
U.S. Bureau of Reclamation
Hoopa Valley Tribe
Trinity County



Trinity River Fishery Restoration

Supplemental Environmental Impact Statement/ Environmental Impact Report

April 2004

W022004007RDD_01

Fishery Resources Technical Appendix B

Fishery Resources

Appendix B

Trinity River Mainstem
Fishery Restoration

Appendix B

1.0 FISHERY RESOURCES

Fishery resources include fish populations, their habitats, and the harvest of those populations. Extensive fishery resources are found within the Trinity River Basin, Lower Klamath River Basin/Coastal Area, and Central Valley. Many of the fish species found within the lower Klamath River Basin are also found within the Trinity River Basin. The coastal areas adjacent to the Klamath River Basin contain marine species as well as provide essential habitat for maturing and adult anadromous fish species that return to the Klamath and Trinity River Basins. The Trinity River Basin consists of the mainstem Trinity River, its numerous tributaries, high mountain lakes, and Trinity and Lewiston Reservoirs. In addition, within the Trinity River Basin, the Trinity River Salmon and Steelhead Hatchery (TRSSH) is intended to mitigate for the reduced salmon and steelhead production resulting from the loss of habitat upstream of Lewiston Dam by releasing chinook and coho salmon and steelhead young into the mainstem Trinity River. Table B-1 (all tables and figures are located at end of this appendix) summarizes the impacts to fishery resources (compared to No Action) associated with each alternative.

The following discussion describes the affected environment and the environmental consequences of the project on anadromous salmonid species, other native anadromous species, resident native species, non-native species, and reservoir species. Anadromous species spend their early life stages in fresh water, migrate to the ocean for maturation, and return to their natal stream to spawn. Resident species, on the other hand, spend their entire lives in the freshwater rivers or reservoirs of the affected project areas. A list of fish species found within the Trinity River Basin, including the Trinity and Lewiston Reservoirs, is shown in Table B-1. Species commonly found in other geographic areas of the affected project area are noted and discussed in those sections.

1.1 ANADROMOUS SALMONID SPECIES

1.1.1 Affected Environment

Native anadromous salmonid species currently found in the Trinity River Basin and the Lower Klamath River Basin/Coastal Areas includes spring, and fall chinook salmon (*Oncoryhnchus tshawytscha*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss irideus*). In addition, coastal cutthroat trout (*O. clarki clarki*) are found in the Lower Klamath River Basin/Coastal Area. In the Central Valley, chinook salmon (fall, late-fall, spring, and winter) and winter steelhead, but not coho salmon and cutthroat trout, constitute the native anadromous salmonids in that geographical area.

1.1.1.1 Trinity River Basin

This section discusses the current status of anadromous salmonid resources and their habitats in the mainstem Trinity River, downstream of Lewiston Reservoir, and the factors influencing these resources. The following native anadromous salmonids are found in the mainstem Trinity River and its tributaries: fall and spring chinook salmon, coho salmon, and winter and summer steelhead (Table B-1). A description of sportfishing activity along the Trinity River was presented in the Recreation Technical Appendix D of the 1999 DEIS/DEIR.

Habitat Characteristics and Requirements. The anadromous salmonids native to the Trinity River Basin have similar life history characteristics. These species all begin life in fresh water as eggs and alevins (larval fish), which are hatched in gravely riffle area in the mainstem Trinity River or in its tributaries. Figure B-1 illustrates the generalized life history of anadromous salmon and steelhead. The time spent in fresh water as incubating eggs and alevins, or rearing fry (earliest free swimming life stage) and juveniles (pre-emigrating immature fish), and emigrating smolts (juveniles physiologically adapting for life in the marine environment) varies with each species, as does the time spent maturing in salt water before returning to their natal stream to spawn (reproduce). The generalized temporal distribution of chinook and coho salmon and steelhead is shown on Figure B-2.

Habitat needs of anadromous salmonids are similar, but each species does differ somewhat in its freshwater habitat needs. These differences are important and have implications from a resource management standpoint. Specific life history information for anadromous salmonids are provided in Table B-2. (A more detailed discussion of chinook, coho, and steelhead life cycles in the Trinity River can be found in Frederiksen, Kamine, and Associates, 1980, or U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999.)

Adequate flows, temperatures, water depths and velocities, appropriate spawning and rearing substrates (e.g., riverbed gravels), and availability of instream cover and food are critical for the production of all anadromous salmonid fish. Spring chinook salmon and summer steelhead also need long-term adult holding habitat, in which pool size and depth, temperature, cover, and proximity to spawning gravel are important requirements. Newly emerged fry and juveniles of all species require rearing habitat with low velocities, open cobble substrate, and cool water temperatures. Emigration of smolts to the ocean and the immigration of adults require adequately timed flows with the appropriate temperature, depth, and velocity.

Populations. The following discussion considers population estimates of the anadromous salmonids in the mainstem Trinity River. A key to understanding anadromous fish populations is the concept of “escapement.” Annual spawner escapement is defined as the number of fish of a particular species that successfully return from the ocean (“escape” harvest and natural mortality) to spawn within a specific river. For the purposes of this document, inriver spawner escapement refers to the number of returning fish (adult and jacks) that physically spawn in the river. Hatchery escapement refers to the number of adults and jacks that return from the ocean to the TRSSH where they are artificially spawned.

Other terms used in this discussion include the following:

- Naturally produced—refers to the progeny of fish that physically spawned in the river or its tributaries, without human intervention.

- Hatchery produced—refers to the progeny of fish that were spawned and raised at the TRSSH.
- Jacks (sometimes referred to as "grilse")—refers to sexually mature fish that return as 2-year old fish to spawn; nearly all jacks are male.
- Half-pounders—refers to sexually immature steelhead, which after residing in fresh water for up to 3 years and salt water for less than 1 year return to fresh water, but not for the intent purpose of spawning; half-pounders subsequently return to the ocean and make their spawning migration months to years later.
- Run size—the total estimated annual number of adults and jacks, including inriver spawner escapement and hatchery escapement, as well as inriver harvest by tribal fisheries and inriver sport anglers. Annual estimates of fall chinook salmon run size in the Trinity River Basin have been compiled by the California Department of Fish and Game (CDFG) since 1978, as a part of the Klamath Basin Fall Chinook Salmon Spawner Escapement Estimates (California Department of Fish and Game, 2003). (Attachment B1, Table B1-1). In addition, since 1977, fall and spring chinook salmon, coho salmon, and adult winter steelhead (in some years) run size, spawner escapement, and angler harvest have been estimated by CDFG. These run size estimates are derived in part from data collected at fish counting weirs are installed annually near Willow Creek and usually Junction City on the mainstem Trinity River. CDFG, Hoopa Valley Tribe (HVT), U.S. Fish and Wildlife Service (Service), and U.S. Forest Service (USFS) have also conducted annual summer steelhead surveys in several tributaries to the mainstem Trinity River to estimate the population of this species.

Trinity River Restoration Program Goals. The 1983 Environmental Impact Statement (EIS) on the Trinity River Basin Fish and Wildlife Management Program (U.S. Fish and Wildlife Service, 1983) documented the inriver spawner escapement goals and the TRSSH production goals established by the Trinity River Basin Fish and Wildlife Restoration Program (TRRP) as escapement numbers that could be met once restoration was completed. The inriver goals represent the total number of naturally produced adult spawners (excluding jacks) for the Trinity River Basin below Lewiston Dam and exclude fish caught by the fisheries. The hatchery goals represent numbers of adult fish needed by the hatchery, exclusive of fisheries for chinook and coho salmon (an undefined inriver harvest is included in the Restoration Program goal for hatchery steelhead). A summary of these restoration goals are shown as Table B-3.

Because the project purpose is the restoration and maintenance of the natural production of anadromous salmonids below Lewiston Dam, the following discussions concern the inriver spawner escapement goals (adults only) and the numbers of fish returns (jacks and adults) that were naturally produced. Restoration and maintenance of natural production implies that the fish spawning inriver began their life as eggs in the river (i.e., were not raised in the hatchery), and that a sufficient percentage of their eggs spawned in the river survive to return as adults to spawn; in other words, naturally producing populations are self-sustaining.

"Inriver spawner escapement," for the purposes of this report, is the number of returning fish that physically spawn in the river, which in reality consists of two factions: naturally produced fish and hatchery-produced fish. This term is analogous to the term "natural spawner escapement" used by CDFG. However, we chose not to use the CDFG term because it is confusing in discussions pertaining to naturally and hatchery-produced fish. "Total basin escapement" refers to the total number of fish that spawned inriver plus those fish that were spawned at the TRSSH.

Hatchery-produced fish are not considered to contribute towards the inriver spawner escapement goals of the Trinity River Restoration Program, although their offspring do (i.e., if hatchery-produced fish spawn inriver and their offspring survive to return to spawn, these offspring are naturally produced by definition [see "natural production" in glossary]. The best available data indicate that large numbers of hatchery-produced fish spawn inriver. Typically, more fish spawn inriver than are spawned at the hatchery, and relatively fewer inriver eggs survive to return as adults. Assuming that hatchery and naturally produced fish are subject to the same environmental conditions after the hatchery releases its fish (typically as smolts), the relatively low returns of naturally produced fish are likely indicative of low survival rates of young freshwater life stages (eggs, fry, and/or juvenile fish).

Spring Chinook Salmon. Fisheries investigations conducted during 1942 through 1946, prior to the construction of the Trinity and Lewiston Dams, identified spring, summer, and fall chinook salmon populations in the Trinity River above the North Fork Trinity River (North Fork) confluence (Moffett and Smith, 1950). In 1955 an inriver spawner escapement estimate of 3,000 spring, 5,000 summer, and 24,000 fall chinook salmon upstream of Lewiston was reported by CDFG (California Department of Fish and Game/U.S. Fish and Wildlife Service, 1956). Contrary to these previous reports, Hubbell (1973) stated that review of data collected up to that time (1973) indicated that only spring and fall chinook salmon existed in the Trinity River, and since that time only estimates of spring and fall chinook salmon have been made by CDFG.

The Service (1983) estimated that prior to the construction of the dams, the average annual mainstem Trinity River spring chinook spawner escapement between the North Fork and Lewiston was approximately 3,500 adults. An additional 300-3,000 spring chinook were estimated to spawn annually upstream of Lewiston. For the years during 1978 through 2002, CDFG estimated that total spring chinook spawner escapements, upstream of the Junction City weir, have averaged approximately 16,000 and have ranged from approximately 2,000-55,000 fish (Attachment B1, Table B1-2). It must be noted that these estimates include hatchery fish spawned at the TRSSH and all spring chinook salmon (hatchery- and naturally produced fish) that spawned in the river. In recent years, estimates of the proportion of hatchery-produced and naturally produced fish contributing to the inriver spring chinook spawner escapement have been made (U.S. Fish and Wildlife Service, 1998 and CDFG, 2003). Escapement estimates for the years 1982 through 2002 (excluding 1983 and 1995) indicated that an average of approximately 82 percent (approximately 14,000) of the in-river spawner escapement of Trinity River spring chinook salmon were hatchery produced (Table B-5). Conversely, only 18 percent (approximately 3,217 annually) were naturally produced, which represents approximately 53 percent of the TRRP goal of 6,000 natural spring chinook in the Trinity River.

Fall Chinook Salmon. Annual pre-dam estimates averaged 45,600 fall chinook salmon, based on studies conducted during 1944, 1945, 1954, 1955, and 1963. Although limited in duration, these pre-dam estimates were the best numerical estimates available from the pre-dam era for the mainstem Trinity River upstream of the North Fork confluence. A review of the literature indicates that, before the construction of Lewiston Dam, approximately 50 percent of the mainstem Trinity River fall chinook salmon above the North Fork confluence spawned above Lewiston (Moffett and Smith, 1950; Gibbs, 1956; LaFaunce, 1965). Fifty percent of the pre-dam average of 45,600 would represent approximately 23,250 adults and jacks in the Trinity River upstream of Lewiston, and 22,350 adults and jacks from the North Fork to Lewiston prior to construction of the dams (Table B-4).

CDFG's 1978 through 2002 fall chinook salmon run-size estimates for the Trinity River Basin upstream of the Willow Creek weir have averaged approximately 43,000 adults and jacks (Table B-5) and ranged from approximately 9,200 (1991) to 148,000 (1986). These estimates are shown in Attachment B1, Table B1-3. These estimates include inriver spawner escapements, TRSSH hatchery returns, and harvest (inriver anglers and tribal) for the entire Trinity River Basin above the Willow Creek weir. As shown in Table B-5, the average annual Trinity basin in-river spawner escapement estimate is approximately 39,600 fall chinook. However, as previously discussed, these estimates include a component of hatchery-produced chinook salmon that spawn in the Trinity River and not at TRSSH. Table B-5 provides an estimate of Trinity River naturally and hatchery-produced fall chinook salmon spawner escapement for the years 1982 through 2002 (Figure B-3). CDFG's post-dam inriver spawner escapement estimates for the Trinity River Basin upstream of the Willow Creek weir from 1982 through 2002 averaged 30,400 fall chinook salmon, of which an average of 12,047 fish are naturally-produced fish. Naturally produced fish have ranged from 10-94 percent of inriver spawner escapements, with an average of 42 percent (Table B-5).

Comparisons between pre- and post-dam averages are problematic because: 1) few pre-dam estimates exist, 2) pre-dam estimates typically represent fish spawning in the river above the North Fork, while post-dam estimates are above Willow Creek, and 3) post-dam estimates are only for the river below Lewiston and are confounded by large numbers of hatchery-produced fish that spawn in natural areas (recent changes have been enacted to reduce competition of hatchery-produced fish with naturally produced spawners).

Comparisons between pre-dam escapements and the TRRP inriver spawner escapement goals are also problematic because the inriver goals represent the numbers of fish that could be produced in the entire Trinity River Basin below Lewiston Dam once successful restoration is completed, whereas the pre-dam numbers are sporadic and limited to the Trinity River above the North Fork. Because of these problems, the following discussions focus on the current post-dam estimates relative to the TRRP inriver spawner escapement goals as an indicator. This is a conservative indicator because the TRRP goals represent adult returns and the numbers for naturally produced fish include jacks and adults (adult only information was not available).

According to the TRRP goals, the hatchery is to produce 9,000 returning fall chinook spawners for the hatchery, and the river below Lewiston is supposed to produce 62,000 naturally produced fall chinook spawners. Both these goals are exclusive of harvest.

The 1982-2002 mean annual estimated naturally produced spawner escapement upstream of Willow Creek is 12,047, approximately 19 percent of the restoration goal of 62,000 naturally produced fall chinook salmon for the Trinity River Basin (Table B-4). These estimates indicate that a significant improvement in escapement must be made to meet the Trinity River restoration goals for fall chinook salmon. A complete summary of the Trinity River fall chinook salmon run sizes, in-river and hatchery escapements, angler harvests, and estimated proportions of naturally and hatchery-produced fish contributing to the inriver spawner escapements for the Trinity River for 1977 through 2002 are shown in Attachment B1, Table B1-3 (California Department of Fish and Game, 2003.

There were large runs of fall chinook salmon in the mainstem Trinity River during 1986 through 1989, and again in 1995 as compared to other years since 1977 (Attachment B1, Table B1-3). These years greatly influenced the long-term mean inriver spawner escapement estimates for the fall chinook salmon in the Trinity River. The large spawner escapements for the years 1986-1989 may have been related to wetter water years during brood years beginning in the 1983 water year. Wetter than normal water years and associated increases in streamflow may have resulted in improved habitat conditions during those brood years. These improvements in stream flows and habitat conditions may have also resulted in significant increases in smolt production and smolt out-migration success during those brood years. This in turn may have resulted in increased run sizes and spawner escapements beginning in the fall of 1986 and continuing through 1989. Harvest restrictions, particularly since 1985, and improved ocean conditions and survival may have also contributed to greater runs and spawner escapements during 1986-1989 and in 1995.

Coho Salmon. Coho salmon populations were historically much smaller than chinook salmon in the Trinity River. Holmberg (1972) reported that the estimated number of coho salmon in the Trinity Basin was approximately 8,000. An average annual pre-dam spawner escapement of approximately 5,000 adult coho above Lewiston was cited by CDFG and Service (1956). After construction of Lewiston Dam, coho in-river escapement estimates below Lewiston ranged from approximately 460-2,100 during 1969 through 1971 (Smith, 1975; Rogers, 1972; and Rogers, 1982). Leidy and Leidy (1984) reported that the returns to Trinity River Hatchery for the period 1973-1980 averaged 3,300 adults. The total Trinity River basin run size estimate for 1977 through 2002 has averaged 16,500 adult coho (CDFG, 2003) (Table B-5**).**

Averages for CDFG's annual coho run-size, inriver spawner escapement, TRSSH escapements, angler harvest, and proportions of naturally and hatchery-produced spawners contributing to the inriver spawner escapement estimates for the years 1977 through 2002 are shown in Table B-5. Since 1978, CDFG has estimated that coho inriver escapements have ranged from approximately 850 (1993) to 55,700 (1987) (Attachment B1, Table B1-4), with an annual average of 16,100 coho salmon (adults and jacks) upstream of the Willow Creek weir. These total basin escapement estimates indicate that recent post-dam spawner escapement may be as great or greater than the "pre-dam" estimates. However, like those estimates for spring and fall chinook salmon, these estimates include both TRSSH escapement and hatchery-produced adults that spawned in the river.

Estimates of the naturally produced coho salmon spawning in the mainstem Trinity River upstream of the Willow Creek weir for the years 1991-1995, and 1997-2002 have been made (CDFG, 2003). Table B-5 shows the average estimated spawner escapement of naturally and hatchery-produced coho salmon for those years. Since 1991 naturally produced coho salmon spawning in the Trinity River upstream of the Willow Creek weir averaged approximately

582 fish, ranging from 0-19 percent of the total annual escapement (an annual average of 7 percent). Approximately 93 percent (11,332) of the coho salmon spawning in-river are produced by the hatchery.

The estimated 582 naturally produced coho spawning in the mainstem Trinity River upstream of the Willow Creek weir represents approximately 42 percent of the restoration program spawner escapement goal of 1,400 for naturally produced adult coho (Table B-3).

Steelhead. Winter steelhead spawner escapements within the Trinity River and its tributaries upstream of Lewiston prior to the construction of the dams were estimated to range from approximately 6,900-24,000 adults (California Department of Fish and Game/U.S. Fish and Wildlife Service, 1956).

Winter steelhead spawner escapement estimates have been highly variable in the Trinity River and its tributaries since 1963. The 1964 steelhead spawner escapement estimate was approximately 8,000 fish (LaFaunce, 1965). A spawner escapement estimate of approximately 1,000 steelhead was made for the year 1972 (Rogers, 1973).

From 1980 through 2002 (for the years in which data is available), the estimated total basin escapement of winter steelhead spawning upstream of the Willow Creek weir has ranged from approximately 2,750 (1992) to 33,700 (1989) (Attachment B1, Table B1-5) and has averaged approximately 9,400 (California Department of Fish and Game, 2003). However, weir data is typically available for fall and early winter period only. Estimates for the remaining winter portion of the escapement are unavailable because increased river flows render weirs inoperable. Estimates of naturally produced winter steelhead for the years 1980, 1982, and 1992 to 1995 and 2002 were made by the CDFG (2003). On the average for those years, approximately 4,700 naturally produced winter steelhead spawned in the Trinity River upstream of the Willow Creek weir (Table B-5). However, this average is largely influenced by the 1980 and 1982 years. The average naturally produced inriver escapement for 1980 and 1982 was 10,675, while the average escapement for 1992-1995 and 2002 was approximately 2,326 adults. The overall average (4,711) represents approximately 12 percent of the restoration goal of 40,000 adult steelhead, while the 1992-1995 and 2002 average represents 6 percent of this goal (Table B-5). The latter average is more likely to represent the current status of the Trinity River steelhead population, because it is more recent, and fairly consistent from year to year. The data available for winter steelhead hatchery and inriver spawner escapements for the years since 1977 are shown in Attachment B1, Table B1-5.

Adult summer steelhead primarily hold in the headwaters of mainstem Trinity tributaries during the summer months, and subsequently spawn in the following late winter/early spring. Average annual summer steelhead inriver spawner escapements for the Trinity River upstream of Lewiston, prior to the construction of the dams, were estimated to average 8,000 adults (California Department of Fish and Game /U.S. Fish and Wildlife Service, 1956). In recent years, CDFG, Service, USFS, and HVT have conducted population surveys for these fish in the North Fork, South Fork, Canyon Creek, and New River tributaries and the upper Trinity River. Population estimates have ranged from a low of 20 adults in the South Fork in 1985 to 1,037 adult summer steelhead in the North Fork in 1991 (California Department of Fish and Game, 1997, unpublished). The estimated mean annual populations of summer steelhead from 1980-1996 are: 460 (North Fork), 40 (South Fork), 15 (Canyon

Creek), 11 (upper Trinity River), and 404 (New River). Summaries of those estimates are shown in Attachment B1, Table B1-6 of the Fishery Technical Appendix to the 1999 DEIS/DRIR.

The steelhead of the Trinity River are characterized by the unique “half-pounder” phase of their life history. An immature steelhead that returns to fresh water from the ocean during July-September after remaining in the ocean only a few months is referred to as a “half-pounder”(U.S. National Marine Fisheries Service, 1994). This phase includes the summer migration in which it does not spawn, followed by winter or spring emigration back to the ocean. These fish are typically 12-14 inches in length and are rarely greater than 16 inches (ACWA, 1995). Half-pounders are highly sought after by sportfishers.

Species Listed and Proposed for Listing under the Endangered Species Act (ESA). After a coast-wide status review by the U.S. National Marine Fisheries Service (NOAA-Fisheries), the Southern Oregon/Northern California evolutionarily significant unit (ESU) naturally produced coho salmon was proposed for listing as threatened on July 25, 1995. Under the ESA, an ESU is a population (or group of populations) that:

- Is substantially reproductively isolated from other nonspecific population units
- Represents an important component in the evolutionary legacy of the species

On October 24, 1996, NOAA-Fisheries extended the period of review and final determination of this ESU’s proposed listing for 6 months until April 25, 1997. On June 5, 1997, NOAA-Fisheries announced its final action that this species would be listed as threatened in the California range of its distribution, which includes the Trinity and Klamath River Basins.

Additionally under the ESA, the Klamath Mountains Province ESU steelhead, which includes stocks from the Trinity River, were proposed for listing as threatened on March 16, 1995. On July 31, 1996, NOAA-Fisheries determined that this species warranted listing as a threatened species under ESA, but the decision to list the species was deferred on August 11, 1997, for 6 months to gather more scientific information. A final ruling on its status was made on April 4, 2001, when NOAA-Fisheries determined that this species did not warrant listing as threatened at that time.

Factors Influencing Trinity River Basin’s Anadromous Salmonid Populations.
Trinity River Salmon and Steelhead Hatchery. TRSSH was constructed by the U.S. Bureau of Reclamation (Reclamation) in 1963 and is operated by CDFG to mitigate for the loss of salmonid habitat and production above Lewiston Dam due to construction of the Trinity River Division (TRD) of the Central Valley Project (CVP). The hatchery was modernized in 1991 as part of the TRRP. The TRSSH’s current goals are to produce sufficient juveniles to provide for returns to the hatchery (exclusive of harvest) of 12,000 chinook salmon (3,000 spring; 9,000 fall); 2,100 coho salmon; and 10,000 steelhead. Fingerling and yearling production of chinook, coho, and steelhead at the TRSSH (and its predecessor facilities) from 1958 through 1996 are summarized in Attachment B1, Table B1-7 of the 1999 DEIS/DEIR Fishery Appendix. Since that time (January, 1997) the TRSSH has operated under new stocking goals and constraints criteria. These goals and constraints are summarized in Table B-6.

Hatchery operations, including the magnitude and the timing of hatchery releases and the subsequent return of adult hatchery-produced fish, can directly affect the behavior, growth, survival, and ultimate success of naturally produced salmon and steelhead. Factors such as competition, predation, and disease organisms transmitted by hatchery-produced fish may adversely affect naturally produced anadromous salmonids within the Trinity River Basin. In a 1991 study of hatchery- and naturally produced juvenile chinook, coho, and steelhead, TRSSH coho juveniles were found to be in poor health resulting from bacteria kidney disease (Foote and Walker, 1992). The diseased coho juveniles may have influenced smolt survival of several naturally produced Trinity River Basin salmonid stocks (Foote and Walker, 1992).

Annual numbers (adults and jacks) of chinook, coho, and steelhead entering TRSSH (or its predecessor facilities) since 1958 are shown on Figure B-4. Since the beginning of operations, there have been two periods of significantly increased numbers of chinook returning to the TRSSH (Figure B-4). The numbers of chinook salmon trapped at the TRSSH peaked in 1988 with more than 20,000 fall and 16,000 spring chinook entering TRSSH. More than 23,000 coho entered the TRSSH in 1987-1988. Except as noted above, since the peaks of the 1980s, TRSSH returns of chinook and coho salmon have generally decreased. Since operations began, the numbers of steelhead entering the TRSSH have varied widely, ranging from 13 fish in 1976-1977 to nearly 7,000 in 1964-1965 (Figure B-4). Since 1990, there have been less than 1,000 adult steelhead trapped annually at the hatchery.

Introductions of Klamath River fall chinook salmon juveniles raised from eggs reared at the TRSSH were made into the Trinity River during 1971, 1977, and 1983 (California Department of Fish and Game, TRSSH Reports: 1971, 1977, and 1983) (Table B-7). Since 1983, no additional fall chinook salmon genetic stocks have been introduced into the Trinity River Basin.

Native Trinity River coho salmon stocks have been potentially intermingled with four out-of-basin coho stocks introduced by the TRSSH since 1965 (Table B-7). Coho salmon juveniles, reared from eggs at the TRSSH, from the Eel and Noyo Rivers (California) were introduced into the Trinity River in 1965 and 1970, respectively (California Department of Fish and Game, TRSSH Reports: 1965 and 1970). Juvenile coho salmon from genetic strains from Alsea River Hatchery (Oregon) were introduced into the Trinity River in 1970 and 1971 (California Department of Fish and Game, TRSSH Reports: 1970 and 1971). Juvenile coho salmon from the Cascade Hatchery (Oregon) were also introduced in 1970. No other coho salmon stocks from out-of-basin sources have been introduced into the Trinity River since 1971. The impact of these introductions are not understood at the present time.

Native Trinity River winter steelhead stocks may also have been intermingled with introduced steelhead from outside the Trinity River Basin (Table B-7). In 1963, American River (California) fall steelhead fry were received and reared at the TRSSH until they were planted into the Trinity River in the spring of 1964 (California Department of Fish and Game, TRSSH Report 65-5). Juvenile winter steelhead reared from eggs received from the Cowlitz River Hatchery (Washington) in 1969, and juveniles from the Roaring River Hatchery (Oregon) were planted into the Trinity River at China Slide in 1970 and 1971 (California Department of Fish and Game, TRSSH Reports 70-19 and 72-4). Winter steelhead fry and juveniles reared from eggs transferred from the CDFG’s Iron Gate Hatchery on the Klamath

River were released at TRSSH beginning in 1971 and continued yearly through 1987 (California Department of Fish and Game, TRSSH Reports: 1970-1988) (Table B-7).

Summer steelhead stocks from two hatchery sources outside the Trinity River Basin have been introduced into the basin: Cedar Creek Hatchery (California) and Skamania Hatchery (Washington) were introduced into the Trinity River from eggs reared to fry or juveniles and released at the TRSSH during 1971 through 1975. (Table B-7) (California Department of Fish and Game, TRSSH Reports: 1971-1976).

The precise impacts on natural anadromous populations downstream of Lewiston from releases of salmonids from the TRSSH are unknown. Hatchery fish pose six primary threats to naturally produced fish (Hilborn,1992):

- Direct competition for food
- Predation of hatchery-produced fish on naturally-produced fish
- Genetic dilution of native fish stocks by hatchery fish allowed to spawn inriver
- Increased fishing pressure on naturally produced stocks due to hatchery production
- Disease transmission from hatchery-produced fish to naturally produced fish
- Direct competition for habitat

Recent concerns involving the potential impacts of hatchery operations on the naturally producing stocks of the Klamath Basin (including the Trinity River) prompted the CDFG to hold a workshop to address these concerns and revise their hatchery operation procedures. New hatchery operating procedures were instituted in 1997 to minimize the potential impacts of hatchery-produced fish on naturally producing stocks.

Recently adopted TRSSH operations designed to minimize impacts include:

- All mature salmon returning to the hatchery are processed and destroyed, in order to reduce the occurrence of hatchery stock spawning with natural stocks. Allowing all hatchery fish (including surplus spawners) entry to the hatchery also reduces competition between hatchery- and naturally produced stocks for appropriate spawning sites. Steelhead are spawned and returned to the river because, unlike salmon, they are capable of spawning in subsequent years.

- Juvenile salmonids from TRSSH are released to mimic natural out-migration patterns at Lewiston prior to dam construction, which are slightly delayed relative to outmigrating naturally produced juveniles in the river reach below Lewiston (Table B-6).

- Hatchery production goals are not to be exceeded (Table B-6).

Fish Harvest. The harvest of Klamath River Basin fall chinook salmon (including Trinity River Basin) is managed jointly by the CDFG, Oregon Department of Fish and Wildlife, California Fish and Game Commission, (Commission) Yurok Tribe, HVT, NOAA-Fisheries, and Bureau of Indian Affairs (BIA). The Pacific Fishery Management Council (PFMC) and the Klamath Fishery Management Council (KFMC) are allocation forums for the ocean and ocean/in-river fisheries, respectively. The mixed-stock ocean population is harvested by commercial and sport fisheries; and the in-river population is harvested by tribal (ceremonial, subsistence, and commercial) and sport fisheries. Chinook salmon harvest (both spring and fall runs) includes both naturally and hatchery-produced fish. Coho harvest in the ocean commercial troll fishery has been prohibited in California and Oregon, and reduced in Washington, since 1994. Coho harvest has also been prohibited in the California ocean sport fishery, and reduced in Oregon. Coho harvest is allowed in the tribal in-river fisheries and currently occurs as incidental take during the harvest of chinook salmon. Steelhead are rarely caught in the ocean commercial and sport fisheries, but are harvested by the in-river tribal and sport fisheries. Frederiksen, Kamine, and Associates (1980) stated that ocean harvest of naturally produced salmon stocks had been sufficient to have caused steady declines in Trinity River spawner escapements at the time of their report. Historically, Klamath/Trinity River chinook and coho populations have been harvested in the ocean from Monterey County, California, to the Oregon/Washington border. Ocean harvest of naturally produced salmon may have been sufficient in the late 1970s to cause declines in Klamath River Basin (including Trinity River) populations, but fall chinook harvest management restrictions implemented since 1986 have decreased harvest impacts to levels believed to be sustainable, based on the best available data. A description of sportfishing activity along the Trinity River is presented in the Recreation Resources Technical Appendix D of the 1999 DEIS/DEIR. Information on tribal fisheries is presented in the Tribal Trust section (3.6) of the 1999 DEIS/DEIR.

Habitat Conditions. Reduced river flow due to the construction and operation of the TRD, combined with excessive watershed erosion, large-scale gold dredging, and other harmful land management activities, have caused major changes in the inriver habitat conditions of the Trinity River (U.S. Fish and Wildlife Service, 1994) since the construction of the Trinity and Lewiston Dams. Factors that have resulted in adverse effects on fish habitat (Frederiksen, Kamine, and Associates, 1980) include the following:

- Obstruction to the river reaches upstream of Lewiston Dam
- Changes in natural flow regime in both quantity and timing
- Changes in water temperature.
- Changes in river channel geomorphology and restriction of river meandering
- Changes in substrate composition, addition of fine sediments, and restriction of gravel recruitment

The quantity and quality of anadromous fish habitat have been seriously reduced since construction of the TRD. The dams blocked fish access to 59 miles of chinook salmon habitat, 109 miles of steelhead habitat, and an undetermined amount of coho salmon habitat (U.S. Fish and Wildlife Service, 1983). Much of this habitat was prime spawning and rearing habitat. In the case of chinook salmon, this habitat represented 50 percent of the spawning habitat in the Trinity Basin. Furthermore, elimination of the upstream reaches, which were dominated by snowmelt and hydrologically different from the river habitats downstream of Lewiston, greatly reduced the diversity of the entire river system, thereby reducing habitat choices for salmonids.

Reduced river flows and disruption of the sediment flow in the mainstem (post-TRD), as well as altered watersheds (both pre- and post-dam), have altered geomorphic processes, particularly in the mainstem above the confluence of the North Fork. For the first 21 years of TRD operations, Trinity River flows were only 21 percent of natural flows. Perhaps more significantly, the peak winter and spring flows were eliminated or greatly reduced. The harmful effects of the reduced flows were manifested in several ways, including changes to channel geomorphology, substrate composition, and water temperatures. Ultimately, the reduction in flows has lead to a reduction in habitat, as evidenced by sand filling in holding pools of adult salmonids, increased fine sediment accumulation in river substrates, and increased channelization of the mainstem (which has made the river banks more vertical and does not allow lateral movement of the channel within the floodplain). The effects of these processes have significantly reduced total wetted habitat and salmonid spawning and rearing habitat area and suitability in the mainstem Trinity River below Lewiston Dam (Frederiksen, Kamine, and Associates, 1980). For example, spawning habitat losses have been estimated to be 80 percent in the first 2 miles below Grass Valley Creek, and at 50 percent in the next 6 miles since construction of Lewiston Dam (California Resources Agency, 1980).

Since the completion of the dams, the degradation of habitat, beginning downstream of Lewiston and adversely affecting approximately 40 river miles (RM) downstream to the North Fork, has generally been accompanied by a decline in salmonid populations (Frederiksen, Kamine, and Associates, 1980). Shallow riffles have been replaced by glides and deeper water habitats, resulting in reduction in total habitat areas suitable for the production of food organisms (Frederiksen, Kamine, and Associates, 1980). Reduced river flows and changes in sediment input are the primary factors in changes to channel geomorphology and, therefore, the degradation of fish habitat. The altered channel geomorphology includes a reduction in the number and quality of alternate bar sequences. Important salmonid habitats associated with alternate bars include: pools that provide cover from predators and cool resting places for juveniles and adults; gravelly riffles where adults typically spawn; open gravel/cobble bars that create shallow, low-velocity zones important for emerging fry; and slack water habitats for rearing juveniles.

Since TRD operation, the Trinity River has become channelized, i.e., the river banks have become more vertical, and there is little lateral movement of the channel within the floodplain. The static nature of the altered river has allowed the root systems of riparian plants to encroach into the river channel. The roots bind spawning gravel and encourage the formation of sand berms along the river banks. This encroachment of riparian vegetation and subsequent berm formation further narrows the channel and reduces shallow, low-velocity salmonid rearing habitat and habitat diversity (see the Geomorphic Environment section [3.2] of the 1999 DEIS/DEIR for additional information).

Changes in substrate composition have occurred because of increases in fine sediment (from increased watershed erosion and attenuation of sediment-transporting flows) and the reduction of coarse sediment (e.g., gravel) recruitment (due to the dams). Fine sediment fills in spaces between gravels and cobbles, which inhibits the percolation of water through these areas. This accumulation of fine sediment decreases survival of eggs and sac-fry and decreases the amount of habitat for overwintering juvenile coho and steelhead (which burrow between gravels and cobbles). Fine sediment accumulation may have also impacted habitat for aquatic invertebrates, which are the primary food source for juvenile salmonids.

Seasonal changes in water temperature and turbidities since the construction of the TRD, particularly in the reach from Lewiston to the North Fork, have been observed (Frederiksen, Kamine, and Associates, 1980). On the average, and prior to the construction of the TRD, water temperatures in the Lewiston-to-North Fork reach of the mainstem Trinity River were warmer than current water temperatures during the migration, holding, and spawning periods of spring chinook salmon. Temperature conditions in the Trinity River during the late summer baseflow periods have been more favorable (cooler) to rearing salmonids than those prior to the construction of the TRD because of an overall increase in summer baseflow. (For more information on flows and temperatures, see the Water Resources section [3.3] of the 1999 DEIS/DEIR.) These changes in water temperatures have implications on the temporal and geographic distribution and life history attributes of the fish resources in the Trinity River.

Construction and operation of the TRD changed the thermal diversity available to Trinity River anadromous salmonids. The dams blocked access to the cool upstream reaches that are dominated by snowmelt runoff and remain cool throughout the year. Prior to the dam, these areas provided important juvenile rearing and adult holding habitats for salmonids when the majority of the lower mainstem habitats (i.e., below Lewiston) had likely become too warm. The upstream tributaries (dominated by snowmelt) provided increased flows and decreased temperatures during the spring and early summer that aided smolt emigration through much of the mainstem. Because these habitats are now blocked by the TRD, and much of the snowmelt is retained in the TRD reservoirs, it is necessary to artificially maintain cooler temperatures below the dam than those that existed prior to the dam. In other words, the mainstem below the dam must now function thermally like the upstream reaches and tributaries (for anadromous salmonids). Exacerbating the problem is the decrease in geomorphic diversity below the dam. Prior to the TRD, water temperatures in the deep mainstem pools stratified; bottom layers were documented as much as 7 degrees Fahrenheit (°F) cooler than upper layers (Moffett and Smith, 1950). The cool temperatures at the bottom of the pools provided important thermal refugia for migrating adult and rearing juvenile salmonids. The altered flow regime and channel geomorphology decreased or eliminated the temperature stratification in pools in the summer/early fall months. Although average post-dam monthly water temperatures at Lewiston are cooler than pre-dam temperatures during June-November, this benefit has not fully compensated for the lost thermal diversity in the system (i.e., above the dams) or for the reduction in stratified pools.

The Trinity River also has a significant influence on the water temperatures in the Klamath River downstream of it's confluence at Weitchpec. Cool water releases from Lewiston Dan during the warm months can benefit anadromous species and their habitats not only within the Trinity River, assisting in rearing, immigration, and smolt outmigration, but also benefits the Klamath fishery. In 2002, low flow conditions in the Lower Klamath River, warm water temperatures, and an above average fall run Chinook salmon escapement combined to create conditions favorable to an epizootic outbreak resulting in a huge fish die-off (TRPP, 2003). At a hearing in response to this die-off, Federal District Court Judge Oliver Wanger directed the Department of the Interior to determine what actions would be necessary to "assure against the risk of fish losses that occurred…." (in 2002). Subsequently, in April, 2003 a ruling also allowed Reclamation to use an additional 50,000 acre-feet of water from the Trinity River Division of the CVP to prevent a recurrence of the September, 2002 fish die-off. In a summary report of the monitoring of that flow release, the Trinity River Restoration Program concluded that the implementation of the 2003 Trinity River Fall Flows Action Plan was successful in reducing the risk of a major die-off event in 2003. A memorandum outlining the methodology and results of the flow releases made by Reclamation during the late-summer of 2003 in response to these orders are attached to this Appendix as Attachment B2.

Finally, in it's investigation on the causes of decline and strategies for recovery of the endangered and threatened fishes in the Klamath River Basin, the National Academy of Sciences final report (NAS, 2003) recommended: "That it is vital that management of the Trinity River, including releases from Lewiston Dam be viewed in the context of the entire Klamath watershed" (NAS,2003). Furthermore the Report states: "While it may be attractive to use Trinity flows to influence conditions in the Lower Klamath River, it must not occur at the expense of the Trinity River restoration goals" (NAS, 2003).

Food Production. During the freshwater phase of their life history, the major food source of anadromous salmonids are aquatic benthic macroinvertebrate (insect) organisms. The production of these organisms occurs on the constantly submerged (wetted) portions of a streambed (Frederiksen, Kamine, and Associates, 1980). The particle size and substrate material of the wetted streambed can greatly affect the production of this food source. Boles (1980) found that when a riffle in the Junction City reach of the Trinity was flushed of its load of granite sand, a marked increase in productivity, biomass, and diversity of benthic organisms occurred.

Food production capability within the mainstem Trinity River was good and compared favorably with that of the North Fork and the Smith River, which have not been impacted by siltation and water diversions (Frederiksen, Kamine, and Associates, 1980). Results of aquatic insect studies, which monitored the mainstem Trinity River upstream of the North Fork confluence, indicated that over the course of the multi-year study, improvements have occurred in the biotic condition indices (BCI) measured at six sampling locations, but habitat conditions could be improved (Mangum, 1995). These results indicated that good to excellent potential food conditions exist at the study sites monitored downstream of Lewiston, particularly for larger juvenile fish (Mangum, 1995). From these investigations it appears that benthic food production may not be a major factor in limiting fish production in the mainstem Trinity River at the current time.

Habitat Restoration Projects. Since the early 1980s, the Trinity River Basin Fish and Wildlife Restoration Program conducted a variety of restoration activities in the mainstem Trinity River and its tributaries. Some activities conducted in tributaries include watershed restoration work as well as habitat enhancement projects, and dam construction and pool dredging in Grass Valley Creek to decrease the amount of fine sediment entering the mainstem Trinity River. Restoration activities that have been implemented in the mainstem include gravel placement, pool dredging, and construction of several channel rehabilitation projects (side channels and bank rehabilitation of point bars).

The Trinity River Basin Fish and Wildlife Restoration Program constructed twenty-seven channel rehabilitation projects on the mainstem Trinity River between Lewiston Dam and the North Fork: 18 side-channel projects and 9 bank rehabilitation projects (also known as feathered-edge projects). Monitoring documented chinook salmon spawning within the constructed side-channels. Observations also indicate that the side-channels are used extensively during the spring by rearing chinook salmon juveniles.

The remaining nine projects were bank rehabilitation projects between Lewiston Dam and the North Fork Trinity River. The projects were constructed by physically removing vegetated sand berms along the bank to restore the channel to a pre-dam configuration. Channel rehabilitation sites are significantly wider and shallower than corresponding control sites at intermediate and high flows. Along with promoting formation of alluvial features characteristic of unregulated rivers, channel rehabilitation projects have been shown to increase the amount and diversity of habitat for adult and juvenile salmon and steelhead. During recent investigations, salmonid fry habitat indexes were greater at rehabilitation sites than at corresponding control sites. Catch per effort for chinook salmon fry was also greater at rehabilitation sites than at control sites, suggesting greater habitat use at these sites. Spawning surveys at project locations have also shown high use of these areas by spawning chinook salmon.

1.1.1.2 Lower Klamath River Basin

The Klamath River is California's second largest river, with an average annual water yield in excess of 13 million acre-feet (maf). Like the Trinity Basin, the lower Klamath River Basin provides habitat for anadromous spring and fall chinook salmon, coho salmon, and steelhead. In addition, coastal cutthroat trout frequent the lower reaches of the basin. All anadromous fish from the Trinity Basin must migrate through the lower Klamath Basin and estuary. The estuary at the mouth of the Klamath is an important rearing and migration area for these anadromous species. Approximately 80 percent of the Native American salmon gill-net fishery occurs within the lower Klamath River, as well as a sport fishery for chinook and coho salmon, steelhead, and coastal cutthroat trout. A description of sportfishing activity along the lower Klamath River is presented in the Recreation Technical Appendix D in the 1999 DEIS/DEIR.

Habitat Characteristics and Requirements. Habitat requirements and characteristics for anadromous salmonids in the lower Klamath River Basin are similar to those discussed for the Trinity River Basin (refer to Trinity River Basin Habitat Characteristics and Requirements). The lower Klamath River Basin provides significant seasonal habitat for anadromous salmonids. Causes for the decline of the numbers of salmonids in the Klamath River Basin have been attributed to land use, water diversions, harvest, ocean conditions, dams, and inriver habitat conditions (California Department of Fish and Game, 1992b). Some of these activities are thought to have degraded juvenile salmonid rearing and nursery habitats (California Department of Fish and Game, 1997.).

Water quality of the Klamath River has been negatively effected by nutrient-rich agricultural runoff. Runoff from the upper Klamath Basin (including reservoirs) contains many inorganic compounds that lead to large plankton blooms, which can make the river turbid in appearance. As evidenced by field crews above Weitchpec during 1997, warm water and high phytoplankton abundance can also periodically lead to low dissolved oxygen levels, which can have a negative effect on fish survival. With increasing distance from Iron Gate Dam, however, the water quality improves through dilution by tributaries, including the Trinity River, largest of tributaries (see Water Quality).

CDFG (1992a, 1992b, 1993a, 1993b, 1994a, 1994b, and 1995) has been conducting investigations to describe fish habitats and monitor water quality in the lower Klamath River and estuary. Their findings have determined that seasonal habitat changes occur as plant growth (especially algae) and fine sediments gradually increase in the summer and fall seasons due to decreased river flows and increased water temperatures. A sand bar occasionally closes the estuary and impounds the outflow of the Klamath River during this time. Salt water dominates the estuary during these months of high biological productivity, and a resulting salt wedge provides thermal refuge for rearing salmonids during the warm summer and fall months.

Populations. Since 1978, CDFG has compiled the inriver and hatchery spawner escapements and Indian net and angler harvests for fall chinook salmon for the Klamath Basin including the lower Klamath and Trinity River Basins. These estimates are compiled annually and are referred to as the "mega-table" (Attachment B1, Table B1-1). Harvest (ocean and inriver combined) of fall chinook salmon is managed for a 33-34 percent escapement for all brood years, or a minimum inriver spawner escapement level (floor) of 35,000 fall chinook salmon adults, whichever is greater. These harvest goals were established in 1989 by the PFMC on the recommendation of the Klamath River Technical Advisory Team (PFMC, 1997). Factors influencing the anadromous salmonid populations inhabiting the Klamath River Basin include: Iron Gate Hatchery operations, harvest (both inriver tribal and sports fisheries, and ocean commercial and sport fisheries), freshwater habitat conditions (including flows from the Trinity and upper Klamath River and its major tributaries, such as the Shasta and Scott Rivers), and ocean productivity conditions.

A description of sportfishing activity along the lower Klamath River is presented in the Recreation Resources Technical Appendix D of the 1999 DEIS/DEIR. Information on tribal fisheries is presented in the Tribal Trust section (3.6) of the 1999 DEIS/DEIR.

1.1.1.3 Coastal Area

The coastal area adjacent to the Klamath River Basin provides habitat for the maturing and adult life stages of the anadromous salmonids found in the lower Klamath and Trinity River Basins. Habitat conditions in this coastal near shore and ocean environment are subject to natural productivity as affected by physical and biological oceanic processes, atmospheric weather, and climate patterns. The influence of humans on anadromous salmonid populations in the coastal areas adjacent to the Klamath River Basin is primarily a result of commercial and recreational harvest activities. The 1999 DEIS/DEIR described recent ocean sport and commercial salmon fishing activity for the six study regions along the California and Oregon coast that could be affected by the project.

1.1.1.4 Central Valley

Habitat Characteristics and Requirements. The Central Valley of California provides essential habitat for the freshwater life stages for chinook salmon as well as steelhead. Within the Central Valley, the Sacramento and San Joaquin Rivers provide corridors for the anadromous salmonids resources found within the valley. The Sacramento River is the largest river system in California and produces more than 90 percent of the Central Valley salmon and steelhead. The Sacramento River supports four runs (races) of chinook salmon: fall, late-fall, winter, and spring. Fall chinook is the predominant salmon in the Central Valley. Fall steelhead are also found in the Central Valley with almost the entire population restricted to the Sacramento River system. Unlike the Trinity and Klamath River Basins, the Central Valley is not known to contain coho salmon or cutthroat trout. Estimates of the abundance of the chinook salmon and steelhead populations found in the Central Valley are shown in Tables B1-8 and B1-9 in Attachment B1 of the 1999 DEIS/DEIR Fishery Appendix.

Limiting Factors. Major limiting factors in the Central Valley that have affected anadromous salmonids (U.S. Fish and Wildlife Service, 1995) include the following:

- Diversions, such as the Red Bluff Diversion Dam/Tehama-Colusa Canal; the Glen-Colusa Irrigation District Canal; the Anderson-Cottonwood Irrigation District Canal; and hundreds of small unscreened diversions throughout the Sacramento and San Joaquin Rivers and the Sacramento-San Joaquin River Delta (Delta)
- Blockage of habitat by major dams (i.e. Shasta Dam)
- Water diversions at the state and federal pumps in the Delta
- Increased water temperatures within the Central Valley rivers and the Delta
- Habitat loss and degradation in the rivers and the Delta
- Industrial, municipal, agricultural, and mining waste discharge that degrades water quality
- Predation by introduced species
- Inadequate instream flows within the rivers and reduced outflows in the Delta

Approximately 25 percent of all warmwater and anadromous sportfishing and 80 percent of the state’s commercial fishery are dependent on species that live in or migrate through the Delta. Most of the state’s anadromous fish, including several state Species of Special Concern, inhabit the waters of the Delta.

Delta outflow plays a key role in influencing the abundance and distribution of fish and invertebrates in San Francisco Bay through changes to salinity, currents, nutrient levels, and pollutant concentrations. The response of organisms to Delta outflow is species and life-stage dependent. The effect of Delta outflow on San Francisco Bay aquatic organisms is determined by timing, magnitude, and duration of the outflow. Fluctuations in water temperature also play an influential role in the productivity of the Bay. The San Francisco Bay provides essential migration and rearing habitat for the anadromous salmonid species of the Central Valley. These species migrate through the bay on their way to and from the ocean as well as rear on their way out of the system.

Species Listed or Proposed for Listing under the Endangered Species Act (ESA) or the California Endangered Species Act (CESA). Special-status anadromous salmonids found in the Central Valley include the federal and State of California endangered winter chinook salmon. Winter chinook salmon were listed endangered under the California Endangered Species Act (CESA) in 1989 and were declared threatened by NOAA-Fisheries on November 5, 1990. NOAA-Fisheries reclassified winter chinook salmon as endangered on January 4, 1994. On June 16, 1993, NOAA-Fisheries published the final rule designating the critical habitat for this species as the Sacramento River from Keswick Dam (Shasta County) to Chipps Island at the westward margin of the Delta. In addition, all waters westward of Chipps Island to Carquinez Bridge, all of San Pablo Bay, and San Francisco Bay north of the San Francisco/Oakland Bay Bridge were designated as critical habitat for winter chinook salmon (U.S. National Marine Fisheries Service, 1997).

The Central Valley ESU steelhead was proposed for listing as threatened under the federal ESA March 16, 1995. On July 31, 1996, NOAA-Fisheries determined that this species warranted listing as a threatened species under ESA, but the decision to list the species was deferred on August 11, 1997, for 6 months to gather more scientific information. A final ruling on its status resulted in the listing of this species as threatened on May 18, 1998.

In April of 1996, the Commission rejected a petition submitted to list the Sacramento River spring chinook salmon as an endangered species under CESA. However, in February 1997, the State of California Superior Court in San Francisco ruled that the Commission committed an error in their finding that the listing of the Sacramento River spring chinook salmon as endangered was not warranted. This resulted in the conclusion by the Commission that the species should be listed as a candidate for endangered status and required CDFG to submit a report to the Commission within one year indicating whether the species should be listed. The State of California listed Sacramento River spring chinook salmon as threatened on February 6, 1999.

In March 9, 1998, NOAA-Fisheries proposed spring chinook salmon ESU as endangered, and fall and late-fall chinook salmon ESU's were proposed as threatened in the Central Valley. On September 9, 1999, NOAA-Fisheries announced that the Central Valley spring chinook ESU was listed as threatened on or about November 15, 1999. The fall/late-fall ESU remains a Federal candidate species.

1.1.2 Environmental Consequences

1.1.2.1 Methodology

Trinity River Basin. The salmon pre-smolt production model (SALMOD) developed for the Trinity River (Williamson, et al., 1993) was previously evaluated as a tool for assessing the effects of project alternatives on anadromous salmonids. For the purposes of the 1999 Draft Environmental Impact Statement/Environmental Impact Report (DEIS/DEIR) it was determined that the SALMOD model is not useful in distinguishing project alternatives because SALMOD was developed only for the uppermost 25-mile reach of the mainstem Trinity River downstream of Lewiston to Dutch Creek; only chinook salmon are modeled; the model covers a limited time-frame (from September 2 to June 9); and the model uses current channel configuration and conditions. Because of these limitations, an alternative methodology was developed and used to determine effects of project alternatives on salmonid fish resources for the 1999 DEIS/DEIR. This methodology was also used in the analysis of impacts and benefits to anadromous salmonids in the Trinity River in this SEIS. In addition to the methodology used in the 1999 DEIS/DEIR, a supplemental and more robust analysis of the effects of river flows and resulting water temperatures on the smolt life-stages of anadromous salmonids was conducted.

The following assumptions were used in the SEIS/SEIR analysis of environmental consequences:

- The TRSSH would be operated as it is currently, and operations would not affect natural production of anadromous salmonids.
- All anadromous salmonid species would respond similarly to actions of any one particular project alternative except as noted below.
- In the year 2020, any rehabilitation sites and/or watershed work would be completed, and the river system processes would be functioning at the full level of their ability within the given flow regime(s); and anadromous fish populations, although not constant from year to year due to varying environmental conditions (especially oceanic factors), would be at their long-term average.
- Except as noted, the analysis assumed the historic distribution of Trinity River Basin water-year class as shown in Attachment B3.

Trinity River System Attribute Analysis Method (TRSAAM). To evaluate the environmental consequences of the proposed project alternatives on anadromous salmonid fish habitat in the Trinity River Basin, the Trinity River System Attribute Analysis Method (TRSAAM) was employed. This approach was based on the fundamentals and relationships of key river system characteristics and functions (McBain and Trush, 1997). In the Trinity River Flow Evaluation Report (U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999), 10 river system habitat attributes (attributes) were identified as essential to the integrity of a healthy fluvial river system. The members of Trinity River EIS/EIR Fisheries and Channel Rehabilitation Technical Team (TRFCRTT) convened numerous times and developed and agreed upon an evaluation methodology that employed these 10 fluvial geomorphic attributes. An additional attribute specific to water temperature and habitat requirements was salmonids was identified and included in the analysis conducted for the 1999 DEIS/DEIR, with objectives and threshold criteria developed for the purposes of assessment. For the SEIS this analysis was replaced with an analysis of water temperature suitability for anadromous salmonid smolts (see description below).

In the DEIS/DEIR, the 11 river system attributes were evaluated in meeting threshold criteria for objectives of a healthy river for each project alternative and the No Action Alternative. Threshold criterion for meeting each of the attribute's objectives was identified from investigations conducted on the Trinity River in recent years. These studies included McBain and Trush (1997); Wilcock, et al., (1995); Trinity Restoration Associates (1993); and Zedonis and Newcomb (1997). The attributes, objectives, and their thresholds evaluated in this SEIS are shown in Table B-8. A summary of the methods are shown in Attachment B3 of Fishery Technical Appendix B to the 1999 DEIS/DEIR. The assumptions for the TRSAAM method are summarized below:

- If actions are made that move closer to meeting or that meet desirable system attributes, fish production will increase.
- All attributes were weighted equally for evaluation of fish production.
- Attributes provide and maintain habitat for all freshwater life stages of anadromous salmonids.

- Decline of one attribute can negate the benefits to fish of all other attributes (i.e., habitat diversity, water quality).
- Changes in fish numbers are not linearly correlated with flow.
- Only set flow release schedules were evaluated (uncontrolled spills were not assessed).
- Sediment-related attributes are limited to mainstem Trinity River channel upstream of Indian Creek confluence.
- The 70 Percent Inflow Alternative is based on weekly flow scheduled as seen in Attachment B4) and not average flow schedules by water-year classes used for other impact assessment.
- Current harvest management practices are sustainable.
- Probability of occurrence for Trinity River water-year classes used for the analysis was based on flows at Lewiston (pre-dam) and inflows to Trinity Lake (post-dam) (Attachment B3); these are as follows: extremely wet = 0.12; wet = 0.28; normal = 0.20; dry = 0.28; and critically dry = 0.12.

For the 1999 DEIS/DEIR the TRFCRTT determined that the objectives of the Attribute No.1 (1998) were contained in portions of other river system attributes, and by scoring objectives 1 through 4 for this attribute, a "double-counting" of objectives would occur. Therefore, for Attribute 1, objectives 1 through 4 (Table B-8) were not analyzed as part of the TRSAAM evaluation for the DEIS/DEIR nor this SEIS/EIR. Additionally, objectives 1 through 4 of Attribute 11 were not scored for the SEIS, as it was determined that it was desirable and necessary to evaluate the effects of water temperature outside this TRAASM methodology. The remainder of the attribute objectives presented in Service and HVT (1999) were used to evaluate each project alternative. In summary, for the SEIS, for each project alternative, a total of 35 objectives were evaluated for the 9 fluvial river system attributes.

<u>TRSAAM Attribute Scoring</u>. For impact analysis for the 1999 DEIS/DEIR the TRFCRTT developed a scoring system for evaluating the performance of each project alternative in meeting all of the attribute objectives. Using the same approach and scoring system, for this SEIS, the following was employed: a numerical 2 was assigned to an objective that always or nearly always met an identified threshold (e.g., flows > 6,000 cfs and achieved the frequency of that threshold); a numerical 1 was assigned to an objective that sometimes exceeded that threshold; and a numerical 0 was assigned to an objective that never or nearly never exceeded that threshold (less than 10 percent of the time). Using this system, each of the 35 objectives were assigned a score of "2," "1," or "0." Because of the difficulty in assessing the relative importance of each attribute objective, an assumption was made that all attribute objectives were equally important. Therefore, there was no attempt to differentially weight the relative contributions of each objective when summarizing an alternative's total score. This assumption is likely incorrect but unavoidable. For example, even if all other habitat attributes were optimized, the inability to provide suitable water temperatures would prevent successful restoration to the fishery. In that example water temperature and microhabitat conditions would act to constrain any beneficial restoration gained from other habitat objectives. However, for this analysis and to facilitate scoring of attributes, all objectives were treated as equally important in meeting the attributes of a healthy and functioning fluvial system.

In summary, for each project alternative, a maximum total score of 70 was possible if all 35 objective thresholds were always or nearly always met (a score of 2 X 35 objectives = 70). Using this process, the Maximum Flow, Flow Evaluation, Revised Mechanical Restoration, and Modified Percent Inflow Alternatives were assessed by assigning a total score to the 11 river system attributes assuming that flows met or exceeded the attribute objective thresholds and identified frequencies using the historic water-year class frequencies. For the 70 Percent Inflow alternative the assessment was made using representative median water years to assess the ability of this alternative to meet the attribute objective thresholds and identified frequencies. Finally, for the No Action, and the Mechanical Restoration project alternatives, which do not have water-year class dependent flow schedules, attribute assessment and scoring were made by assessing the ability of this alternative to meet the attribute objective thresholds and identified frequencies using the flow schedules as shown in Attachment B4.

Water Temperature and Microhabitat Attribute Evaluation. In the 1999 DEIS/DEIR and as part of the habitat attribute analysis (above), mainstem Trinity River water temperatures were evaluated as to their ability in meeting two temperature objectives These two temperature objectives were: flows sufficient in quantity, on average, to meet salmonid smolt emigration temperature requirements during normal hydro-meteorological conditions (Attribute 11, Objective No.1); and flow volumes (450 cubic feet per second [cfs]) sufficient to meet State Water Quality Control Board (SWQCB) temperature objectives for the Trinity River upstream of the North Fork (Attribute 11, Objective No.2).

To assess the impacts of water temperature on populations of salmonids in the Mainstem Trinity River for this SEIS an evaluation of the temperature-flow relationships and suitability for the smolt lifestages of steelhead, coho and chinook salmon were conducted (see description below). This analysis replaced the water temperature and microhabitat attribute evaluation previously conducted in the TRAASM Analysis. The role of water temperature acting to limiting the success of a population of salmonids were determined to be of significant biological importance and outside the evaluation of purely physical habitat conditions (e.g. channel migration frequency).

Assessment of Temperature Influences on Potential Salmonid Smolt Production in the Trinity River.

The object of this analysis was to assess, evaluate, and discriminate differences (if any) between proposed project alternatives with regards to the effects of water temperature on the smolting success of anadromous salmonids in the mainstem Trinity River. Water temperature is crucial to the success of salmonid populations. In order to assess temperature effects on smolt outmigration as a potentially limiting factor, the evaluation of water temperature effects was removed from TRSAAM and evaluated independently. Adverse water temperature conditions could result in large losses of sensitive salmonid life-stages (i.e. smolts) irregardless of other habitat conditions within the watershed. Due to it's importance to survival during out-migration and recruitment to the population, a detailed evaluation of the effects of water temperature on emigrating smolts for the three principal salmonid species, Chinook and coho salmon and steelhead, in the Trinity River was conducted.

Salmonid smolt temperature indices were developed to evaluate the impacts of changing water temperatures on successful smolt outmigration. While the index is called a smolt survival index, the term refers to an index of indirect smolt survival as opposed to an index of direct acute lethality. It is recognized that not all smolts of a given cohort would be expected to perish at the upper marginal temperature thresholds provided in Table 9. However, it would be expected that at these temperature thresholds smolts would likely revert to a non-migratory lifestage (parr) and attempt to rear in the river. Given that scenario, these parr may be considered potentially lost to that years' recruitment and therefore don't "survive".

This analysis focused on potential smolt survivability, based on smolt lifestage specific temperature threshold criteria (Table B-9) identified for these species in the Trinity river (Zedonis and Newcomb, 1997). Also, smolt emigration timing (TRFES, 1999), specific river flows, flow/temperature relationship estimates, and smolt temperature survival estimates were also used to calculate these indices. These factors were used to calculate an annual smolt survival suitability index (S.I.) for each species for each alternative and No Action. These indices, predicting smolt out-migration success at Weitchpec were then compared to distinguish performance of proposed project alternatives in meeting for the water temperature needs of the anadromous salmonids in the Trinity River. Furthermore the influence of differing flow regimes and resulting water temperatures on Chinook salmon smolts and resulting harvest and spawning escapement were evaluated using a Chinook salmon life cycle model. The methodology and results of these analyses are found as Attachment B5 to this Fishery Appendix.

<u>Harvest Factors and Allocations</u>. In the 1999 DEIS/DEIR, harvest to escapement ratios (harvest factors) were generated for chinook salmon, coho salmon, and steelhead so that harvest levels based on estimated spawner escapements could be generated. (See Attachment B6 of the 1999 DEIS/DEIR Fishery Technical Appendix for methods and data used to generate harvest factors.) From this analysis, allocation estimates for total harvest, tribal harvest, commercial (ocean) harvest, ocean sport harvest, and inriver sport harvest were made.

However, for this SEIS/SEIR, the results of a Chinook salmon harvest index calculated from the smolt temperature suitability analyses replaced the escapement estimates presented in the 1999 EIS/EIR in an attempt to distinguish project alternatives. The methodology and results of these analyses are also found as Attachment B6 to this Fishery Appendix. Chinook salmon production was evaluated by using an existing harvest/escapement model that is commonly used for evaluations in the Klamath Management Zone. Use of the harvest/ escapement model allowed for analysis of various smolt survival rates on the relative numbers of adult fish between alternatives. The harvest/escapement model used in this analysis is specific to chinook salmon life cycle uses life history parameters (age specific survival, maturity rates, harvest rates, etc.) as developed for Trinity (or Klamath Basin) Chinook salmon. This model utilized alternative-specific annual smolt survival indexes generated by this document. Because no similar model exists for the steelhead and coho, Chinook is the only species that underwent this evaluation.

<u>Evaluation of Sediment Transport and Augmentation Needs</u>. The flow and sediment management actions in each alternative benefits and impacts the sediment regime on the Trinity River. Actions are necessary to balance the coarse sediment budget by transporting

Rush Creek sediments at a rate equal to input, and by augmenting coarse sediment immediately downstream from Lewiston Dam to compensate that transported by the high flow release hydrograph. To assess the ability of each alternative to accomplish sediment transport and the needs for augmentation an analysis was conducted based on field derived measurements conducted on the upper mainstem Trinity River. As a comparative tool, fine and coarse sediment transport was computed for each alternative and for each water year for that alternative. The weighted annual fine and coarse sediment transport rates for the Lewiston and Limekiln gaging stations as reported in the TRFES (Service and Hoopa Valley Tribe, 1999) were averaged and summarized for the analysis. The implications of the computed fine and coarse sediment transport rates were considered in light of: (1) ability to transport and route coarse sediment delivered from tributaries, (2) coarse sediment imbalance in the reach immediately downstream of Lewiston Dam, which would require compensating coarse sediment introduction (augmentation) to maintain coarse sediment storage, and (3) ability to transport large volumes of fine sediment, which would reduce fine sediment storage in the mainstem Trinity River. The details of the methodology are found as Attachment B9 of this Fishery Resources Appendix.

Assessment of Riparian Vegetation Regeneration. The seed dispersal timing of desirable woody riparian species (black cottonwood, Fremont cottonwood, shiny willow) on Trinity River floodplains occurs in the late spring and early summer months, corresponding to the historic snowmelt hydrograph of the Trinity River. Successful plant initiation requires that: (1) a higher elevation bar, scour channel, or floodplain surface be exposed and wetted during the seed dispersal period, (2) the surface be exposed and moist for a short duration to allow seed germination, (3) the subsurface capillary fringe declines at a rate less than the root growth rate of the initiating seedling, and (4) when the flow recession transitions into the summer baseflow period, the seedling roots are at the summer baseflow capillary fringe (Mahoney and Rood 1992, Segelquist et al. 1993, Amlin and Rood 2002, McBride, et al. 1988. Riparian recruitment on floodplains and other higher elevation surfaces during Extremely Wet years, and perhaps some Wet water years, is an appropriate riparian restoration objective for the future.

To assess the ability of each alternative to provide conditions conducive to riparian seed dispersal and riparian forest regeneration along the mainstem Trinity River, the stage-discharge curve at the Lewiston gaging station, and assumptions of target floodplain surface for riparian inundation, the hydrograph for each alternative was evaluated for riparian initiation. The hydrographs for Extremely Wet and Wet water years were plotted, and the receding hydrograph necessary for riparian initiation was also plotted. For the 70 percent Inflow Alternative and Modified Percent Inflow Alternative, median Extremely Wet and Wet years were used from the 1912-2002 period of record. Detailed methodology for this analysis is found as Attachment B9 of this Fishery Resources Appendix.

Lower Klamath River Basin. There were no quantitative methods available to directly evaluate the effects of project alternatives on the anadromous salmonid resources within the lower Klamath River. For this reason, several assumptions were made to assist in assessing changes or effects of alternatives on anadromous salmonid resources.

These assumptions included:

- Increased coldwater releases to the Trinity River could reduce Klamath River temperatures during mid-May through late-June to a small degree and are beneficial for emigrating and immigrating salmonids (U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999).
- Increases in flows in the Trinity River would improve habitat conditions and river system health.
- Mechanical restoration of riverine habitats within the Trinity River would not affect anadromous salmonids in the Klamath River Basin.
- Watershed protection in the Trinity River would improve habitat conditions and system health in the Klamath River Basin.

Using these assumptions, a qualitative assessment of the effects of project alternatives, as compared to No Action, was made.

Coastal Area. In the 1999 DEIS/DEIR changes in ocean salmon populations from Trinity River stocks were analyzed. For the methodology of that analysis see the Fishery Technical Appendix of the 1999 DEIS/DEIR. For this SEIS/SEIR, no analysis of changes in ocean population were intended nor conducted.

Central Valley. The effects of each project alternative on the anadromous salmonids in the Sacramento River were evaluated using Reclamation's Sacramento River Salmon Mortality Model, (LSACTEMC) (U.S. Bureau of Reclamation, 1991). For each project alternative, monthly water temperatures for the Sacramento River were estimated using Reclamation's Sacramento River Basin Temperature Model (LSALSRC3) (U.S. Bureau of Reclamation, 1990-1991). For the purpose of the water temperature analysis, it was assumed that the Shasta Temperature Control Device (STCD) would operate as designed. Estimated monthly temperature data from Reclamation's temperature model were input into Reclamation's salmon mortality model. Spatial and temporal spawning distributions for each of the four chinook salmon species found in the Sacramento River were also input into the salmon mortality model. Updated spawning distributions for winter chinook salmon from the years 1990 through 2002) were used in the salmon mortality model. From the salmon mortality model, losses of chinook salmon eggs and fry were estimated for all four species of chinook salmon spawning in the Sacramento River from Keswick Dam to Woodson Bridge.

There was no similar temperature mortality model available to estimate effects of project alternatives to steelhead in the Sacramento River. To evaluate the effects of project alternatives on steelhead spawning in the Sacramento River, it was assumed that estimated losses of steelhead eggs or fry would be similar to those estimated for late-fall chinook salmon using the LSACTEMC model. It was assumed that the peak of steelhead spawning in the Sacramento River is February (Hallock, 1989), and subsequent steelhead egg and fry incubation occurs at times similar to those for late-fall chinook salmon (Vogel and Marine, 1992) within the mainstem Sacramento River. It was recognized that the actual number of steelhead spawning in the mainstem Sacramento River is likely to be much less than those spawning in tributaries to the Sacramento River (Hallock, 1989). Therefore, any actual adverse effects on steelhead populations, as a result of changes in water temperatures from project alternatives, would likely be much less than that estimated using late-fall chinook salmon mortality as a surrogate analysis.

1.1.2.2 Significance Criteria

Effects are considered significant for anadromous salmonids if they result in any of the following:

- Potential for reductions in the number, or restrictions of the range, of an endangered or threatened anadromous salmonid species or an anadromous salmonid species that is a candidate for state listing or proposed for federal listing as endangered or threatened
- Potential for substantial reductions in the habitat of any anadromous salmonid species other than those that are listed as threatened or endangered or are candidates (CESA) or proposed (ESA) for threatened or endangered status
- Potential for causing an anadromous salmonid population to drop below self-sustaining levels
- Substantial adverse effect, either directly or through habitat modifications, on any anadromous salmonid species identified as a sensitive or special-status species in local or regional plans, policies, or regulations by the California Department of Fish and Game, the U.S. Fish and Wildlife Service, or the National Marine Fisheries Service
- Substantial interference with the movement of any anadromous salmonid species
- A conflict with, or violation of, the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan relating to the protection of anadromous salmonid species
- Mortality of state or federally listed anadromous salmonid species, or anadromous salmonid species that are candidates for listing (CESA) or proposed for listing (ESA)
- Reductions in the size of an anadromous salmonid species population sufficient to jeopardize its long-term persistence
- Temporary impacts to habitats such that anadromous salmonid species suffer increased mortality or lowered reproductive success that jeopardizes the long-term persistence of those local populations
- Permanent loss of essential habitat of a listed species or special-status anadromous salmonid species
- Reduction in the quantity or quality of habitats in which anadromous salmonid populations occur sufficient to reduce the long-term abundance and productivity of local populations.

Ocean sport and commercial salmon fishing levels have varied considerably from year to year over the past 30 years within each region. Some variation in activity and harvest levels is normal; however, substantial reductions, especially in harvest levels, can adversely affect the industries that rely on salmon harvests. Ocean sport and commercial salmon harvests were not specifically analyzed for the SEIS. Benefits to salmon harvest from implementation of the alternatives considered in the SEIS would fall within the range of those for the alternatives considered in the 1999 DEIS/DEIR. It is likely for any of the project alternatives considered in this SEIS, salmon harvest levels would be potentially greater than under no action conditions. This would result in beneficial economic effects within the sportfishing and commercial harvesting sector.

1.1.2.3 Results

Summary. The results of the comparisons of the No Action Alternative to each project alternative are summarized in Table B-19. Compared to the No Action Alternative, the Maximum Flow, Flow Evaluation, 70 Percent Inflow, Revised Mechanical Restoration, and Modified Percent Inflow Alternatives would all result in highly beneficial habitat conditions for anadromous salmonid species in the Trinity River as measured using the TRAASM methodology. The Mechanical Restoration Alternative would result in only modest benefits to these species in the Trinity River Basin using the TRAASM methodology. Using the supplemental analysis of water temperature-salmonid smolt outmigration, and sediment transport estimates the alternatives were further evaluated. The results indicated that the water temperature conditions for smolt outmigration, as reflected in the Smolt Suitability Indices (SI), were best for the Maximum Flow, Flow Evaluation, 70 Percent Inflow, Revised Mechanical, and Modified Percent Inflow alternatives, (in that order). The result of the Chinook Salmon Harvest index analyses also indicated that the improvement in harvestable Chinook salmon increased from 1,427 percent to 370 percent over that for No Action (in the same order of the alternatives given above). Additionally, the sediment transport analyses indicated that the: 70 Percent Inflow, Flow Evaluation, Modified Percent Inflow and Revised Mechanical Restoration Alternatives would provide beneficial coarse and fine sediment transport conditions (in the order of alternatives given).

The results of the sediment transport and augmentation analysis determined that the Flow Evaluation Alternative provided a desirable balance of fine and coarse sediment transport along with a moderate level of gravel augmentation. The Maximum Flow and the 70 Percent Inflow alternatives increase fine and coarse sediment transport volumes of up to approximately 90 to greater than 200 fold over that over No Action but would require a huge gravel augmentation program to provide sustained salmonid spawning substrates. The Modified Percent and Revised Mechanical were intermediate in their capacity to transport fine and coarse sediments and the need for gravel augmentation when compared to No Action and the Flow evaluation (see Table 2 and discussion in Attachment B9).

The Results of the riparian regeneration analysis indicated that the Flow Evaluation Alternative, 70 Percent Inflow Alternative, Maximum Flow Alternative, and the Revised Mechanical Alternative all would provide hydrographs during Extremely Wet years that would likely result in riparian initiation on the floodplains. The Modified Percent Inflow Alternative and No Action Alternative all have recession limbs steeper than that required to initiate riparian vegetation and therefore would not act to promote riparian vegetative regeneration on the upper mainstem Trinity River floodplain (see Table 3 and the discussion in Attachment B9 to this Fishery Resources Appendix).

Except for the Mechanical Restoration Alternative, for which there would be no change in habitat benefits, all of the remaining alternatives would benefit, to some degree, native anadromous salmonid species in the Klamath River Basin compared to the No Action Alternative. These benefits would be principally due to increased flows and in some cases somewhat cooler water temperatures in the Klamath River downstream of its confluence with the Trinity River.

The Maximum Flow, 70 Percent Inflow, Flow Evaluation, Revised Mechanical Restoration, and Modified Percent Inflow Alternatives all may negatively impact some of the native anadromous salmonid species including either Winter and/or Spring-run Chinook salmon in the Central Valley. For any impacts to Fall Chinook salmon, re-operation of the CVP are measures likely adequate to mitigate to less than significant any adverse effects in the Central Valley from implementing the Maximum Flow, Flow Evaluation, Modified Percent Inflow 70 Percent Inflow, Revised Mechanical Restoration, and Modified Percent Inflow Alternatives.

Adverse impacts from the implementation of the Maximum Flow, Flow Evaluation, Modified Percent Inflow, and the 70 Percent of Inflow Alternatives to federal and state listed endangered Winter-run Chinook salmon, in any water year in which the drawdown of Shasta Reservoir results in storage levels of less than 1.9 maf on September 30th, it would be necessary to re-consult with NOAA-Fisheries under terms of the 1993 Winter-Run Chinook Biological Opinion (NMFS-Fisheries, 1993). This re-consultation would result in operations that would attempt to minimize any losses to these species. Formal consultation with NOAA-Fisheries would be continued, as necessary, in order to operationally meet the Reasonable and Prudent Alternatives (RPAs) and Reasonable and Prudent Measures (RPMs) stipulated in the 1993 Biological Opinion for this species.

In the case of adverse impacts from the Maximum Flow, Flow Evaluation Alternative, Modified Percent Inflow, revised Mechanical Restoration and the 70 Percent of Inflow Alternatives to federal and state listed threatened Spring-run Chinook salmon, continued operation of the Cross-Channel gates in the Delta in consultation with NOAA-Fisheries would offset, mitigate and minimize any incremental losses of these species attributed to those alternatives.

1.1.2.4 No Action Alternative

Trinity River Basin. The results of the TRSAAM scoring for all attribute objectives for the No Action Alternative are shown in Table B-10. The individual scoring worksheets are shown in Attachment B6. The assumptions and rationale for scoring each attribute objective is shown in Attachment B7. A summary of the total score of the attributes for all project alternatives is shown in Table B-11. Attachment B5 provides details of the analysis of smolt outmigration temperature effects for the mainstem Trinity River for the project alternatives. Attachment B9 provides details of the sediment transport and riparian revegetation analysis for the mainstem Trinity River.

As shown in Table B-11, the No Action Alternative scored only 4 of the total possible 70 attribute objectives points believed necessary for a restored fluvial river system. For 32 of the 35 attribute objectives, thresholds were rated as never or nearly never exceeded (Table B-12). For only two objectives (attribute 2-objectives 4 and 5) did the proposed No

Action Alternative sometimes meet the attribute objective thresholds. For only one objectives did the No Action Alternative always or nearly always meet attribute objective thresholds. Those objective thresholds that were always or nearly always met were groundwater recharge of gravel bars (attribute 10-objective 1 (Table B-12).

Furthermore, the results of the detailed salmonid smolt temperature suitability analysis indicated that water temperature conditions in the mainstem Trinity River would likely result in allowing only approximately 41 percent, 84 percent, and 60 percent, of chinook and coho salmon, and steelhead smolts (respectively) to successfully emigrate (Table B-13). The receding limb of the spring hydrograph for the No Action alternative (Attachment B4) has insufficient stream flows throughout the out-migration months of June and July to ensure adequate cool water for those smolts leaving the Trinity river at Weichpec during that period. The effect of increased water temperatures on steelhead smolts may be less critical to their overall survival as smolts of this species could be expected to reverse their physiological condition (smoltification), allowing them to remain in-river as parr (rearing juvenile lifestage). Parr steelhead are significantly less vulnerable to increased water temperature, and therefore would not necessarily be entirely lost to the population. However, this effect would delay and would be an adverse impact, changing the timing of their entrance into the ocean. Should this occur, an indirect index of overall survivability for steelhead parr may be a more appropriate index for water temperature effects and the index of smolt suitability may be an index of direct water temperature impacts to steelhead. For the results of the analysis see Table B-13.

The weighted average sediment transport for No action is summarized in Table 1 of Attachment B9. The fine and coarse sediment transport rates for the Lewiston and Limekiln gaging stations as reported in the TRFES were averaged for the results shown in Table 1 in Attachment B9. For the No Action Alternative coarse and fine sediment transport is approximately 680 yd^3 and 230 yd^3 respectively. The benefits and deficiencies in sediment transport and augmentation for this alternative are summarized in Table 2 of Attachment B9. The No Action Alternative has a recession limb of the hyrodograph steeper than that required to initiate riparian vegetation on floodplains (See Table 3, Figure 1, and discussion in Attachment B9). Therefore, No Action is not conductive to riparian regeneration during any water year type.

The No Action Alternative performed poorly in meeting the habitat smolt temperature, sediment transport, and riparian revegetation requirements necessary for restoring anadromous salmonids in the mainstem Trinity River. These results indicate that, under the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would not provide the conditions necessary to allow salmonid stocks, including federal threatened coho salmon, to recover to pre-dam population levels. The consequences of reduced rates of smolt out-migration for Chinook and coho salmon during their normal emigration periods are significant annual reductions in their respective year class recruitment, significant impedance in recovery of coho salmon, and generally impede the overall restoration of the anadromous fisheries in the Trinity River.

The results of the salmonid smolt temperature suitability analysis indicated that there were significant deficiencies in the performance of the No Action Alternative, compared to the proposed alternatives in meeting the biological needs for these species. A summary of that analysis and the evaluation of the differences between the No Action alternative and the other alternatives for the Chinook harvest index are seen in Table B-14.

Furthermore, it is likely that habitat conditions would continue to deteriorate under the No Action Alternative, resulting in lower populations of these species in the year 2020 for the No Action Alternative.

Lower Klamath River Basin. As discussed in the methodology section, the assumptions were that improvements in water temperature conditions and increases in flows in the Trinity River would result in more favorable conditions in the lower Klamath River, thus benefiting anadromous salmonids within the lower Klamath River and estuary. Habitat conditions for the No Action Alternative would remain the same as currently found in the lower Klamath River and estuary; therefore, anadromous salmonid populations would remain unchanged under the No Action Alternative.

Central Valley. A summary of the estimated average annual losses of early life stages of Chinook salmon from Reclamation's LSACTEMC is shown in Table B-16. Tables of annual estimated mortalities for fall, late-fall, winter, and spring Chinook salmon for the No Action Alternative are shown in Attachment B8. In Table B-16, estimates of average annual simulated losses of Chinook salmon for the entire simulation period (1922-1993) are presented.

From this evaluation for the No Action Alternative for the entire period of simulation, annual losses of Chinook early life stages averaged 18 percent for fall run and 24 percent for spring run (Table B-16). Late-fall and federally and state endangered winter Chinook salmon losses were estimated to be much less than those for fall and spring Chinook and averaged from 1 to 8 percent for the entire 1922-1993 simulation period (Table B-16).

Using estimated losses of late-fall Chinook salmon as an estimate for steelhead losses, approximately 1 percent of these fish may be lost annually under the No Action Alternative (Table B-16).

1.1.2.5 Maximum Flow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Maximum Flow Alternative are shown in Table B-10. The individual scoring worksheets are shown in Attachment B6. The assumptions and rationale for scoring each attribute objective is shown in Attachment B7. A summary of the total score of the attributes for all project alternatives is shown in Table B-11. Fisheries Attachment B5 provides details of the analysis of smolt outmigration temperature effects for the mainstem Trinity River for the project alternatives. Results of the salmonid smolt outmigration temperature suitability analysis are summarized and shown in Table B-13. Detailed results of the sediment transport and riparian revegetation analysis is found in Attachment B9.

As shown in Table B-11, the Maximum Flow Alternative was scored 58 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Only 3 of the 35 attribute objectives thresholds were rated as never or nearly never exceeded (Table B-12). Six of the 35 attributes were scored as sometimes meeting threshold criteria. Twenty-six of the 35 attribute objectives were scored as always or nearly always exceeding objective thresholds for the Maximum Flow Alternative (Table B-12). Compared to No Action, the Maximum Flow Alternative excelled in meeting the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. Table B-15 summarizes the percent change in river system health and habitat conditions for anadromous salmonids for the Maximum Flow Alternative compared to No Action. These results indicate that river system health and habitat conditions would be expected to improve approximately 1,350 percent under the Maximum Flow Alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-15).

The salmonid smolt temperature suitability analysis indicated that, on average, water temperature conditions would be suitable for allowing approximately 76 percent, 99 percent, and 81 percent of Chinook, coho, and steelhead smolts, respectively, to successfully migrate out of the Trinity River at Weitchpec (Table B-13; Figures B5a through B5c). These indices represent improvements of 86 percent, 18 percent and 35 percent respectively, from No Action Alternative (Tables 6 through 8, Attachment 6). The Chinook Salmon Production index, a measure of the potential in harvest production is 1,427 percent greater, approximately a 14-fold increase over the No Action Alternative (Table 9 of Attachment 6). The summary of the changes in the instream release volumes, anadromous salmonid smolt temperature survival indices, and Chinook Harvest Index from the No Action Alternative are shown in Table B-14.

For the Maximum Flow alternative, the estimated annual coarse and fine sediment transport volumes are estimated to be very large, and are approximately 156,000 yd^3 and 21,500 yd^3 respectively (Table 1 Attachment B9). The huge volume of coarse sediment transported by this alternative would require a much larger gravel augmentation program to keep coarse sediment volumes balanced in the mainstem Trinity River. The benefits and deficiencies in sediment transport and augmentation for this alternative are summarized in Table 2 of Attachment B9. The recession limbs of the hydrograph during Extremely Wet and Wet years would likely result in riparian initiation on floodplains and initiate riparian regeneration during those water years (See Table 3 and Figures 2 and 3, and discussion in Attachment B9).

These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under the Maximum Flow Alternative (Table B-19). This project alternative would result in highly beneficial improvements in river system and habitat conditions, including significantly improving water temperature conditions for outmigrating smolts. These conditions would allow naturally produced anadromous salmonid populations, including federal threatened coho salmon, to greatly increase over those expected for No Action (Table B-14).

Lower Klamath River Basin. As discussed in the methodology section, the assumptions were that improvements in water temperature conditions and increases in flows in the Trinity River would result in more favorable conditions in the lower Klamath River, thus benefiting anadromous salmonids within the lower Klamath River and estuary. Increases in flows to the Trinity River from approximately 122 thousand acre-feet (taf) (critically dry water year) up to 1,800 taf (extremely wet water year) would benefit habitat conditions in the lower Klamath River and estuary. In their evaluation of the Flow Evaluation Alternative, the

Service and Hoopa Valley Tribe (1999) found that increases in flow in the Trinity River resulting from spring reservoir releases, dependent on timing and magnitude, can decrease or maintain water temperatures in the Klamath River downstream of the confluence. The temperature benefits determined from the evaluation of the Flow Evaluation Alternative would likely occur as a result of increased discharges in the Trinity and into the Klamath River for the Maximum Flow Alternative as well. Decreased water temperatures and increased flows would enhance habitat conditions and reduce travel time in the lower Klamath River during a critical period of out-migration of anadromous salmonid smolts.

Beneficial habitat conditions, as a result of more optimal temperatures and increased flows, would likely improve survival rates of outmigrating smolts and enhance the probability of their successful passage to the ocean. An additional benefit to anadromous salmonids in the lower Klamath River and estuary would result from improved rearing conditions for juveniles that will rear in the river for an additional year before out-migrating. Coho salmon and steelhead would particularly benefit from improvements in rearing conditions in the lower Klamath River and estuary due to their life history characteristic of smolting and out-migrating during the second year of their lives. For these reasons, it is likely that anadromous salmonids in the Klamath River as well as the Trinity River Basin would benefit. These benefits would result in increased populations under the Maximum Flow Alternative.

Central Valley. A summary of the estimated average annual losses of early life stages of Chinook salmon for the Maximum Flow Alternative from Reclamation's LSACTEMC is shown in Table B-16. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for the Maximum Flow Alternative are shown in Attachment B8.

From this evaluation, the Maximum Flow Alternative for the historic simulated period of 1922 through 1993 increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 27 percent of fall Chinook early life stages (Table B-16), an increase over the No Action Alternative of 9 percent (Table B-17).The estimated losses for late-fall chinook were nearly unchanged from those estimated for this species under the No Action Alternative (less than approximately 1 percent) (Table B-16). The average annual losses for endangered winter chinook were estimated to be 16 percent for the 1922-1993 simulation period (Table B-16).

Increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 55 percent of spring chinook early life stages (Table B-16), an increase over the No Action Alternative of 31 percent percent (Table B-17).For endangered winter chinook salmon, these estimates represent an increase in annual average losses of 8 percent greater than those estimated for the No Action Alternative for the 1922-1993 period of simulation (Table B-17). Reviewing the estimated losses of winter chinook salmon in Attachment B8 revealed that the majority of estimated losses for this species, compared to the No Action Alternative, resulted from extremely high mortalities during a number of critically dry water years (1924, 1931 through 1934, 1977, and 1988 through 1992). For any water year in which the drawdown of Shasta Reservoir results in levels of less than 1.9 maf at the end of September 30th, it would be necessary to re-consult with NOAA-Fisheries under terms of the 1993 Winter-Run Chinook Biological Opinion (U.S. Fish and Wildlife Service, 1993). This re-consultation would result in operations that would attempt to minimize any losses to these species.

Using the estimated average annual losses of late-fall chinook salmon as an estimate for steelhead losses in the upper Sacramento River, approximately 1 percent of these fish may be lost annually for the Maximum Flow Alternative (Table B-16). This estimate is unchanged from that for the No Action Alternative (Table B-17).

In summary, the estimated losses resulting from increases in water temperature on the early life stages of chinook salmon and steelhead in the Sacramento River for the Maximum Flow Alternative were compared to No Action. The results of this evaluation ranged from no change to an 31 percent increase in average annual losses for the 1922-1993 period of simulation (Table B-18). For the most part these incremental increases in losses are small compared to the No Action Alternative. However, the estimated increased losses of fall, spring, and winter- run chinook salmon in the Sacramento River are considered significant and represent adverse effects compared to the No Action Alternative.

The results of the evaluation of the Maximum Flow Alternative on the anadromous salmonids within the Sacramento River are summarized in Table B-18.

The results of the evaluation of the Maximum Flow Alternative on the anadromous salmonids of the affected area (Trinity and Klamath Basins and the Central Valley) are summarized in Table B-19.

1.1.2.6 Flow Evaluation Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Flow Evaluation Alternative are shown in Table B-10. The individual scoring worksheets are shown in Attachment B6. The assumptions and rationale for scoring each attribute objective is shown in Fisheries Attachment B7. A summary of the total score of the attributes for all project alternatives is shown in Table B-11. Fisheries Attachment B5 provides details of the analysis of smolt outmigration temperature effects for the mainstem Trinity River for the project alternatives. Results of the salmonid smolt outmigration temperature suitability analysis are summarized and shown in Table B-13.

As shown in Table B-11, the Flow Evaluation Alternative was scored 49 of the total possible 70 attribute objective points believed necessary to restore the Trinity River fluvial river system. Eight of the 35 attribute objectives were determined to never or nearly never exceed threshold criteria (Table B-12). Five of the 35 attribute objectives were found to sometimes exceed thresholds. Twenty-two of the 35 attribute objectives were scored as always or nearly always exceeding objective thresholds for the Flow Evaluation Alternative (Table B-12). While this alternative was not as effective as the Maximum Flow Alternative in meeting the objectives of the TRAASM Attributes, compared to No Action, the Flow Evaluation Alternative excelled in meeting the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River.
Table B-15 summarizes the percent change in river system health and habitat conditions for anadromous salmonids for the Flow Evaluation Alternative compared to No Action. These results indicate that river system health and habitat conditions would be expected to improve approximately 1,125 percent, approximately an 11-fold increase, under the Flow Evaluation

Alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-15).

The salmonid smolt temperature suitability analysis indicated that, on average, water temperature conditions would be suitable for allowing approximately 60 percent, 95 percent, and 80 percent of Chinook, coho, and steelhead smolts, respectively, to successfully migrate out of the Trinity River from April 9th to August 27th at Weitchpec (Table B-13; Figures B5a through B5c). These increases over No Action, ranged from 47 percent (Chinook), 13 percent (coho); to 33 percent (steelhead) (Tables 6 through 8, Attachment 6). The Chinook Salmon Production index, a measure of the potential in harvest production is 919 percent greater, approximately an 9-fold increase over the No Action Alternative (Table 9 of Attachment 6). Compared to the No Action Alternative, the Flow Evaluation Alternative had an estimated annual Chinook Salmon Harvest Index greater than approximately 40,000 adults. The summary of the changes in the instream release volumes, anadromous salmonid smolt temperature survival indices, and Chinook Harvest Index from the No Action Alternative are shown in Table B-14.

The analysis of fine and coarse sediment transport in the upper mainstem Trinity River for the Flow Evaluation alternative is found in Attachment B9 of this Fishery Resources Appendix. For this alternative, the estimated annual coarse and fine sediment transport volumes are balanced, from 8-12 fold greater than to those for No Action and are approximately 8,570 yd^3 and $1{,}870^3$ respectively (Table 1 Attachment B9). The benefits and deficiencies in sediment transport and augmentation for this alternative are summarized in Table 2 of Attachment B9. The recession limbs of the hydrograph during Extremely Wet years would likely result in riparian initiation on floodplains and initiate riparian regeneration during those water years. The recession limbs of the hydrograph during Extremely Wet years would likely result in riparian initiation on floodplains and initiate riparian regeneration during those water years (See Table 3, Figures 1 through 9, and discussion in Attachment B9).

The Flow Evaluation alternative would provide the instream flows necessary to meet these sediment transport processes, would notably reduce fine sediment storage, and improve coarse sediment balance, as well as minimize coarse sediment augmentation.

These results indicate that, compared to the No Action Alternative, fishery habitat, water temperature conditions, sediment transport, and riparian revegetation conditions in the mainstem Trinity River in the year 2020 would greatly improve under the Flow Evaluation Alternative (Table B-19). This alternative would result in highly beneficial improvements in river system and habitat conditions allowing naturally produced anadromous salmonid populations to greatly increase over those expected under No Action (Table B-14).

Lower Klamath River Basin. The Flow Evaluation Alternative would result in improved water temperature conditions and increases in Trinity River flows, both of which would result in more favorable conditions in the lower Klamath River. These improved conditions would benefit anadromous salmonids within the lower Klamath River and estuary. An annual increase in Trinity River flows, from approximately 28 taf (critically dry water year) to approximately 475 taf (extremely wet water year), would likely improve habitat conditions in the lower Klamath River and estuary in most years. In their evaluation of the Flow Evaluation Alternative, the Hoopa Valley Tribe and Service (1999) predicted that increases in flow in the Trinity River would reduce water temperatures in the Klamath River downstream of their confluence. These improvements would enhance habitat conditions and reduce travel time in the lower Klamath River during a critical period of out-migration of salmonid smolts.

Beneficial habitat conditions, as a result of more optimal temperatures and increased flows, would likely improve survival rates of out-migrating smolts and enhance the probability of their successful passage to the ocean. An additional benefit to anadromous salmonids in the lower Klamath River and estuary would result from improved rearing conditions for juveniles that will rear in the river for an additional year before out-migrating (U.S. Fish and Wildlife Service, 1998). Like the Maximum Flow Alternative, coho salmon and steelhead would particularly benefit from improvements in rearing conditions in the lower Klamath River and estuary due to their life history characteristics of smolting and out-migrating during the second year of their lives. For these reasons, it is likely that anadromous salmonids in the Klamath River and Trinity River Basin would benefit. These benefits would likely result in very large increases in salmonid populations with this Alternative.

Central Valley. A summary of the estimated average annual losses of early life stages of chinook salmon for the Flow Evaluation Alternative from Reclamation's LSACTEMC is shown in Table B-16. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for the Flow Evaluation Alternative are shown in Attachment B8.

From this evaluation for the Flow Evaluation Alternative for the historic simulated period of 1922 through 1993, increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 21 percent for fall chinook early life stages (Table B-16); an annual increase over the No Action Alternative of 3 percent (Table B-17).Average annual losses of late-fall and winter chinook salmon were estimated to be substantially less than those for spring chinook and averaged less than 2 percent for late-fall chinook. This estimated average annual loss for late-fall chinook was unchanged from that estimated for this species under the No Action Alternative.

For the historic simulated period of 1922 through 1993, increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 32 percent of spring chinook early life stages (Table B-16); an annual increase over the No Action Alternative of 8 percent (Table B-17). The average annual losses for endangered winter chinook were estimated to be approximately 9 percent for the entire 1922-1993 simulation period (Table B-16). For endangered winter chinook salmon, these estimates represent a small net increase (less than 1 percent) in annual average losses compared to the No Action Alternative (Table B-17).

For any water year in which the drawdown of Shasta Reservoir results in levels of less than 1.9 maf at the end of September 30th, it would be necessary to re-consult with NOAA-Fisheries under terms of the 1993 Winter-Run Chinook Biological Opinion (U.S. Fish and Wildlife Service, 1993). This re-consultation would result in operations which would attempt to minimize losses to these species.

Using the estimated average annual losses of late-fall chinook salmon as an estimate for steelhead losses in the upper Sacramento River, approximately 2 percent of these fish may be lost annually for the Flow Evaluation Alternative (Table B-16). This estimate is only slightly greater than that for the No Action Alternative (Table B-17).

In summary, the estimated losses resulting from increases in water temperature on the early life stages of chinook salmon and steelhead in the Sacramento River for the Flow Evaluation Alternative were compared to No Action. The results of this evaluation ranged from no change to a 8 percent increase in average annual losses for the 1922-1993 period of simulation, depending on species (Table B-18). Many of the increases in losses are small as compared to the No Action Alternative and may be within the limits of precision of the model used to estimate them. However, the estimated losses for fall, winter, and spring run chinook salmon in the Sacramento River are considered significant and represent adverse effects compared to the No Action Alternative. The results of the evaluation of the Flow Evaluation Alternative on the anadromous salmonids within the Sacramento River are summarized in Table B-18.

The results of the evaluation of the Flow Evaluation Alternative on the anadromous salmonids of the affected area (Trinity and Klamath Basins and the Central Valley) are summarized in Table B-19.

1.1.2.7 70 Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the 70 Percent Inflow Alternative are shown in Table B-10. The individual scoring worksheets are shown in Attachment B6. The assumptions and rationale for scoring each attribute objective is shown in Attachment B7. A summary of the total score of the attributes for all project alternatives is shown in Table B-11. Fisheries Attachment B5 provides details of the analysis of smolt outmigration temperature effects for the mainstem Trinity River for the project alternatives. Results of the salmonid smolt outmigration temperature suitability analysis are summarized and shown in Table B-13.

As shown in Table B-11, the 70 Percent Inflow Alternative was scored 50 out of the total possible 70 attribute objective points believed necessary to restore the Trinity River fluvial river system. A majority of the attribute objectives (19 of the 35) were determined to always exceed threshold criteria for this alternative (Table B-12). Twelve of the 35 attribute objectives were found to sometimes exceed objective thresholds. Only four of the 35 attribute objectives were scored as never or nearly never meeting objective thresholds for this alternative (Table B-12).

On further evaluation using the smolt temperature suitability analysis, water temperature conditions for the 70 Percent Inflow Alternative would, on average, would allow approximately 54 percent, 94 percent, and 74 percent of Chinook, coho, and steelhead smolts (respectively) to successfully migrate out of the Trinity River at Weitchpec from April 9th through August 27th (Table B-13; Figures B5a through B5c). These increases over No Action, ranged from 33 percent (Chinook), 23 percent (steelhead); to 12 percent (coho) (Tables 6 through 8, Attachment 6). The Chinook Salmon Production index, a measure of the potential in harvest production is 755 percent greater, or an increase of approximately 6-fold over the No Action Alternative (Table 9 of Attachment 6).

These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would improve under the 70 Percent Inflow Alternative Table B-19). This alternative would result in highly beneficial improvements in river system and habitat conditions allowing naturally produced anadromous salmonid populations to significantly increase over those expected under No Action. Table B-15 summarizes the estimated changes in river system health and habitat conditions for anadromous salmonids for the 70 Percent Inflow Alternative compared to No Action. These results indicate that habitat conditions would be expected to improve approximately 1150 percent under the 70 Percent Inflow Alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-15).

The analysis of the estimated fine and coarse sediment transport in the upper mainstem Trinity River for the 70 Percent Inflow alternative is shown in Attachment B9. For this alternative, it was estimated that the weighted annual average transport of coarse sediments (> 8mm) for both Lewiston and Limekiln Gulch combined, would be approximately 17,000 cubic yards, or approximately 97 percent greater than that for the Flow Evaluation Alternative (Table 1, Attachment B9). The weighted annual average transport of fine sediment for this alternative was estimated to be approximately 3,200 cubic yards. The 70 Percent Inflow alternative would provide the instream flows necessary to meet these sediment transport processes, would notably reduce fine sediment storage, and also greatly increase coarse material transport. However, to rehabilitate and not maintain mainstem Trinity River morphology, coarse bed material augmentation must meet or exceed transport capacity (FWS, 1999). Therefore, the estimated volume of coarse bed material augmentation would proportionally be much greater (on average, 97 percent greater) for the 70 Percent Inflow alternative as compared to the Flow Evaluation. This additional level of augmentation would necessitate a greater cost for and coarse bed material augmentation program.

The benefits and deficiencies in sediment transport and augmentation for this alternative are summarized in Table 2 of Attachment B9. The recession limbs of the hydrograph during Extremely Wet and Wet water years would likely result in riparian initiation on floodplains and initiate riparian regeneration during those water years (See table 3, Figures 4 and 5 and discussion in Attachment B9).

Significant improvements in river system habitats would benefit anadromous salmonid populations as compared to No Action. However this alternative, compared to the Maximum Flow and the Flow Evaluation Alternatives, would not perform as well in providing cool water temperatures for outmigrating smolts, especially after July 1st. This reduction would act to depress the overall recovery of anadromous salmonids in the mainstem Trinity River compared to the Maximum Flow and the Flow Evaluation alternatives. The Chinook Harvest Index for the 70 Percent Inflow alternative indicates that the average annual number of harvestable adult Chinook salmon may be reduced from approximately 9,500 to 38,000 adults from the estimates for the Flow Evaluation and the Maximum Flow alternatives respectively (Table 9, Attachment 6). The summary of the changes in the instream release volumes, anadromous salmonid smolt temperature survival indices, and Chinook Harvest Index from the No Action Alternative are shown in Table B-14.

Lower Klamath River Basin. The 70 Percent Inflow Alternative would result in improved water temperature conditions and increased Trinity River flows in many water years. In these years, increased annual flows (and improved water temperature conditions during smolt out-migration) could result in improved habitat conditions in the lower Klamath River and estuary (Table B-19). Compared to the No Action alternative, these improvements may result in significant benefits and improvements in populations of anadromous salmonids under the 70 Percent Inflow Alternative.

Central Valley. A summary of the estimated average annual losses of early life stages of chinook salmon for the 70 Percent Inflow Alternative from Reclamation's is shown in Table B-16. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for this Alternative are shown in Attachment B8.

From this evaluation, for the historic simulated period of 1922 through 1993, increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 25 percent of fall chinook salmon early life stages; an increase of approximately 7 percent annually from the No Action Alternative (Table B-17).

Average annual losses of late-fall chinook salmon were estimated to be approximately 2 percent for the 1922-1993 simulation period (Table B-16). These estimated losses for late-fall chinook were unchanged (less than 1 percent) from those estimated for this species under the No Action Alternative (Table B-17).

Increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 47 percent for threatened spring chinook early life stages (Table B-16); an increase of approximately 23 percent annually from the No Action Alternative (Table B-17). The average annual losses for endangered winter chinook were estimated to be 11 percent for the 1922-1993 simulation period (Table B-16). For endangered winter chinook salmon, these estimates represent an increase of 3 percent in annual average losses from those estimated for the No Action Alternative (Table B-17). For any water year in which the drawdown of Shasta Reservoir results in levels of less than 1.9 maf at the end of September 30th, it would be necessary to re-consult with NOAA-Fisheries under terms of the 1993 Winter-Run Chinook Biological Opinion (U.S. Fish and Wildlife Service, 1993). This re-consultation would result in operations which would attempt to minimize losses to these species. Using the estimated average annual losses of late-fall chinook salmon as an estimate for steelhead losses in the upper Sacramento River, approximately 2 percent of these fish may be lost annually for the 70 Percent Inflow Alternative (Table B-16). This estimate is numerically unchanged from that for the No Action Alternative (Table B-17).

In summary, the estimated losses resulting from increases in water temperature on the early life stages of chinook salmon and steelhead in the Sacramento River for this alternative were compared to No Action. The results of this evaluation ranged from no change to a 23 percent increase in average annual losses for the 1922-1993 period of simulation, depending on species (Table B-18). These increases in losses are relatively small as compared to the No Action Alternative. However, these estimated losses in fall, winter and spring-run chinook salmon in the Sacramento River are considered significant and represent adverse effects from the No Action alternative. The results of the evaluation of the 70 Percent Inflow Alternative on the anadromous salmonids within the Sacramento River are summarized in Table B-18.

The results of the evaluation of the 70 Percent Inflow Alternative on the anadromous salmonids of the affected area (Trinity and Klamath Basins and the Central Valley) are summarized in Table B-19.

1.1.2.8 Mechanical Restoration Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Mechanical Restoration Alternative are shown in Table B-10. The individual scoring worksheets are shown in Attachment B6. The assumptions and rationale for scoring each attribute objective is shown in Attachment B7. A summary of the total score of the attributes for all project alternatives is shown in Table B-11. Fisheries Attachment B5 provides details of the analysis of smolt outmigration temperature effects for the mainstem Trinity River for the project alternatives. Results of the salmonid smolt outmigration temperature suitability analysis are summarized and shown in Table B-13.

As shown in Table B-11, the Mechanical Restoration Alternative was scored 13 out of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. A majority of the attribute objectives (25 of the 35) were determined to never or nearly never exceed threshold criteria for this alternative (Table B-12). Seven of the 35 attribute objectives were found to sometimes exceed objective thresholds. Only 3 of the 35 attribute objectives were scored as always or nearly always exceeding objective thresholds for this alternative (Table B-12). One of the objectives which was determined to always or nearly always exceed threshold criteria was that for Attribute 8 in which periodic removal of large deposits of tributary delta materials and construction and rehabilitation of side channels would be accomplished by mechanical means.

Similar to conditions in the No Action alternative, the consequences of reduced rates of smolt out-migration for Chinook and coho salmon during their normal emigration periods are significant. As the flows under this alternative would be the same as the No Action Alternative the water temperature conditions for the Mechanical Restoration Alternative would also remain the same and, on average, allow only approximately 41 percent, 84 percent, and 60 percent of Chinook, coho, and steelhead smolts (respectively) to successfully migrate out of the Trinity River at Weitchpec from April 9th through August 27th (Table B-13). Annual reductions in their respective year class recruitment, significant impedance in recovery of coho salmon, and generally impedance of the overall restoration of the anadromous fisheries in the Trinity River would result from poor water temperature conditions for outmigrating salmonid smolts (Table 13).

The total weighted average sediment transport for the Lewiston and Limekiln gaging stations for the Mechanical Restoration Alternative is the same as that for the No action alternative and is summarized in Table 1 in Attachment B9. The coarse and fine sediment transport is approximately 680 yd^3 and 230 yd^3 respectively. The benefits and deficiencies in sediment transport and augmentation for this alternative are summarized in Table 2 of Attachment B9. This alternative has the same recession limb of the hyrodograph as the No Action alternative and is steeper than that required to initiate riparian vegetation on floodplains (See Table 3, Figure 1 and the discussion in Attachment B9). This alternative is not conductive to riparian regeneration during any water year type.

This alternative was determined to provide some benefit in meeting river system attribute objectives compared to the No Action Alternative, but much less than that for the all the other alternatives considered. The Mechanical Restoration Alternative was not effective, as compared to those alternatives in meeting the river system and habitat requirements necessary for substantially restoring naturally produced anadromous salmonids in the mainstem

Trinity River. Table B-15 summarizes the estimated changes in river system health and habitat conditions for anadromous salmonids for the Mechanical Restoration Alternative compared to No Action. These results indicate that conditions would be expected to improve approximately 225 percent under this alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-15). However, these measures of habitat improvement must be tempered with the results of the smolt temperature suitability analysis (Attachment B5). That analysis indicated that water temperature conditions for smolt migration may be inadequate, especially for chinook salmon and steelhead, and may potentially limit fishery restoration for anadromous salmonids in the Trinity River (Table B-14). The estimated Harvest Index for the Mechanical Restoration alternative, which would have the same Harvest Index (approximately 4,400 fall Chinook salmon adults) as the No Action alternative (see Attachment B5, Table 9).

Compared to No Action, fishery habitat in the mainstem Trinity River in the year 2020 would be expected to improve only slightly under the Mechanical Restoration Alternative (Table B-19). Small and localized beneficial improvements in river system health and function would result in small benefits to naturally produced anadromous salmonid populations as compared to No Action.

Lower Klamath River Basin. As discussed in the No Action Alternative, the assumptions were that improvements in water temperature conditions and increases in flows in the Trinity River would result in more favorable conditions in the lower Klamath River, thus benefiting anadromous salmonids within the lower Klamath River and estuary. The only changes in habitat conditions in the Trinity River Basin in the Mechanical Restoration Alternative are through mechanical means. Therefore, no benefits resulting from increased flows or cool water temperatures would be expected in the lower Klamath River and estuary under the Mechanical Restoration Alternative. Habitat conditions under this alternative would remain the same as No Action for the lower Klamath River and estuary. Anadromous salmonid populations would likely remain unchanged under this project alternative.

Central Valley. There would be no changes to anadromous salmonid species or their habitats in the Central Valley as a result of implementing this alternative.

1.1.2.9 Revised Mechanical Restoration Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Revised Mechanical Restoration Alternative are shown in Table B-10. The individual scoring worksheets are shown in Attachment B6. The assumptions and rationale for scoring each attribute objective is shown in Attachment B7. A summary of the total score of the attributes for all project alternatives is shown in Table B-11. Fisheries Attachment B5 provides details of the analysis of smolt outmigration temperature effects for the mainstem Trinity River for the project alternatives. Results of the salmonid smolt outmigration temperature suitability analysis are summarized and shown in Table B-13.

As shown in Table B-11, the Revised Mechanical Restoration Alternative was scored 37 out of the total possible 70 attribute objective points believed necessary to restore the Trinity River fluvial river system. A large number of the attribute objectives (14 of the 35) were determined to always exceed threshold criteria for this alternative (Table B-12). Nine of the 35 attribute objectives were found to sometimes exceed objective thresholds. Twelve of the

35 attribute objectives were scored as never or nearly never meeting objective thresholds for this alternative (Table B-12).

On further evaluation using the smolt temperature suitability analysis, water temperature conditions for the Revised Mechanical Restoration Alternative would, on average, allow approximately 51 percent, 91 percent, and 67 percent of Chinook, coho, and steelhead smolts (respectively) to successfully migrate out of the Trinity River at Weitchpec from April 9th through August 27th (Table B-13 and Figures B5a through B5c). These increases over No Action, ranged from 23 percent (Chinook), 8 percent (coho); to 12 percent (steelhead) (Tables 6 through 9, Attachment 6). The Chinook Salmon Production index, a measure of the potential in harvest production is 634 percent greater, or an increase of approximately 6-fold over the No Action Alternative (Table 9 of Attachment 6). The summary of the changes in the instream release volumes, anadromous salmonid smolt temperature survival indices, and Chinook Harvest Index from the No Action Alternative are shown in Table B-14

These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would improve somewhat under the this alternative (Table B-19). The alternative would result in beneficial improvements in river system and habitat conditions allowing naturally produced anadromous salmonid populations to increase over those expected under No Action. Table B-15 summarizes the estimated changes in river system health and habitat conditions for anadromous salmonids for the Revised Mechanical Alternative compared to No Action. These results indicate that conditions would be expected to improve approximately 825 percent under the alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-15).

The analysis of the estimated fine and coarse sediment transport in the upper mainstem Trinity River for the Revised Mechanical Restoration alternative is shown in Attachment B9. For this alternative, it was estimated that the weighted annual average transport of coarse sediments (> 8mm) for both Lewiston and Limekiln Gulch combined, would be approximately 1,100 cubic yards, or approximately 88 percent less than that for the Flow Evaluation Alternative (Table 1 of Attachment B9). The weighted annual average transport of fine sediment for this alternative was estimated to be approximately 400 cubic yards. The Revised Mechanical Restoration alternative would not generally provide the instream flows necessary to meet sediment transport processes. This alternative would not notably reduce fine sediment storage, or increase coarse material transport.

The benefits and deficiencies in sediment transport and augmentation for this alternative are summarized in Table 2 of Attachment B9. For the Revised Mechanical Restoration alternative the recession limbs of the hydrograph during Extremely Wet and Wet years would likely result in riparian initiation on floodplains and initiate riparian regeneration during those water years (See Table 3, Figures 6 and 7, and discussion in Attachment B9).

Improvements in habitat conditions for native anadromous salmonids in the mainstem Trinity River, as measured by the TRAASM score, must also be tempered with the results of the smolt temperature suitability analysis. That analysis indicated that, while there is measured improvement in water temperature for smolt migration over the No Action Alternative, this improvement may not be sufficiently robust to optimize smolt emigration and limit fish population recovery and restoration in the Trinity River. This alternative, compared to the Maximum Flow and the Flow Evaluation Alternatives, would not provide perform as nearly well in providing cool water temperatures for outmigrating smolts, especially after July 1st (Table B-14). The Chinook harvest index for the Revised Mechanical Restoration alternative also indicates that the average annual number of harvestable adult Chinook salmon may be reduced from approximately 12,500-24,000 adults (depending on the assumption of the level of restoration for the Revised Mechanical Restoration alternative) to approximately 34,500-46,000 adults from those estimates for the Flow Evaluation and the Maximum Flow alternative respectively (Table B-14; and Attachment B5).

Lower Klamath River Basin. The Revised Mechanical Restoration Alternative would result in somewhat improved water temperature conditions and increased Trinity River flows in many water years compared to No Action. In these years, increased annual flows (and improved water temperature conditions during smolt out-migration could result in some modest improvements in habitat conditions in the lower Klamath River and estuary. These benefits may result in only modest increases to populations under this alternative during those years.

Central Valley. A summary of the estimated average annual losses of early life stages of chinook salmon for the Revised Mechanical Restoration Alternative from Reclamation's LSACTEMC is shown in Table B-16. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for this Alternative are shown in Attachment B8.

From this evaluation for this alternative, for the historic simulated period of 1922 through 1993, increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 18 percent of fall chinook early life stages, 1 percent greater than the No Action Alternative (Table B-17). Average annual losses of late-fall were estimated to average approximately 1 percent for the 1922-1993 simulation period (Table B-16). These estimated losses for late-fall chinook were also unchanged from those estimated for this species under the No Action Alternative (Table B-17).

Increased water temperatures in the Sacramento River resulted in an estimated annual average loss of approximately 25 percent of threatened spring chinook early life stages (Table B-16), a change of 1 percent from the No Action Alternative (Table B-17). The average annual losses for endangered winter chinook were estimated to be 8 percent for the 1922-1993 simulation period (Table B-16), also virtually unchanged from those estimated for the No Action Alternative (Table B-17).

Using the estimated average annual losses of late-fall chinook salmon as an estimate for steelhead losses in the upper Sacramento River, approximately 1 percent of these fish would be lost annually for the Revised Mechanical Restoration Alternative (Table B-16). This estimate is unchanged from that for the No Action Alternative (Table B-17).

In summary, the estimated losses resulting from increases in water temperature on the early life stages of chinook salmon and steelhead in the Sacramento River for the Revised Mechanical Restoration Alternative were compared to No Action. The results of this evaluation resulted in small changes in average annual losses for the 1922-1993 period of simulation, for fall and spring chinook salmon species. These estimated losses of fall and spring chinook salmon are considered significant and represent adverse effects as compared to the No Action Alternative. The results of the evaluation of this alternative on the anadromous salmonids within the Sacramento River are summarized in Table B-18.

The results of the evaluation of the Revised Mechanical Restoration Alternative on the anadromous salmonids of the affected area (Trinity and Klamath Basins and the Central Valley) are summarized in Table B-19.

1.1.2.10 Modified Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Modified Percent Inflow Alternative are shown in Table B-10. The individual scoring worksheets are shown in Attachment B6. The assumptions and rationale for scoring each attribute objective is shown in Attachment B7. A summary of the total score of the attributes for all project alternatives is shown in Table B-11. Fisheries Attachment B5 provides details of the analysis of smolt outmigration temperature effects for the mainstem Trinity River for the project alternatives. Results of the salmonid smolt outmigration temperature suitability analysis are summarized and shown in Table B-13.

As shown in Table B-11, this Alternative was scored 51 out of the total possible 70 attribute objective points believed necessary to restore the Trinity River fluvial river system. A large number of the attribute objectives (23 of the 35) were determined to always exceed threshold criteria for this alternative (Table B-12). Five of the 35 attribute objectives sometimes exceeded objective thresholds. However, seven of the 35 attribute objectives were scored as never or nearly never meeting objective thresholds for this alternative (Table B-12).

On further evaluation using the smolt temperature suitability analysis, water temperature conditions for the Modified Percent Inflow Alternative would, on average, allow approximately 49 percent, 91 percent, and 58 percent of Chinook, coho, and steelhead smolts (respectively) to successfully migrate out of the Trinity River at Weitchpec from April 9th through August 27th (Table B-13 and Figures B5a through B5c). These increases over No Action, ranged from 21 percent (Chinook), to 8 percent (coho) and decreased 3 percent for steelhead (Tables 3 through 5, Attachment 6). The Chinook Salmon Production index, a measure of the potential in harvest production is 606 percent greater, or an increase of approximately 6-fold over the No Action Alternative (Table 9 of Attachment 6).

These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under this alternative Table B-19). The alternative would result in beneficial improvements in river system and habitat conditions allowing naturally produced anadromous salmonid populations to increase over those expected under No Action. Table B-15 summarizes the estimated changes in river system health and habitat conditions for anadromous salmonids for this Alternative compared to No Action. These results indicate that habitat conditions would be expected to improve approximately 783 percent under the alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-15).

The analysis of the estimated fine and coarse sediment transport in the upper mainstem Trinity River for the Modified Percent Inflow alternative is shown in Attachment B9. For this alternative, it was estimated that the weighted annual average transport of coarse sediments (> 8mm) for both Lewiston and Limekiln Gulch combined, would be approximately 5,400 cubic yards, or approximately 37 percent less than that for the Flow Evaluation Alternative. The weighted annual average transport of fine sediment for this alternative was also estimated to be only approximately 1,100 cubic yards, 41 percent less than that estimated for the Flow Evaluation alternative. The Modified Percent Inflow alternative would partially provide some of the instream flows necessary to meet sediment transport processes, would reduce fine sediment storage somewhat, and increase coarse material transport over that for the No Action Alternative. However these improvements would be approximately 40-50 percent less than those estimated for the Flow Evaluation alternative, resulting in a lesser overall benefit to mainstem Trinity River morphology.

The benefits and deficiencies in sediment transport and augmentation for this alternative are summarized in Table 2 of Attachment B9. The Modified Percent Inflow Alternative generally have recession limbs steeper than that required to initiate riparian vegetation on floodplains. Because the analyses for the Modified Percent Inflow Alternative uses the median years to represent an Extremely Wet and a Wet water years type, the median year does not represent all years for those two water year classes. Therefore, there could be individual years within the period of record where the recession limbs are sufficient to initiate riparian vegetation. (See Table 3, Figures 8 and 9, and discussion in Attachment B9).

In addition, these measures of habitat improvement must be tempered with the results of the smolt temperature suitability analysis. That analysis indicated that, while there is measured improvement in water temperature for smolt migration over the No Action Alternative, these improvements may not be adequate and inhibit the rate of fishery recovery in the Trinity River. The Modified Percent Inflow alternative, compared to the Maximum Flow and the Flow Evaluation Alternatives, would not perform as well in providing cool water temperatures for outmigrating smolts, especially after July 1st (Table B-14). The Chinook Harvest Index for the Modified Percent Inflow alternative also indicates that the average annual number of harvestable adult Chinook salmon may be reduced from approximately 18.000 to 47,000 adults from the estimates for the Flow Evaluation and the Maximum Flow alternatives respectively (Table 9, Attachment 6). The summary of the changes in the instream release volumes, anadromous salmonid smolt temperature survival indices, and Chinook Harvest Index from the No Action Alternative are shown in Table B-14.

Lower Klamath River Basin. Compared to the No Action Alternative, the Modified Percent Inflow Alternative would result in improvements in water temperature conditions and increased Trinity River flows in many water years. In these years, increased annual flows (and improved water temperature conditions during smolt out-migration could result in improvements in habitat conditions in the lower Klamath River and estuary. These benefits would result in increases to populations under this alternative (Table B-16).

Central Valley. A summary of the estimated average annual losses of early life stages of chinook salmon for this Alternative from Reclamation's LSACTEMC is shown in Table B-16. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for this Alternative are shown in Attachment B8.

From this evaluation for the Modified Percent Inflow Alternative, for the historic simulated period of 1922 through 1993, increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 19 percent of fall chinook early life stages (Table B-16); an increase of approximately 2 percent annually from the No Action Alternative (Table B-17). Annual losses of late-fall chinook salmon were estimated to be approximately 1 percent for the 1922-1993 simulation period (Table B-16). These estimated losses were unchanged from those estimated for this species under the No Action Alternative (B-16).

Increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 27 percent of threatened spring chinook early life stages (Table B-16); an increase of approximately 4 percent annually from the No Action Alternative (Table B-17). The average annual losses for endangered winter chinook were estimated to be 8 percent for the 1922-1993 simulation period (Table B-16). These estimates represent a small increase (slightly less than ½ of 1 percent) that those estimated for the No Action Alternative (Table B-17).

Using the estimated average annual losses of late-fall chinook salmon as an estimate for steelhead losses in the upper Sacramento River, approximately 1 percent of these fish may be lost annually for this Alternative (Table B-16). This estimate is unchanged from that for the No Action Alternative(Table B-17).

In summary, the estimated losses resulting from increases in water temperature on the early life stages of chinook salmon and steelhead in the Sacramento River for the Modified Percent Inflow Alternative were compared to No Action. The results of this evaluation ranged from no change to approximately 4 percent increase in average annual losses for the 1922-1993 period of simulation, depending on species (Table B-18). These increases in losses are small as compared to the No Action Alternative and may be within the limits of precision of the model used to estimate them. However, these estimated losses in fall, and spring-run chinook salmon in the Sacramento River are considered significant and represent adverse effects from the Modified Percent Inflow Alternative. The results of the evaluation of this Alternative on the anadromous salmonids within the Sacramento River are summarized in Table B-18.

The results of the evaluation of the modified Percent Inflow Alternative on the anadromous salmonids of the affected area (Trinity and Klamath Basins and the Central Valley) are summarized in Table B-19.

1.1.2.11 Existing Conditions versus Preferred (Flow Evaluation) Alternative

Trinity River Basin and Lower Klamath River Basin. The No Action Alternative is, by definition, projected into the year 2020. Existing Conditions are representative of current conditions (2001 level of development). For CEQA purposes, the Preferred (Flow Evaluation) Alternative, which is also projected into the year 2020, must be compared to Existing Conditions. This comparison should be consistent with analyses performed to compare action alternatives to the No Action Alternative. The No Action Alternative and Existing Conditions have the same volume of water releases to the Trinity River, and are modeled on similar release schedules. The TRSAAM cannot detect temporal changes for the same release schedule; hence, the TRSAAM analysis results in the same number of estimated fish for both the No Action and Existing Conditions. The only difference between the No Action Alternative and Existing Conditions for fishery resources is the passage of time (~20 years).

Although the river and its fish habitats would continue to gradually degrade under the No Action Alternative, the majority of the degradation occurred in the decade immediately following dam construction. Therefore, naturally producing anadromous salmonid populations are not expected to substantially change from existing conditions versus the projected numbers for the No Action Alternative. The change that would occur over this 20-year period under the 340 taf water volume will not significantly improve conditions in the Trinity River, river health, or the diversity of fish habitats, and correspondingly will result in, at best, status quo fish populations, and likely somewhat reduced populations.

Implementation of the Preferred Alternative would substantially restore the diverse fish habitats necessary for restoration and maintenance of anadromous salmonid populations compared to existing conditions. Because the Preferred Alternative also includes the watershed protection component of the Mechanical Restoration Alternative, it would likely accelerate and enhance the improvements in habitat and the resultant increases in salmonid production. The Preferred Alternative would also benefit the lower Klamath River beyond the benefits accrued by either the Flow Evaluation Alternative or Revised Mechanical Restoration Alternative individually, due to increased flow releases and improved watershed conditions.

The TRSAAM was only intended to show relative differences between the alternatives after the passage of time (i.e., projected conditions in the year 2020). Existing Conditions is not an alternative, but represents today's conditions with today's environment. No Action conditions are predicted to be slightly worse than what exist today (Existing Conditions), because the volume of water available is not sufficient to manage for a healthy river. The Preferred Alternative has additional measures to improve fish habitat than the Flow Evaluation Alternative alone, so the Preferred Alternative will be better at improving fish habitats and increasing the fish populations that depend on those habitats.

If these four scenarios were ranked for conditions that promote river health, habitat restoration, and naturally producing fish populations, beginning with the best conditions for fishery resources, the ranking would be:

1. Preferred Alternative
2. Flow Evaluation
3. Existing Conditions
4. No Action

Because of the similarity between the Preferred Alternative and the Flow Evaluation Alternative, and the similarity between Existing Conditions and the No Action Alternative, and their relative rankings to one another, it seems appropriate to conclude that the amount of improvement of the Preferred Alternative over Existing Conditions (1 vs. 3) will be similar to the improvement of the Flow Evaluation Alternative over the No Action Alternative (2 vs. 4).

This is the most consistent and logical way to compare, given the following limitations:

1. There was no way to use the TRSAAM to show differences between these No Action and Existing Conditions.

2. Using the actual escapement data for comparison with modeled results from the TRSAAM analysis is inconsistent with alternative assessment methodologies.

The TRSAAM was only intended to show relative differences between the alternatives after the passage of time (i.e., projected conditions in the year 2020).

Central Valley. A summary of the estimated average annual losses of early life stages of chinook salmon for the Preferred Alternative and existing conditions from Reclamation's LSACTEMC Model are shown in Table B-18. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for the Flow Evaluation Alternative and existing conditions are shown in Attachment B8.

Increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 21 percent of fall chinook early life stages for the Preferred Alternative (Table B-15), an increase over existing conditions of 3 percent (Table B-17). Average annual losses of late-fall chinook salmon were estimated to be approximately 1 percent for the simulation period (Table B-15). The estimated average annual loss of late-fall chinook was unchanged from that estimated for this species under the existing conditions (Table B-17).

Increased water temperatures in the Sacramento River resulted in an estimated annual average loss of nearly 32 percent of spring chinook early life stages for the Preferred Alternative (Table B-16), an increase over existing conditions of approximately 8 percent, (Table B-17). For the Preferred Alternative, the average annual loss of winter chinook was estimated to be approximately 9 percent for the 1922-1993 simulation period (Table B-15). This estimate represents an increase in annual average loss of less than approximately 1 percent greater than those estimated for existing conditions (Table B-17).

Reviewing the annual estimated losses of winter chinook salmon in Attachment B8 revealed that the majority of the estimated loss of this species, compared to existing conditions, resulted from extremely high mortalities during three critically dry water years (1933, 1934, and 1977). For any water year during which the drawdown of Shasta Reservoir results in levels of less than 1.9 maf at the end of September 30, it would be necessary to re-consult with NOAA-Fisheries under terms of the 1993 Winter-Run Chinook Biological Opinion (NMFS, 1993). This re-consultation would result in operations that would attempt to minimize losses to these salmonid species.

Using the estimated average annual losses of late-fall chinook salmon as an estimate for steelhead losses in the upper Sacramento River, approximately 1 percent of these fish may be lost annually for the Preferred Alternative (Table B-16). This estimate is less than 1 percent greater that that estimated for existing conditions Table B-17.

In summary, the estimated losses resulting from increases in water temperature on the early life stages of chinook salmon and steelhead in the Sacramento River for the Preferred Alternative were compared to existing conditions. The results of this evaluation from no change to a 8 percent increase in average annual losses for the 1922-1993 period of simulation, depending on species (Table B-18). These increases in losses are small as compared to existing conditions and may be within the limits of precision of the model used to estimate them. However, the estimated losses of chinook salmon in the Sacramento River for the Preferred Alternative are considered significant and represent adverse effects compared to the existing conditions.

The results of the evaluation of impacts of anadromous salmonids within the Trinity and Klamath River Basins, and the Central Valley, for the Preferred Alternative as compared to existing conditions are summarized in Table B-18.

1.2 OTHER NATIVE ANADROMOUS FISH

1.2.1 Affected Environment

Other native anadromous fish species (non-salmonids) found in the areas affected by the project include: white sturgeon (*Acipenser transmontanus*), green sturgeon (*A. medirostris*), Pacific lamprey (*Lampetra tridentata*), and candlefish (eulachon) (*Thaleichthys pacificus*).

1.2.1.1 Trinity River Basin

Native, non-salmonid, anadromous species found in the Trinity River Basin are listed in Table B-1. These species include: white and green sturgeon and Pacific lamprey. As stated previously, anadromous species spend their early life stages in fresh water, migrate to the ocean for maturation, and return to their natal stream to spawn.

Habitat Characteristics and Requirements. Life history characteristics and habitat requirements for green sturgeon and Pacific lamprey in the Trinity River Basin are less precisely known than those for anadromous salmonids. However, life history information and habitat requirements for these species in other river systems have been established. This information is summarized and shown in Table B-20. Green sturgeon are thought to spend less time in fresh water as compared to white sturgeon (Moyle et al., 1995). Migrating green sturgeon move into the Klamath Basin in late February through July and spawn in spring and early summer. Sturgeon require water depths greater than 9 feet (Galbreath, 1979) and water temperatures of approximately 58°F. (Kolhorst, 1976). After spawning, the adhesive eggs of sturgeon settle to the river bottom and attach to substrates. Excessive fine sediment can decrease the adhesiveness of sturgeon eggs, preventing their attachment on the bottom following spawning (Conte, et al. 1988). Rearing requirements for juvenile sturgeon are generally unknown except that juvenile green sturgeon remain within fresh water environments until they emigrate to the estuary sometime during summer through fall and leave the estuary before they are 2 years of age (Moyle, et al., 1995).

Pacific lamprey are somewhat unique in that they have a larval life stage (ammocoete) which remains buried in soft substrates for as long as 5 years before emergence and emigration. Generalized life history and habitat characteristics for Pacific lamprey are summarized in Table B-20.

Populations. While the numbers of non-salmonid native anadromous species residing in the Trinity and Klamath River Basins is generally unknown, it has been established that these basins contain the largest spawning population of green sturgeon in California. Apparently, only small runs of white sturgeon occur in the Klamath and Trinity River Basins. In the Trinity Basin, spawning green sturgeon are known to occur in the mainstem upstream to at least as far as Gray’s Falls, near Burnt Ranch. Historically, green sturgeon were also known to use the South Fork. Since the large flood in 1964, this species was apparently eliminated due to the loss of suitable sturgeon habitat in the South Fork (Moyle, et al., 1995).

The only population information generally available for sturgeon is the green sturgeon harvest estimated annually from the Native American net harvests in the spring and early summer. Typical green sturgeon catches reported for the Yurok tribal harvest in the Klamath River have ranged from 158 adult green sturgeon in 1987 to 810 in 1981 with a mean of 349 in 1987 (Moyle, et al., 1995). Yurok tribal harvest for 1990 and 1991 were 239 and 309 fish, respectively. These estimates do not account, however, for tribal harvest in the Trinity River Basin by the Hoopa Valley Tribe. Some juvenile green sturgeon have been captured during annual surveys in the mainstem Trinity as far as Big Bar.

1.2.1.2 Lower Klamath River Basin

In addition to the native non-salmonid anadromous species found in the Trinity River Basin (Table B-1), eulachon are known to occur in the lower Klamath River. The non-salmonid anadromous species found in the lower Klamath River Basin include: white and green sturgeon, Pacific lamprey, and candlefish.

Life history characteristics and habitat requirements for green sturgeon, white sturgeon, and Pacific lamprey are previously described for those species found in the Trinity River (Table B-20). The populations of sturgeon and lamprey found in the lower Klamath River Basin is unknown. The only information available for these species is the number of green sturgeon harvested annually in the Native American net harvests. See discussion in Trinity River Basin section above.

The main population of eulachon in California occurs in the Klamath River (Moyle, et al., 1995). These native anadromous species spend most of their lives in salt water, migrating into the Klamath in March and April. Eulachon penetrate no more than approximately 6-8 miles upstream of the mouth of the Klamath River. Mass spawning occurs following their arrival during nighttime hours. After hatching, the larvae are swept downstream to the ocean immediately. Eulachon populations in the Klamath estuary have been severely depressed since the mid-1980s.

1.2.1.3 Coastal Area

The coastal area adjacent to the Klamath River Basin provides rearing and foraging habitat for the maturing and adult life stages of the native non-salmonid anadromous species found in the lower Klamath and Trinity River Basins. Habitat conditions in this coastal near shore and ocean environment are subject to natural productivity as affected by physical and biological oceanic processes, weather, and climate patterns. Except indirectly, humans generally do not affect populations of these species in the coastal areas adjacent to the Klamath River Basin as there is no commercial and little, if any, recreational harvest of these species. Factors affecting the abundance of these species in the coastal areas adjacent to the project are likely to be the result of natural factors.

1.2.1.4 Central Valley

The native non-salmonid anadromous fish in the Central Valley include the green sturgeon and white sturgeon, and Pacific lamprey. Life history and habitat characteristics have previously been described in the Klamath and Trinity River Basin discussion above.

The estimated population of adult white sturgeon in the Central Valley for the period of 1967-1991 has been estimated to be approximately 64,000 fish with a low of 28,000 estimated for the year 1990 (Mills and Fisher, 1993) (Attachment B1, Table B1-10 of the 1999 DEIS/DEIR Fishery Technical Appendix). Adult green sturgeon abundance for the same interval has been estimated to be approximately 870 fish (Mills and Fisher, 1994). There are no estimates of Pacific lamprey in the Central Valley.

The factors affecting the abundance of native non-salmonid anadromous fish in the Central Valley include: inadequate stream flows and temperatures in the Sacramento and San Joaquin Rivers, water export/inadequate outflows in the Delta, entrainment losses at water diversions, lack of abundant food, poor water quality, predation by and competition from introduced species, and lack of suitable spawning and rearing habitat. (U.S. Fish and Wildlife Service, 1995).

1.2.2 Environmental Consequences

1.2.2.1 Methodology

Trinity River Basin. There are no direct methods to assess the effects of project alternatives on other native anadromous fish species in the Trinity River. To evaluate the effects of the project on these species the following assumptions were made:

- Increased coldwater releases to the Trinity River are not harmful for other native emigrating and immigrating anadromous fish species.
- Increases in stream flows in the Trinity River would improve habitat conditions and river system health for other native anadromous fish species within the Trinity River.
- Mechanical restoration of riverine habitats within the Trinity River would not affect other native anadromous fish species within the Trinity River.
- Watershed protection activities in the Trinity River would improve habitat conditions and river system health for other native anadromous fish species within the Trinity River.

In summary, for the purposes of this analysis, it was assumed that any benefits or adverse effects on native anadromous fish species in the Trinity River would be the same as those for naturally produced anadromous salmonid species. Using these assumptions, a qualitative assessment of the effects of project alternatives, as compared to No Action, was made.

Lower Klamath River Basin. There were no methods available to directly measure or evaluate the effects of project alternatives on other native anadromous fish resources within the lower Klamath River. For this reason, several assumptions were made to assist in assessing the effects of project alternatives on these resources. These assumptions were:

- Increased coldwater releases to the Trinity River reduce Klamath River temperatures during mid-May through late-June (U.S. Fish and Wildlife Service, 1998) and are not harmful for native non-salmonid anadromous fish.
- Increases in stream flows in the Trinity River would improve habitat conditions and river system health for other native anadromous fish within the lower Klamath River and estuary.
- Mechanical restoration of riverine habitats within the Trinity River would not affect other native anadromous fish species within the lower Klamath River.
- Watershed protection activities in the Trinity River would improve habitat conditions and river system health for other native anadromous fishery resources in the lower Klamath River.

In summary, for the purposes of this analysis, it was assumed that any benefits or adverse effects on native anadromous fish species in the Klamath River would be the same as those for naturally produced anadromous salmonid species in the Klamath River. Using these assumptions, a qualitative assessment of the effects of each project alternative, as compared to No Action, was made.

Coastal Area. There were no methods readily available to estimate or directly measure any effect of project alternatives on other native anadromous species inhabiting Coastal Area. It was assumed that there would be no measurable or incremental effect on food availability, rates of predation or survival, or other ecological consequences to other native anadromous fish species in the adjacent Coastal Areas as a result of any of the project alternatives. Therefore, it was assumed that there would be no likely measurable effects.

Central Valley. There are no direct methods for estimating the effects of project alternatives on native non-salmonid anadromous fish species in the Central Valley. For the purpose of estimating effects of the project alternatives, it was assumed that any adverse effects or benefits to naturally produced anadromous salmonid species in the Central Valley from changes in stream flows resulting in reduced habitat area would similarly effect or benefit other native anadromous fishery resources.

To evaluate the potential effects of the project alternatives on other native anadromous fish species in the Central Valley, a comparison of the annual flows at various locations in the Sacramento River (and Delta) was conducted. Total annual discharges for each alternative for Keswick, Grimes, Verona, inflow into the Delta, and outflow from the Delta were compared to the No Action Alternative to determine potential changes in habitat for other native anadromous fish species. It was assumed that decreases in monthly average stream flows or inflows and outflows in the Delta greater than 10 percent of those for the No Action Alternative would be sufficient to reduce habitat quality and/or quantity for other native anadromous fish in the Central Valley. The evaluation was focused on the middle and lower portions of the Sacramento River and Delta as this region provides the majority of spawning and rearing habitats for species such as sturgeon in the Central Valley.

1.2.2.2 Significance Criteria

Effects are considered significant for native anadromous fish (other than salmonids) if they result in any of the following:

- Potential for reductions in the number, or restrictions of the range, of an endangered or threatened native anadromous species or a native anadromous species that is a candidate for state listing or proposed for federal listing as endangered or threatened
- Potential for substantial reductions in the habitat of any native anadromous species other than those that are listed as threatened or endangered or are candidates (CESA) or proposed (ESA) for threatened or endangered status
- Potential for causing a native anadromous fish population to drop below self-sustaining levels
- Substantial adverse effect, either directly or through habitat modifications, on any native anadromous fish species identified as a sensitive or special-status species in local or regional plans, policies, or regulations by the California Department of Fish and Game, the U.S. Fish and Wildlife Service, or the National Marine Fisheries Service
- Substantial interference with the movement of any native anadromous fish species
- A conflict with, or violation of, the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan relating to the protection of native anadromous fish species
- Mortality of state or federally listed anadromous species, or species that are candidates for listing (CESA) or proposed for listing (ESA)
- Reductions in the size of a native anadromous species' population sufficient to jeopardize its long-term persistence
- Temporary impacts to habitats such that native anadromous species suffer increased mortality or lowered reproductive success that jeopardizes the long-term persistence of those local populations
- Permanent loss of essential habitat of a listed species or special-status native anadromous fish species
- Reduction in the quantity or quality of habitats in which native anadromous populations occur sufficient to reduce the long-term abundance and productivity of local populations

1.2.2.3 Results

Summary. The results of the comparisons of the No Action Alternative to each project alternative are summarized in Table B-19. Compared to the No Action Alternative, the Maximum Flow, Flow Evaluation, 70 Percent Inflow, Revised Mechanical Restoration, and

Modified Percent Inflow Alternatives would all result in highly beneficial habitat conditions for other anadromous species in the Trinity River. The Mechanical Restoration Alternative would result in only modest benefits to these species in the Trinity River Basin. Except for the Mechanical Restoration Alternative, all of the alternative would benefit other anadromous species in the Klamath River Basin to some extent. This benefit would be principally due to increased flows and somewhat cooler water temperatures in the Klamath River downstream of its confluence with the Trinity River.

The Maximum Flow, Alternative may adversely impact other anadromous species in the Central Valley. In the Central Valley, there would be no measures to mitigate, to less than significant, the adverse effects to native resident species from implementing from implementing the Maximum Flow, Alternative.

1.2.2.4 No Action Alternative

Trinity River Basin. As stated in the methodology section, it was assumed that increased coldwater releases to the Trinity River would not harm other native anadromous as well as naturally produced anadromous salmonid species. Increased stream flows in the Trinity River would provide river system benefits resulting in improved habitat conditions for the other native anadromous fish species. Mechanical habitat restoration and watershed sediment management activities on the mainstem Trinity River would improve habitat conditions and benefit other native anadromous fish species in the Trinity River Basin. Thus, it was assumed that any benefits or adverse effects on native anadromous fish species in the Trinity River would be the same as those for naturally produced anadromous salmonid species. Using these assumptions, the assessment of the effects of the No Action Alternative on other anadromous species was made.

The No Action Alternative performed poorly in meeting the river system attributes and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River (Tables B-10 and B-11). TRSAAM results indicate that, under the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would also not likely provide the conditions necessary to allow other native anadromous stocks to recover to pre-dam population levels.

Lower Klamath River Basin/Coastal Area. It was assumed that any benefits or adverse effects on native anadromous fish species in the Klamath River would be the same as those for naturally produced anadromous salmonid species in the Klamath River. Using these assumptions, a qualitative assessment of the effects of the No Action Alternative was made. As shown in Tables B-10 and B-11, the No Action Alternative performed poorly in meeting the river system attributes and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. TRSAAM results indicate that, under the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would also not likely provide the conditions necessary to provide sufficient benefits to other native anadromous species in the lower Klamath River and estuary to restore populations to pre-dam levels.

Central Valley. The other native anadromous fish in the Central Valley that may be affected by the project are green and white sturgeon and Pacific lamprey. All of these species are primarily found in the middle to lower reaches of the Sacramento River, the Delta, and the lower reaches of the San Joaquin River. For the simulated period 1922-1993, the average annual discharge of the Sacramento River as estimated at Grimes and Verona was approximately 11,300 cfs and 19,300 cfs, respectively (Table B-21). Total average annual inflow and outflows for the Delta are approximately 29,200 cfs and 19,900 cfs, respectively (Tables B-22 and B-23). Habitat quantity and quality for the other native anadromous species in the Central Valley areas affected by the project alternatives are directly effected by the volume and quality of water moving through this region. The changes, from No Action, in estimated average yearly and monthly Sacramento River discharges and Delta inflows and outflows were used to qualitatively evaluate changes in habitat for these species. This is necessary as there are no specific habitat/discharge relationships known for these species for the Sacramento River or Delta..

1.2.2.5 Maximum Flow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Maximum Flow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the Maximum Flow Alternative was scored 58 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, the Maximum Flow Alternative excelled in meeting the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. This would also greatly enhance habitat conditions for other anadromous fish species in the Trinity Basin (Table B-19). These results indicate that river system health and habitat conditions would be expected to improve approximately 1350 percent under the Maximum Flow Alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under the Maximum Flow Alternative and would likely result in large increases in other native anadromous fish populations as compared to those expected from the No Action Alternative.

Lower Klamath River Basin/Coastal Area. Improvements in water temperature conditions and increases in flows in the Trinity River would result in more favorable conditions in the lower Klamath River, thus benefiting other anadromous species within the lower Klamath River and estuary. Increases in flows to the Trinity River would increase habitat quantity and benefit habitat conditions in the lower Klamath River and estuary. Increases in flow in the Trinity River resulting from spring reservoir releases would improve temperature conditions in the Klamath River downstream of the confluence. This alternative would provide habitat conditions more suitable to other native anadromous fish species than the No Action Alternative.

Beneficial habitat conditions, as a result of more optimal temperatures and increased flows, would likely improve survival rates for young life stages of other native anadromous species and enhance the probability of their successful passage to the ocean. Improved habitat conditions for juveniles rearing in the lower Klamath River and estuary would also likely occur (Table B-19). These benefits would likely result in increased populations under the Maximum Flow Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative during months critical to spawning and early rearing (February through August) would significantly diminish habitat quality and quantity for other native anadromous species in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative during February through August were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Maximum Flow Alternative is approximately 7,693, 10,500, and 18,400 cfs, respectively (Table B-21). For the Maximum Flow Alternative, the total average annual discharges in the upper and middle reaches of the Sacramento River decreased approximately 12 and 9 percent at Keswick and Grimes respectively (Table B-24). The monthly average flows diminished from 12 to up to 21 percent for some months (July through November) compared to the No Action Alternative (Table B-24). The total average annual discharges in the lower reach of the Sacramento River decreased by approximately 6 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). Flows at Verona decreased from 10 up to 13 percent (September through November) compared to the No Action Alternative. Considering the magnitude of the decreases in some of the monthly average discharges, it is likely that reductions in habitat quantity and quality would be sufficient to adversely affect other anadromous species in the lower Sacramento River.

The average annual inflow and outflow in the Delta for the Maximum Flow Alternative is estimated to be approximately 28,300 and 19,400 cfs, respectively (Tables B-22 and B-23). These flows are approximately 4 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-26).

There would be substantial numbers of months in many years in which reductions in Sacramento River flows would be significantly less than those for the No Action Alternative. These reductions in flow and resulting habitat quality and quantity may result in significant impacts to other native anadromous species in the Central Valley (Table B-19).

1.2.2.6 Flow Evaluation Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Maximum Flow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the Flow Evaluation Alternative was scored 49 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, the Flow Evaluation Alternative provided greatly improved river system and habitat conditions necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. These improvements would also greatly enhance habitat conditions for other native anadromous fish species in the Trinity Basin. The results indicate that river system health and habitat conditions would be expected to improve approximately 1,125 percent under the Flow Evaluation Alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under the Flow Evaluation Alternative (Table B-19) and would likely result in increases in other native anadromous populations compared to those expected from the No Action Alternative.

Lower Klamath River Basin/Coastal Area. For the Flow Evaluation Alternative, improvements in water temperature conditions and increases in flows in the Trinity River would likely result in more favorable conditions in the lower Klamath River and estuary, thus benefiting other native anadromous species. An annual increase in Trinity River flows would likely improve habitat conditions in the lower Klamath River and estuary in most years (Table B-19). Increases in flow in the Trinity River resulting from spring Lewiston Dam releases would greatly improve temperature and habitat conditions in the Klamath River downstream of the confluence with the Trinity River (U.S. Fish and Wildlife Service, 1998).

Beneficial habitat conditions, as a result of cooler summer water temperatures and increased flows, would likely improve survival rates for young life stages of other native anadromous species and enhance the probability of their successful passage to the ocean. Improved habitat conditions for juveniles rearing in the lower Klamath River and estuary would likely occur. These benefits would likely result in increased populations of these species for the Flow Evaluation Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for other native anadromous species in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Flow Evaluation Alternative is approximately 8,703, 11,000, and 19,000 cfs, respectively (Table B-21). For this alternative, the total average annual discharges in the upper and middle reach of the Sacramento River decreased approximately 4 and 3 percent at Keswick and Grimes, respectively, and monthly average flows ranged from no change to a decrease of 6 percent compared to the No Action Alternative (Table B-24). The total average discharges in the lower reach of the Sacramento River decreased by approximately 2 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). Average monthly flows at Verona decreased up to 4 percent compared to the No Action Alternative. Considering the magnitude of the decreases in the annual monthly discharges, it is likely that reductions in habitat quantity and quality would be insufficient to adversely affect other anadromous species in the mid and lowermost reaches of the Sacramento River.

The average annual inflow and outflow in the Delta for the Flow Evaluation Alternative is estimated to be approximately 28,900 and 19,700 cfs, respectively (Tables B-23 and B-23). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-26).

The yearly average inflows to or outflows from the Delta would not be significantly less than those for No Action (Tables B-25 and B-26). These reductions in flow and resulting habitat quality and quantity would not result in significant impacts to other native anadromous species in the Sacramento River and/or the Delta for this Alternative (Table B-19).

1.2.2.7 70 Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the 70 Percent Inflow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the 70 Percent Inflow Alternative was scored 51 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative provided significantly beneficial improvement to river system and habitat conditions necessary for restoring anadromous salmonids species in the mainstem Trinity River (Table B-19). These expected improvements would likely provide significant benefits to habitat conditions for other native anadromous fish species in the Trinity Basin. The TRSAAM analysis indicated that river system health and habitat conditions improved approximately 1,175 percent for the 70 Percent Inflow Alternative as compared to No Action (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would improve under the 70 Percent Inflow Alternative and would likely result in increases in other native anadromous fish populations as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The 70 Percent Inflow Alternative would result in improved water temperature conditions and increased Trinity River flows in many water years. In these years, increased annual flows (and improved water temperature conditions) could result in improved habitat conditions in the lower Klamath River and estuary (Table B-19). These improvements may result in significant improvements to populations of other native anadromous salmonids under the 70 Percent Inflow Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for other native anadromous species in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the 70 Percent Inflow Alternative is approximately 8,007, 10,700, and 18,700 cfs, respectively (Table B-21). For this Alternative, the total average annual discharges in the upper and middle reach of the Sacramento River decreased approximately 9 and 6 percent at Keswick and Grimes respectively, and the range of monthly average flows decreased 1 to 8 percent compared to the No Action Alternative (Table B-24). The total average annual discharges in the lower reach of the Sacramento River decreased by approximately 4 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). Average monthly flows at Verona decreased from 1 percent (January, February, and April) to 8 percent (November) as compared to the No Action Alternative (Table B-24). Considering the magnitude of the decreases (≥10 percent less than No Action) in the monthly average discharges at Grimes from September through November, reductions in habitat quantity and quality may be sufficient to adversely affect other anadromous species in the lower Sacramento River.

The average annual inflow and outflow in the Delta for the 70 Percent Inflow Alternative is estimated to be approximately 28,600 and 19,400 cfs, respectively (Tables B-22 and B-23). These flows are approximately 3 percent less, on average annually, than those for the No Action Alternative (Tables B-25 and B-26).

The monthly flows in the Sacramento River and inflows to and outflows from the Delta would not be significantly less, on average, than those for the No Action Alternative. The reductions in discharges and outflows would result in significant reductions in habitat quality or quantity and therefore significant impacts to other native anadromous species would occur in the Central Valley (Table B-19).

1.2.2.8 Mechanical Restoration Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Mechanical Restoration Alternative are shown in Table B-10 and summarized in Table B-11. As shown in these tables, this alternative was scored 13 out of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. A majority of the attribute objectives were determined to never or nearly never exceed threshold criteria for this alternative. This alternative was determined to provide only some small benefit in meeting river system attribute objectives compared to the No Action Alternative. These results indicate that conditions would be expected to improve approximately 225 percent under this alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-15). Small and localized beneficial improvements in river system health and function would likely result in only small benefits to other native anadromous fish populations as compared to No Action (Table B-19).

Lower Klamath River Basin/Coastal Area. The only changes in habitat conditions in the Trinity River Basin under the Mechanical Restoration Alternative are through mechanical means. Therefore, no benefits resulting from increased flows or cool water temperature would be expected in the lower Klamath River and estuary under the Mechanical Restoration Alternative. Habitat conditions for this Alternative would remain unchanged from No Action for the lower Klamath River and estuary. Other native anadromous fish populations in the lower Klamath River would likely remain unchanged under this project alternative (Table B-19).

Central Valley. This alternative would not affect habitats for other native anadromous fish species in the Central Valley and therefore would result in no change from the No Action Alternative (Table B-19).

1.2.2.9 Revised Mechanical Restoration Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Revised Mechanical Restoration Alternative are shown in Table B-10 and summarized in Table B-11. As shown in these tables, this alternative was scored 37 out of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. While many of the attribute objectives were determined to never or nearly never exceed threshold criteria for this alternative there were substantial improvements in habitat due to increased flows and physical mechanical enhancements. This alternative was determined to be largely beneficial in meeting river system attribute objectives compared to the No Action Alternative (Table B-19). These results indicate that conditions would be expected to improve approximately 825 percent under this alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-15). Beneficial improvements in river system health and function would result in benefits to other native anadromous fish populations as compared to No Action.

Lower Klamath River Basin/Coastal Area. The changes in habitat conditions in the Trinity River Basin under the Revised Mechanical Restoration Alternative are largely through mechanical means with some benefits from increase flow releases. This Alternative would result in some improvements water temperature conditions and increased Trinity River flows in all but critically dry water years. In those years with increased annual flows (and improved water temperature conditions) could result in some improvements in habitat conditions in the lower Klamath River and estuary. These benefits to habitat condition may result in modest benefits to populations of other native anadromous fish under this alternative (Table B-19).

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for other native anadromous species in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for this alternative is approximately 8,574, 11,200, and 19,200 cfs, respectively (Table B-21). For this alternative, the total average annual discharge in the upper and middle reaches of the Sacramento River decreased approximately 1 percent at Keswick and Grimes, and the changes in the monthly average flows ranged from no change in January through April to a decrease of 3 percent in October and June compared to the No Action Alternative (Table B-24). The total average annual discharges in the lower reach of the Sacramento River also decreased by approximately 1 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). The changes in the average monthly flows at Verona ranged from no change (December through April and September) to a decrease of 3 percent in June as compared to the No Action Alternative. Considering the magnitude of the decreases (≥10 percent less than No Action) in the annual and monthly average discharges, it is likely that reductions in habitat quantity and quality would not be sufficient to adversely affect other anadromous species in the lower Sacramento River.

The average annual inflow and outflow in the Delta for the Revised Mechanical Restoration Alternative is estimated to be approximately 29,100 and 19,800 cfs, respectively (Tables B-22 and B-23). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-26).

These changes would not result in significant adverse impacts to these species in the lower Sacramento River/Delta for this Alternative (Table B-19).

1.2.2.10 Modified Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Modified Percent Inflow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, this alternative was scored 51 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative provided significantly beneficial improvements to river system and habitat conditions necessary for restoring anadromous salmonids species in the mainstem Trinity River (Table B-15). These expected improvements would likely provide large improvements in habitat conditions for other native anadromous fish species in the Trinity Basin (Table B-19). The TRSAAM analysis indicated that river system health and habitat conditions improved approximately 1,175 percent for this Alternative as compared to No Action (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under the Modified Percent Inflow Alternative and would likely result in increases in other native anadromous fish populations as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The Modified Percent Inflow Alternative would result in improved water temperature conditions and increased Trinity River flows in most water years. In these years, increased annual flows (and improved water temperature) would result in improved habitat conditions in the lower Klamath River and estuary. These improvements would result in benefits to other native anadromous fish populations under the Modified Percent Inflow Alternative (Table B-19).

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for other native anadromous species in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Modified Percent Inflow Alternative is approximately 8,514, 11,200, and 19,200 cfs, respectively (Table B-21). For this alternative, the total average annual discharge in the upper and middle reaches of the Sacramento River decreased approximately 2 percent, and the changes in monthly average flows ranged from no change percent to a decrease of 4 percent compared to the No Action Alternative (Table B-24). The total average annual discharge in the lower reach of the Sacramento River (Verona) decreased by approximately 1 percent compared those estimated for the No Action Alternative (Table B-24). Average monthly flows at Verona ranged from no change to a decrease of 4 percent (June) as compared to the No Action Alternative. Considering the magnitude of the decreases (≥10 percent less than No Action) in the annual and monthly average discharges, it is likely that reductions in habitat quantity and quality not would be sufficient to adversely affect other anadromous species in the lower Sacramento River.

The average annual inflow and outflow in the Delta for the Modified Percent Inflow Alternative is estimated to be approximately 29,000 and 19,800 cfs, respectively (Tables B-22 and B-23). These flows are approximately 1 percent less, on an annual average, than those for the No Action Alternative (Tables B-25 and B-26).

None of the monthly flows in the Sacramento River and/or inflows to or from the Delta would be significantly less, on average, than those for the No Action Alternative. For the Modified Percent Inflow Alternative, no reductions in inflows and outflows would be sufficient so as to result in adverse effects to other native anadromous species in the Delta (Table B-19).

1.2.2.11 Existing Conditions versus Preferred (Flow Evaluation) Alternative

Trinity River Basin and Lower Klamath River Basin/Coastal Area. Implementation of the Preferred (Flow Evaluation) Alternative would substantially restore the diverse fish habitats necessary for restoration and maintenance of native anadromous fish populations compared to existing conditions. The degree of improvement is similar to that of the Flow Evaluation alternative over the No Action Alternative, even though the No Action Alternative is projected into the year 2020. Although the river and its fish habitats would continue to gradually degrade under the No Action Alternative, the majority of the degradation occurred in the decade immediately following dam construction. Therefore, native anadromous fish populations are not expected to substantially change from existing conditions versus the projected numbers for the No Action Alternative (the TRSAAM was not designed to detect temporal changes for the same release conditions). Because the Preferred Alternative also includes the watershed protection component of the Mechanical Restoration Alternative, it would likely accelerate and enhance the improvements in habitat and the resultant increases in fish production. The Preferred Alternative would also benefit the Klamath River beyond the benefits accrued by either the Flow Evaluation Alternative or Mechanical Restoration Alternative individually, due to increased flow releases and improved watershed conditions. The Preferred Alternative would likely impact native anadromous fish in the Central Valley similar to the impacts of the Flow Evaluation compared to the No Action Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for existing conditions during months critical to spawning and rearing (February through August) would significantly diminish habitat quality and quantity for other native anadromous species in the Central Valley. Increases in flows greater than 10 percent of those for existing conditions were considered beneficial to these species. For existing conditions (for the simulated period 1922-1993), the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 8,703, 11,300, and 19,300 cfs, respectively (Table B-21). For the Preferred Alternative (Flow Evaluation Alternative), for the simulated period 1922-1993, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 8,387, 11,000, and 19,000 cfs, respectively (Table B-21). The estimated changes in the average annual Sacramento River flows for Keswick, Grimes, and Verona for the Preferred Alternative as compared to existing conditions are shown in Table B-24. Changes in the estimated average annual Sacramento River flows at Keswick and Grimes for the Preferred Alternative averaged approximately 4 percent less and ranged from no change up to nearly 10 percent less compared to existing conditions (Table B-24). These decreases in stream flows would likely be insufficient to result in significant losses in habitat for other native anadromous species residing in the middle and lower reaches of the Sacramento River.

For the Preferred Alternative, the total average annual discharge (in cfs) for the lower reach of the Sacramento River at Verona decreased by an average of approximately 2 percent and ranged from no change to a decrease of 4 percent compared to existing conditions (Table B-24). Considering the magnitude of these decreases in annual discharges, it is not likely that the quantity and quality of other native anadromous species’ habitats would be significantly impacted in the lower Sacramento River reach.

For existing conditions, the total average annual inflow and outflows for the Delta are approximately 29,300 and 20,000 cfs, respectively (Tables B-22 and B-23). For the Preferred Alternative, the total average annual inflow and outflow for the Delta are approximately 28,900 and 19,700 cfs, respectively (Tables B-22 and B-23). The annual average decrease in Delta inflows and outflows for the Preferred Alternative are 2 percent and 3 percent, respectively, as compared to existing conditions.

On average, there would be no significant numbers of years in which inflows to the Delta would be significantly less than those for existing conditions. These changes would not result in significant impacts to other native anadromous species in the Delta (Table B-19).

1.3 RESIDENT NATIVE FISH

1.3.1 Affected Environment

1.3.1.1 Trinity River Basin

Resident native fish species found in the Trinity River Basin are listed in Table B-1. These species include gamefish: rainbow trout (*Oncorhynchus mykiss*); and non-gamefish: speckled dace (*Rhinichthys osculus*), Klamath smallscale sucker (*Catostomus rimiculus*), and coast range sculpin (*Cottus aleuticus*).

Rainbow trout in the Trinity River Basin are found in the mainstem Trinity River, its tributaries, and the Trinity River Basin reservoirs. This species is the nonanadromous form of the steelhead that are found in cool, swift waters throughout the basin. This species spawns in the tributaries and possibly the mainstem Trinity River in suitable riffle areas primarily during February through late May. Eggs incubate starting in February and generally hatch no later than late June. The Trinity River sport fishery for rainbow trout may include juvenile steelhead and salmon, as well as rainbow trout (Frederiksen, Kamine, and Associates, 1980).

Speckled dace and Klamath smallscale sucker are common within the Trinity and Klamath River Basins. Smallscale suckers prefer deep, quiet pools of the mainstem rivers and tributaries. They are presumed to spawn in the tributary streams in these basins during the spring months (Moyle, 1976). Speckled dace are the most widely distributed freshwater fish in the western United States. They inhabit cool, slow, rocky-bottomed streams and rivers where they browse on small invertebrate prey organisms. This species is found in small groups that feed extensively at night in the Trinity River (Moyle, 1976). Coast range sculpins are generally less abundant and widely distributed than other sculpins (Moyle, 1976). They are typically found in swift gravel areas in the lower reaches of coastal rivers and streams. They are active at night and thought to be predatory on small insect larvae, clams, and snails. The abundance of these species and the factors affecting their abundance within the Trinity River Basin is not well understood.

1.3.1.2 Lower Klamath River Basin

In addition to the native resident species found in the Trinity River Basin, marbled sculpin *(Cottus klamathensis)*, prickly sculpin (*Cottus asper*), threespine stickleback *(Gasterosteous aculeatus)*, staghorn sculpin *(Leptocottus armatus)*, longfin smelt (*Spirinchus thaleichthys*), and starry flounder *(Platichthys stellatus)* are known to occur in the lower Klamath River Basin (Moyle, 1976). Except for marbled sculpins, these fish are species that range into estuarine, marine, and adjacent freshwater habitats. Other marine species such as topsmelt, shiner perch, arrow goby, and sharpnose sculpin may occasionally occur in the lower Klamath River estuary. The abundance and distribution of all of these species and the factors affecting their abundance in the lower Klamath River Basin are not known.

Non-native species know to occur in the Lower Klamath are similar to those found in upstream areas including the reservoirs. Some of these species include yellow perch, black crappie, green sunfish, golden shiner, and brown bullhead.

Specific information on the life history characteristics and habitat requirements for longfin smelt in the lower Klamath River Basin is generally unknown. However, these requirements are known for the Delta estuary (see discussion in the Central Valley section below). The population of longfin smelt found in the Klamath River estuary is small and of uncertain status (Moyle, et al., 1995). In November 1992, two individual longfin smelt were collected in the Klamath River estuary (Moyle, et al., 1995). The factors that limit longfin smelt abundance in the Klamath estuary are unknown. It is likely however, that the reduction in Klamath and Trinity Basin river flows have adversely affected this species just as Delta outflow reductions have impacted this species' population in the Delta.

1.3.1.3 Coastal Area

Numerous native marine species are found in tidepool, and nearshore habitats in the coastal area adjacent to the lower Klamath River Basin. There are as many as 250 species of tide-pool and nearshore fish in the coastal water of California (Fitch and Lavenberg, 1973), most of which would be expected to occur in the coastal waters adjacent to the project. Important recreational species include representatives from the following families: halibut and sanddab (*Bothidae*), herring (*Clupidae*), surf perch (*Embiotocidae*), lingcod and greenling (*Hexagrammidae*), smelt (*Osmeridae*), sole and flounder, (*Pleuroectidae*), and rockcod (*Scorpaenidae*).

In addition, important commercial fisheries exist for numerous coastal marine fish harvested from waters adjacent to the project area. These species include the following: flatfish, (dover, english, petrale, and rex sole, and California halibut); roundfish, (sablefish-black cod and Pacific hake or whiting); rockfish (*genus Sebastes, Sebastolobus*, and *Scorpaena* including black, calico, blackgill, canary, and widow rockfish, Pacific ocean perch, bocaccio, chilepepper, and thornyhead); albacore tuna; and lingcod. Most or all of these species are landed in Eureka and Crescent City, California, and Brookings, Oregon.

1.3.1.4 Central Valley

Many of the same species found in the lower Klamath and Trinity River Basins also occur in the Central Valley. In addition to the species shown in Table B-1, the following native resident species occur (Moyle, 1976): Pacific brook lamprey, hardhead, hitch, blackfish, California roach, Sacramento squawfish, Sacramento splittail, Sacramento sucker, tule perch, prickly sculpin, longfin smelt, and Delta smelt.

A longfin smelt population abundance index is annually estimated by the CDFG. For the period for of 1967 through 1991 this index has ranged from greater than 80,000 adult fish (1967) to less than 1,000 fish during the drought years of 1988 through 1991 (U.S. Bureau of Reclamation, 1997). Spawning-aged fish begin moving into upper areas of their distribution in the Suisun Bay and the middle and lower Delta in late summer. Some spawning may occur as early as November and continue until June, and takes place in freshwater habitats containing sandy-gravel substrates, rock, and vegetation. In the Delta, most spawning occurs in February through April (Moyle, et al., 1995). Most longfin smelt die following spawning. Newly hatched larvae are subject to being transported downstream into brackish waters because of their preference for the upper water column. Therefore, increased river outflows greatly influence longfin smelt larval survival rates as the larvae are quickly transported to more productive estuarine environments.

Delta smelt are found in the upper Sacramento-San Joaquin estuary and were listed as threatened by federal and state governments in 1993 (U.S. Fish and Wildlife Service, 1994). This species is rarely found in habitats where the salinity is greater than 10-12 parts-per-thousand (ppt) and prefers salinity of approximately 2 ppt. A target salinity of 2 ppt occurring within Suisun Bay and the western Delta during the months of February through June (inclusive) is thought to provide habitat conditions conducive to the survival and recovery of this species (USFWS, 1995). The salinity target is referred to X2 and is an approximate location in Suisun Bay and the western Delta, calculated (in Kilometers) upstream of the Golden Gate Bridge. Delta smelt occur in the Sacramento River downstream of Isleton and in the San Joaquin downstream of Mossdale. Adults move upstream into fresh water during January through July to spawn downstream of Sacramento in the Sacramento River and in the Mokelumne River and the freshwater sloughs of the Delta. Spawning can occur at temperatures ranging from 45-62°F. Reduction of Delta outflows, high Delta outflows, losses to entrainment at water diversions, changes in food organisms, toxic substances, disease, competition, predation, and loss of genetic integrity in the Delta are suspected causes in the population decline of Delta smelt (U.S. Fish and Wildlife Service, 1995).

Sacramento splittail are found only in California's Sacramento–San Joaquin Delta and Central Valley rivers. Presently, this species is restricted to the Delta, Suisun Bay, and Suisun and Napa Marshes (U.S. Fish and Wildlife Service, 1999). These fish are members of the minnow family and grow up to 16 inches long and live up to 7 years (U.S. Fish and Wildlife Service, 1999). Peak spawning of this species occurs during March through May but can occur from January through June. Splittail populations were found to have declined as much as 62 percent over the last 20 years. Threats to splittail occur primarily as a result of water-development projects. Activities that could harm splittail include: diversion of water, levee maintenance, dredging and discharge of dredge materials, and discharges of toxic materials into their habitat (U.S. Fish and Wildlife Service, 1999). This species was listed as federally threatened under ESA on March 10, 1999, by the Service (1999). However, USFWS's final decision to list the Sacramento splittail was subsequently challenged and on June 23, 2000, the Federal Eastern District Court of California found the final rule to be unlawful, and remanded the determination back for a re-evaluation of the final decision. After a thorough review and consideration of all the best scientific and commercial information available, USFWS removed the Sacramento splittail from the list of threatened species effective September 22, 2003 (*Fed. Reg. 68 (183), 55139-55166*).

1.3.2 Environmental Consequences

1.3.2.1 Methodology

Trinity River Basin. There are no direct methods to assess the effects of project alternatives on resident native fish species in the Trinity River. To evaluate the effects of the project on these species, the following assumptions were made:

- Increased coldwater releases to the Trinity River are not harmful for resident native fish species.
- Increases in Trinity River flows would improve habitat conditions and river system health for resident native fish species within the Trinity River.
- Mechanical restoration of riverine habitat within the Trinity River would not affect resident native fish species within the Trinity River.
- Watershed protection activities in the Trinity River would improve habitat conditions and river system health for resident native fish species within the Trinity River.

In summary, for the purposes of this analysis, it was assumed that any benefits or adverse effects on resident native fish species in the Trinity River would be the same as those for naturally produced anadromous salmonid species. Using these assumptions, a qualitative assessment of the effects of project alternatives, as compared to No Action, was made.

Lower Klamath River Basin. There were no methods available to directly evaluate the effects of project alternatives on other native fish species within the lower Klamath River. For this reason, several assumptions were made to assist in assessing changes or effects of project alternatives on these resources. These assumptions were:

- Increased coldwater releases to the Trinity River reduce Klamath River temperatures during mid-May through late-June (U.S. Fish and Wildlife Service, 1998) and are not harmful to other resident native fish.
- Increases in stream flows in the Trinity River would improve habitat conditions and river system health for resident native fish within the lower Klamath River and estuary.

- Mechanical restoration of riverine habitats within the Trinity River would not affect resident native fish species within the lower Klamath River.
- Watershed protection activities in the Trinity River would improve habitat conditions and river system health for resident native fishery resources in the lower Klamath River.

In summary, for the purposes of this analysis, it was assumed that any benefits or adverse effects on resident native fish species in the Klamath River would be the same as those benefits or effects on naturally produced anadromous salmonid species in the Klamath River. Using these assumptions, a qualitative assessment of the effects of project alternatives, as compared to No Action, was made.

Coastal Area. There were no methods readily available to estimate or directly measure any effect of project alternatives on other native fish species inhabiting Coastal Area. It was assumed that there would be no measurable or incremental effect on food availability, rates of predation or survival, or other ecological consequences to other native resident fish species in the adjacent Coastal Areas as a result of any of the project alternatives. Therefore, it was assumed that there would be no likely measurable effects.

Central Valley. For the purpose of estimating effects of the project alternatives on resident native fish species in the Central Valley, it was assumed that any adverse effects or benefits to naturally produced anadromous species in the Central Valley would similarly effect or benefit resident native fishery resources. Sacramento River flows, Delta inflow and outflow, ratio of Delta inflow to exports, and position of X2 in the Delta were evaluated. X2 refers to the calculated 2 part-per-thousand (2ppt) salinity position, in kilometers from the Golden Gate Bridge. X2 (2 ppt salinity) is believed optimal for maximizing native Delta smelt.

To evaluate the potential effects of the project alternatives on native resident fish species in the Central Valley, a comparison of the annual flows at various locations in the Sacramento River and Delta was conducted. For each project alternative, for the Sacramento River, average annual and monthly flows in cfs at Keswick, Grimes, and Verona were compared to flows for the No Action Alternative. Total annual and monthly inflows into the Delta, outflows from the Delta, the ratio of Delta inflow to exports. We evacuated the changes in the position of X2 as compared to the No Action Alternative were used to determine potential changes in the habitat and impacts to Delta smelt.

1.3.2.2 Significance Criteria

Effects are considered significant for resident native fish species if they result in any of the following:

- Potential for reductions in the number, or restrictions of the range, of an endangered or threatened resident native fish species or a resident native fish species that is a candidate for listing as threatened
- Potential for substantial reductions in the habitat of any resident native fish species other than those that are listed as threatened or endangered or are candidates for threatened or endangered status
- Potential for causing a resident native fish population to drop below self-sustaining levels

- Substantial adverse effect, either directly or through habitat modifications, on any resident native fish species identified as a sensitive or special status species in local or regional plans, policies, or regulations by the California Department of Fish and Game, the U.S. Fish and Wildlife Service, or the National Marine Fisheries Service
- Substantial interference with the movement of any resident native fish species
- A conflict with, or violation of, the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan relating to the protection of resident native fish species
- Direct mortality (losses) of state or federally listed resident native fish species, or species that are candidates for listing (CESA) or proposed for listing (ESA)
- Reductions in the size of a special-status resident native fish species population sufficient to jeopardize its long-term persistence
- Temporary impacts to habitats such that listed or special-status species suffer increased mortality or lowered reproductive success that jeopardizes the long-term persistence of those local populations
- Permanent loss of essential habitat of a listed species or special-status fish species
- Reduction in the quantity or quality of habitats in which resident native fish populations occur sufficient to affect the abundance and productivity of local populations

1.3.2.3 Results

Summary. Compared to the No Action Alternative, all the alternatives considered would result in beneficial habitat conditions for resident native species in the Trinity River. However, the Mechanical Restoration Alternative would result in rather small incremental habitat benefits for resident native species in the Trinity River Basin. Except for the Mechanical Restoration Alternative, all the alternatives would also benefit resident native species in the Klamath River Basin to some extent. These benefits would principally stem from increased flows, somewhat cooler water temperatures in the Klamath River Basin downstream its confluence with the Trinity River, and watershed restoration actions within the Trinity Basin. In the Central Valley only the 70 percent inflow and the Maximum Flow Alternative may have potential for adverse impacts to habitat quantity and quality for resident native species, principally due to reductions of flows in the upper Sacramento River for native species and habitat for Delta smelt in Sacramento-San Joaquin River Delta.

In the Central Valley, there would be no measures to mitigate, to less than significant, the adverse effects to native resident species and Delta smelt from implementing the maximum flow and 10 percent inflow alternatives would be to re-operate the Central Valley Project, including changing the pattern or increasing stream flows in the Sacramento River, inflows to the Delta, increasing Delta outflows, or reducing Delta exports.

1.3.2.4 No Action Alternative

Trinity River Basin. As stated in the methodology section, it was assumed that increased coldwater releases to the Trinity River would not harm resident native fish species. Increased stream flows in the Trinity River would provide river system benefits resulting in improved habitat conditions for the resident native species as well as anadromous species. Mechanical habitat restoration and watershed activities on the mainstem Trinity River were also assumed to improve habitat conditions and benefit resident native fish species in the Trinity River Basin. Thus, any benefits or adverse effects on resident native species in the Trinity River would be the same as those for naturally produced anadromous species. Using these assumptions, a qualitative assessment of the effects of the No Action Alternative was made.

As previously discussed, the No Action Alternative performed poorly in meeting the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River (Tables B-10 and B-11). TRSAAM results indicate that, under the No Action Alternative, fishery habitats in the mainstem Trinity River in the year 2020 would not likely provide the conditions necessary to allow resident native species to recover to pre-dam population levels.

Lower Klamath River Basin/Coastal Area. It was assumed that any benefits or adverse effects on resident native fish species in the Klamath River would be the same as those for naturally produced anadromous salmonid species in the Klamath River. Using these assumptions, a qualitative assessment of the effects of the No Action Alternative was made. As shown in Tables B-10 and B-11, the No Action Alternative performed poorly in meeting the river system attributes and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. TRSAAM results indicate that, under the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would also not likely provide the conditions necessary to provide benefits to resident native species in the lower Klamath River and estuary.

These results indicate that, under the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would not likely provide the flow, temperature, and habitat conditions necessary to restore populations of resident native fish species in the lower Klamath River and estuary to pre-dam levels.

Central Valley. The resident native fish species in the Central Valley have evolved in an environment in which wide ranges of conditions, including water temperatures and flows, fluctuate widely both within and between years. Habitat quantity and quality for native resident species in the Sacramento River and Delta areas are affected by the quantity and quality of water moving through this region. Populations of these species in the portions of the Central Valley affected by operations of the TRD (Sacramento River and the Delta) would be expected to largely fluctuate in response to any changes in environmental conditions (e.g., flows, temperatures, and salinity).

For the simulated period 1922-1993, the average annual discharge of the Sacramento River as estimated at Keswick, Grimes, and Verona was approximately 8,700 cfs; 11,300 cfs; and 19,300 cfs, respectively (Table B-21). Total average annual inflow and outflows for the Delta are approximately 29,200 cfs and 19,900 cfs, respectively (Tables B-22 and B-23). For the simulated period, the average monthly position of the X2 position, in Kilometers (KM) from the Golden Gate Bridge, during the months of February through June (inclusive) ranges from 65.7 KM (April) to 71.3 KM (February) (Table B-27; and Attachment B10).

1.3.2.5 Maximum Flow Alternative

Trinity River Basin. As previously discussed, the results of the TRSAAM analysis for all attribute objectives for the Maximum Flow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the Maximum Flow Alternative was scored 58 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, the Maximum Flow Alternative excelled in meeting the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. This would also greatly enhance habitat conditions for resident native fish species in the Trinity Basin. These results indicate that river system health and habitat conditions improved approximately 1350 percent under the Maximum Flow Alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under the Maximum Flow Alternative and would likely result in large increases in resident native fish populations compared to those expected from the No Action Alternative (Table B-19).

Lower Klamath River Basin/Coastal Area. Improvements in water temperature conditions and increases in flows in the Trinity River would result in more favorable conditions in the lower Klamath River, thus benefiting resident native species within the lower Klamath River and estuary. Increases in flows to the Trinity River would increase habitat quantity and benefit habitat conditions in the lower Klamath River and estuary. Increases in flow in the Trinity River resulting from spring reservoir releases would improve temperature conditions in the Klamath River downstream of the confluence.

Beneficial habitat conditions, as a result of more optimal temperatures and increased flows, would likely improve survival rates for young life stages of resident native species. Improved habitat conditions would benefit juveniles rearing and adults occupying the lower Klamath River and estuary (Table B-19). These benefits would likely result in increased populations of resident native species under the Maximum Flow Alternative.

Central Valley. It was assumed that decreases in monthly average flows in the Sacramento River and Delta greater than 10 percent of those for the No Action Alternative during the months critical to spawning and early rearing (February through June) would significantly diminish habitat quality and quantity for resident native species in the Central Valley. Increases in stream flows greater than 10 percent of those for No Action during those months were considered beneficial to these species for the maximum flow alternative. For the simulated period 1922-1993, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 7,700 cfs; 10,500 cfs; and 18,400 cfs, respectively (Table B-21). The estimated changes in the average annual Sacramento River flows for Keswick and Grimes for the Maximum Flow Alternative as compared to No Action are shown in Table B-24. Changes in the estimated average annual Sacramento River flows at Keswick (upper reach of the river) for the Maximum Flow

Alternative decreased an average of approximately 12 percent. Changes in the estimated average annual Sacramento River flows at Grimes (middle reach of the river) for the Maximum Flow Alternative decreased an average of approximately 9 percent compared to No Action Alternative (Table B-24). These changes in stream flows would likely result in significant losses of habitat for resident native species residing in the Keswick reach of the Sacramento River only.

For this alternative, the total average annual discharge (in cfs) for the lower reach of the Sacramento River at Verona decreased an average of approximately 6 percent compared to No Action Alternative (Table B-24). Considering the magnitude of the decreases in annual discharges, it is not likely that reductions in habitat quantity and quality may be sufficient to significantly reduce habitat and adversely affect native resident species in the lower Sacramento River reaches.

The average annual inflow and outflow in the Delta for the Maximum Flow Alternative is estimated to be approximately 28,300 and 19,400 cfs, respectively (Tables B-22 and B-23). These flows are approximately 4 percent less, on average, that those for the No Action Alternative (Tables B-25 and B-26).

For the months critical to life stages of Delta Smelt in the Delta (February through June), Delta inflows ranges from 1 percent (March) to 3 percent (June) (Table B-25). For the same months critical to these species in the Delta, the Delta outflows ranges from 0 percent (March) to 3 percent (June) (Table B-26). The maximum ratio of Delta inflows to exports, (35 percent for February through June and 65 percent for July through January), were not violated for any year simulated for the Maximum Flow Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27 and in Attachment B10. During the months of February through June, the average monthly X2 position ranged from 65.8 KM (April) to 71.6 KM (February) (Table B-27). During these months, X2 moved 0.3 kilometers or less for the years simulated (a change of 0.4 percent or less relative to that for No Action) (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found as Attachment B10. The analysis of the frequency and direction of movement of the predicted X2 position in the Delta are shown in Table B-29 and in Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Maximum Flow Alternative, a total of 55 months (15.3 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 23 months (6.4 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that while there are both movements of X2 greater than 0.5 KM eastward (15.3 percent of the months) and westward (6.4 percent of the months), on the balance for the vast majority of months these movements would not significantly reduce habitat quantity or quality sufficiently to adversely affect Delta smelt or other native resident species in the Delta.

On an average annual basis the monthly ratio of Delta inflows to exports in the Delta would not significantly change for the Max Flow Alternative. The changes in streamflows in the lower Sacramento or Delta inflows or outflows would not significantly reduce habitat for resident native species in the Central Valley, (Table B-19) reduction in streamflows in the Keswick Research of the upper Sacramento River would reduce habitat for native resident species (but not Delta smelt). There are no measures to mitigate these impacts to resident native species.

1.3.2.6 Flow Evaluation Alternative

Trinity River Basin. As previously discussed, the results of the TRSAAM analysis for all attribute objectives for the Flow Evaluation Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the Flow Evaluation Alternative was scored 49 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative greatly improved conditions necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. This alternative would also greatly enhance habitat conditions for resident native fish species in the Trinity Basin. These results indicate that river system health and habitat conditions would be expected to improve approximately 1125 percent under the Flow Evaluation Alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve with this alternative (Table B-19) and would likely result in large increases in resident native fish populations compared to those expected from the No Action Alternative.

Lower Klamath River Basin/Coastal Area. Improvements in water temperature conditions and increases in flows in the Trinity River would result in more favorable conditions in the lower Klamath River, thus benefiting resident native species within the lower Klamath River and estuary. Annual increases in Trinity River flows, from approximately 28 taf (critically dry water year) to approximately 475 taf (extremely wet water year), would likely improve habitat conditions in the lower Klamath River and estuary in most years. Increases in flow in the Trinity River resulting from spring Lewiston Dam releases would greatly improve temperature and habitat conditions in the Klamath River downstream of the confluence with the Trinity River (U.S. Fish and Wildlife Service, 1998).

Beneficial habitat conditions, as a result of more optimal temperatures and increased flows, would likely improve survival rates for young life stages of resident native species. Improved habitat conditions would benefit juveniles rearing and adults occupying the lower Klamath River and estuary (Table B-19). These benefits would likely result in increased populations of resident native species under the Flow Evaluation Alternative.

Central Valley. It was assumed that decreases in monthly average flows greater than 10 percent of those for the No Action Alternative during months critical to spawning and rearing (February through June) would significantly diminish habitat quality and quantity for resident native species in the Central Valley. Increases in stream flows greater than 10 percent of those for No Action during these months were considered beneficial to these species. For the flow evaluation alternative, the simulated period 1922-1993, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 8,400 cfs; 11,000 cfs; and 19,000 cfs, respectively (Table B-21). The estimated changes in the average annual Sacramento River flows for Keswick and Grimes for the Flow Evaluation Alternative as compared to No Action are shown in Table B-24.

Changes in the estimated average annual Sacramento River flow at Keswick (upper reach of the river) for the Flow Evaluation Alternative decreased an average of 4 percent. Changes in the estimated average annual Sacramento River flows at Grimes (middle reach of the river) for the Flow Evaluation Alternative decreased on an average of approximately 3 percent compared to the No Action Alternative (Table B-24). These reductions in stream flows would not likely result in significant losses of habitat for resident native species residing in the upper and middle reaches of the Sacramento River.

For this alternative, the total average annual discharge (in cfs) for the lower reach of the Sacramento River at Verona decreased an average of approximately 2 percent compared to the average annual discharge estimated for the No Action Alternative (Table B-24). Considering the magnitude of the decreases in annual discharges, it is not likely that reductions in habitat quantity and quality would be sufficient to significantly reduce habitat and adversely affect resident native species in the lower Sacramento River.

The average annual inflow and outflow in the Delta for the Flow Evaluation Alternative is estimated to be approximately 28,900 and 19,700 cfs, respectively (Tables B-22 and B-23). These flows are approximately 1 percent less, on average, that those for the No Action Alternative (Tables B-25 and B-26).

For the months critical to life stages of Delta smelt (February through June), ranges from 0 percent (February through April) to 2 percent (June). For the months critical to these species in the Delta, outflows 0 percent (February, March, and April) to 2 percent (June). The compliance target maximum ratio of Delta inflows to exports were not violated for any year simulated for the Flow Evaluation Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. During the months of February through June the average monthly X2 position ranged from 65.8 KM (April) to 71.4 KM (February) (Table B-27). During these months, X2 moved 0.1 kilometers or less for the years simulated (a change of 0.1 percent or less relative to that for No Action) (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and in Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Flow Evaluation alternative, a total of 35 months (9.7 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 29 months (8.1 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that while there are both movements of X2 greater than 0.5 KM eastward (9.7 percent of the months) and westward (8.1 percent of the months), on the balance for the vast majority of months (≥90 percent) these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect Delta smelt or other native resident species in the Delta.

On an average annual basis, the monthly ratio of Delta inflows to exports in the Delta would not significantly change for the Flow Evaluation Alternative compared to No Action. The changes in streamflows, or Delta inflows and outflows would not significantly reduce habitat for resident native species in the Central Valley (Table B-19).

1.3.2.7 70 Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the 70 Percent Inflow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the 70 Percent Inflow Alternative was scored 50 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative provided significant benefits to habitat conditions necessary for restoring anadromous salmonids species in the mainstem Trinity River. These expected improvements would also provide significant benefits to habitat conditions for resident native fish species in the Trinity Basin (Table B-19). The TRSAAM analysis indicated that river system health and habitat conditions improved approximately 1,150 percent for the 70 Percent Inflow Alternative as compared to No Action (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would improve under this alternative and would likely result in increases in resident native fish populations as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The 70 Percent Inflow Alternative would result in improved water temperature conditions and increased Trinity River flows in many water years. In those years, increased annual flows (and improved water temperature conditions would result in improved habitat conditions in the lower Klamath River and estuary (Table B-19). These improvements would result in benefits to other resident native fish populations under the 70 Percent Inflow Alternative.

Central Valley. It was assumed that decreases in monthly average flows greater than 10 percent of those for the No Action Alternative during months critical to spawning and rearing (February through June) would significantly diminish habitat quality and quantity for resident native species in the Central Valley. Increases in stream flows greater than 10 percent of those for No Action during those months were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 8,000 cfs; 10,700 cfs; and 18,700 cfs, respectively (Table B-21). The estimated changes in the average annual Sacramento River flows for Keswick and Grimes for the 70 Percent Inflow Alternative as compared to No Action are shown in Table B-24. Changes in the estimated average annual Sacramento River flows at Keswick (upper reach of the river) for the 70 Percent Inflow Alternative decreased an average of 9 percent. Changes in the estimated average annual Sacramento River flows at Grimes (middle reach of the river) for this Alternative decreased an average of 6 percent compared to the No Action Alternative (Table B-24). These reductions in stream flows would not likely result in significant losses of habitat for resident native species residing in the upper and middle reaches of the Sacramento River.

For this alternative, the total average annual discharge (in cfs) for the lower reach of the Sacramento River at Verona decreased approximately 4 percent compared to the average annual discharge estimated for the No Action Alternative (Table B-24). Considering the magnitude of the decreases in annual discharges, it is not likely that reductions in habitat quantity and quality would be sufficient to significantly reduce habitat and adversely affect resident native species in the lower reaches of Sacramento River.

The average annual inflow and outflow in the Delta for the 70 Percent Inflow Alternative is estimated to be approximately 28,600 and 19,400 cfs, respectively (Tables B-22 and B-23). These flows are approximately 3 percent less, on average, that those for the No Action Alternative (Tables B-25 and B-26).

For the months critical to life stages of Delta smelt (February through June), Delta inflows ranges from 1 to 2 percent less than those for No Action (Table B-25). Similarly, for the months critical to these species in the Delta, it was determined that Delta outflows ranges from 1 to 2 percent less than those for No Action. The maximum ratio of Delta inflows to exports were not violated for any year simulated for the this Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. During the months of February through June the average monthly X2 position ranged from 65.9 KM (April) to 71.6 KM (February) (Table B-27). During the months of February through June, X2 moved 0.3 kilometers or less for the years simulated (a change of 0.4 percent or less relative to that for No Action) (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and in Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the 70 Percent Inflow Alternative, a total of 54 months (15 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 12 months (3.3 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, there are both movements of X2 greater than 0.5 KM eastward (15 percent of the months) and westward (3.3 percent of the months). However, on the balance greater than 10 percent of all months X2 movement would likely reduce habitat quantity or quality sufficiently to adversely affect Delta smelt or other native resident species in the Delta.

On an average annual basis, the monthly ratio of Delta inflows to exports, would not significantly change for the 70 Percent Inflow Alternative. The number and magnitude of habitat changes may result in impacts to Delta smelt (Table B-19). There are no measures to mitigate these impacts to Delta smelt.

1.3.2.8 Mechanical Restoration Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Mechanical Restoration Alternative are shown in Table B-10 and summarized in Table B-11. As shown in these tables, the Mechanical Restoration Alternative was scored 13 out of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. A majority of the attribute objectives were determined to never or nearly never exceed threshold criteria for this alternative. This alternative was determined to provide only small benefits in meeting river system attribute objectives compared to the No Action Alternative (Table B-19). These results indicate that conditions would be expected to improve approximately 225 percent under this alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-15). Small and localized beneficial improvements in river system health and function would result in only small benefits to resident native fish populations as compared to No Action.

Lower Klamath River Basin/Coastal Area. The only changes in habitat conditions in the Trinity River Basin in the Mechanical Restoration Alternative are through mechanical means. Therefore, no benefits resulting from increased flows or cool water temperature would be expected in the lower Klamath River and estuary under the Mechanical Restoration Alternative. Habitat conditions for this alternative would remain the same as No Action for the lower Klamath River and estuary (Table B-19). It is likely that resident native fish populations in the lower Klamath River would remain unchanged under this project alternative.

Central Valley. This alternative would not affect habitats for resident native fish species in the Central Valley and therefore would result in no change from the No Action Alternative (Table B-19).

1.3.2.9 Revised Mechanical Restoration Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Revised Mechanical Restoration Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, this alternative was scored 37 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative provided some improvement to river system and habitat conditions necessary for restoring anadromous salmonid species in the mainstem Trinity River. These expected improvements would be moderately beneficial and improve habitat conditions for resident native fish species in the Trinity Basin (Table B-19). The TRSAAM analysis indicated that river system health and habitat conditions improved approximately 825 percent for this Alternative as compared to No Action (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitats in the mainstem Trinity River in the year 2020 would improve under this alternative and would likely result in increased resident native fish populations as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The Revised Mechanical Alternative would result in some improvement in water temperature conditions and increased Trinity River flows in some water years. In those years, increased flows during spring and early summer months could result in improved habitat conditions in the lower Klamath River and estuary (Table B-19). However, in dry and critically dry water years, water temperature conditions in the Trinity River would be either similar or less beneficial to resident native species as compared to temperatures for No Action. Populations of resident native species in the lower Klamath River and estuary may benefit somewhat from implementation of this alternative.

Central Valley. It was assumed that decreases in monthly average flows greater than 10 percent of those for the No Action Alternative during the months critical to spawning and rearing (February through June) would significantly diminish habitat quality and quantity for resident native species in the Central Valley. Increases in stream flows greater than 10 percent of those for No Action during these months were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 8,600 cfs; 11,200 cfs; and 19,200 cfs, respectively (Table B-21). The estimated changes in the average annual Sacramento River flows for Keswick and Grimes for the Revised Mechanical

Restoration Alternative as compared to No Action are approximately 1 percent less than No Action and are shown in Table B-24. Changes in the estimated average monthly Sacramento River flows at Keswick, Grimes, and Verona (upper, middle and lower reaches of the river respectively) ranged from no change to a 3 percent decrease compared to the No Action Alternative (Table B-24).These reductions in stream flows would not likely result in significant losses of habitat for resident native species residing in these reaches of the Sacramento River.

The average annual inflow and outflow in the Delta for the Revised Mechanical Restoration Alternative is estimated to be approximately 29,100 and 19,800 cfs, respectively (Tables B-22 and B-23). These annual flows are approximately 1 percent less, on average, and range from no change to a 3 percent decrease compared to those for the No Action Alternative (Tables B-25 and B-26). For the months critical to life stages of Delta smelt (February through June), Delta inflows range from 0 to 2 percent less than those for No Action (Table B-25) for the months critical to life stages of Delta smelt Delta outflows range from 0 to 2 percent less than those for No Action (Table B-26). The maximum ratio of Delta inflows to exports were not violated for any year simulated for the Revised Mechanical Restoration Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. The average monthly position of X2 remained relatively unchanged compared to the No Action Alternative for the period of simulation (Table B-28). During the months of February through June the average monthly X2 position ranged from 65.8 KM (April) to 71.3 KM (February) (Table B-27). Overall, during the months of February through June, X2 did not significantly move, relative to No Action, during the years simulated (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and as Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Revised Mechanical Restoration alternative, a total of 17 months (4.7 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 14 months (3.9 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that while there are both movements of X2 greater than 0.5 KM eastward (4.7 percent of the months) and westward (3.3 percent of the months), on the balance for the vast majority of months (≥95 percent) these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect Delta smelt or other native resident species in the Delta.

On an average annual basis the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Revised Mechanical Restoration Alternative. No impacts to habitat quantity and quality for resident native species would occur in the Sacramento River or in the Delta (Table B-19).

1.3.2.10 Modified Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Modified Percent Inflow Alternative are shown in Table B-10 and are summarized in

Table B-11. As shown in these tables, this Alternative was scored 51 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative provided significantly beneficial improvements to river system and habitat conditions necessary for restoring anadromous salmonids species in the mainstem Trinity River. These expected improvements would likely provide large benefits to habitat conditions for resident native fish species in the Trinity Basin (Table B-19). The TRSAAM analysis indicated that river system health and habitat conditions improved approximately 1125 percent for this Alternative as compared to No Action (Table B-15). These results indicate that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under the Modified Percent Inflow Alternative and would likely result in increases in resident native fish populations as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The Modified Percent Inflow Alternative would result in improved water temperature conditions and increased Trinity River flows in most water years. In these years, increased annual flows (and improved water temperature conditions would result in improved habitat conditions in the lower Klamath River and estuary (Table B-19). These improvements would result in benefits to resident native fish populations under this Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative during months critical to spawning and rearing (February through June) would significantly diminish habitat quality and quantity for resident native species in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative during those months were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Modified Percent Inflow Alternative is approximately 8,500, 11,100 and 19,100 cfs, respectively (Table B-21). For this Alternative, the total average annual discharges in the lower and middle reach of the Sacramento River decreased approximately 2 percent at Keswick and Grimes, and the monthly average flows ranged from no change (March at Keswick; January through March at Grimes) to 4 percent (November and May at Keswick; and June at Grimes) compared to the No Action Alternative (Table B-24). The total average annual discharges in the lower reach of the Sacramento River (Verona) decreased by approximately 1 percent compared to those discharges estimated for the No Action Alternative (Table B-24). Average monthly flows at Verona ranged from no change (January through April, and July) to 4 percent (June) as compared to the No Action Alternative. Considering the magnitude of the decreases in the annual and monthly average discharges, it is unlikely that reductions in habitat quantity and quality would be sufficient to adversely affect resident native species in the Sacramento River.

On an average annual basis, inflow and outflow in the Delta for the Modified Percent Inflow Alternative is estimated to be approximately 29,000 and 19,800 cfs, respectively (Tables B-22 and B-23). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-26). Delta inflows and outflows during months critical to Delta smelt range from 0 to 2 percent less than No Action. (Tables B-25 and B-26). The allowable maximum ratio of Delta inflows to exports were not violated for any year simulated for the Modified Percent Inflow Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. The average monthly position of X2 remained relatively unchanged compared to the No Action Alternative for the period of simulation (Table B-28). During the months of February through June the average monthly X2 position ranged from 65.7 KM (April) to 71.3 KM (February). On the average, for the months of February through June, X2 did not appreciably move (≤0.1 KM), relative to No Action, during the years simulated (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and as Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Modified Percent Inflow alternative, a total of 23 months (6.4 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 19 months (5.3 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that while there are both movements of X2 greater than 0.5 KM eastward (6.4 percent of the months) and westward (5.3 percent of the months), on the balance for the vast majority of months (≥93 percent) these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect Delta smelt or other native resident species in the Delta.

On an average annual basis, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Modified Percent Inflow Alternative. The magnitude of these changes would not result in impacts to habitat quantity and quality for resident native species in the Sacramento River or in the Delta (Table B-19).

1.3.2.11 Existing Conditions versus Preferred (Flow Evaluation) Alternative

Trinity River Basin and Lower Klamath River Basin/Coastal Area. Trinity River impacts of the Preferred (Flow Evaluation) Alternative compared to existing conditions for resident native fish would be similar to the impacts of the Flow Evaluation alternative compared to the No Action conditions in the year 2020. However, the watershed protection component of the Preferred Alternative would benefit resident native fish by reducing sediment inputs to the Trinity River.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for existing conditions during the months critical to spawning and rearing (February through June) would significantly diminish habitat quality and quantity for resident native species in the Central Valley. Increases in flows greater than 10 percent of those for existing conditions during those months were considered beneficial to these species. For existing conditions (for the simulated period 1922-1993), the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 8,700 cfs; 11,300 cfs; and 19,300 cfs, respectively (Table B-21). For the Preferred Alternative (Flow Evaluation Alternative), for the simulated period 1922-1993, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 8,400 cfs; 11,000 cfs; and 19,000 cfs, respectively (Table B-21). The estimated changes in the average annual Sacramento River flows for Keswick and Grimes for the Preferred Alternative as compared to existing conditions are shown in Table B-24.

Changes in the estimated average annual Sacramento River flows at Grimes (middle reach of the river) for the Preferred Alternative averaged approximately 4 percent less and ranged from no change to 8 percent less compared to existing conditions (Table B-24).

For the Preferred Alternative, the total average annual discharge (in cfs) for the lower reach of the Sacramento River (Verona) decreased by an average of approximately 2 percent and ranged from an increase of 1 percent to a decrease of 4 percent compared to existing conditions (Table B-24). Considering the magnitude of these decreases in annual discharges, it is not likely that the quantity and quality of resident native species' habitats would be significantly impacted in the lower Sacramento River reach.

For existing conditions, the total average annual inflow and outflows for the Delta are approximately 29,300 and 20,000 cfs, respectively (Tables B-22 and B-23). For the Preferred Alternative, the total average annual inflow and outflow for the Delta are approximately 28,900 and 19,700 cfs, respectively (Tables B-21 and B-22). The annual average change in Delta inflows and outflows for the Preferred Alternative are 2 percent and 3 percent, respectively, as compared to existing conditions (Tables B-25 and B-26).

The maximum allowable ratio of Delta inflows to exports were not violated for any year simulated for the Preferred Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. During the months of February through June, X2 moved 0.1 kilometers or less for the years simulated (a change of 0.1 percent or less relative to that for existing conditions) (Table B-28). During the months of February through June the average monthly X2 position ranged from 65.6 KM (April) to 71.2 KM (February) (Table B-27). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and as Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Preferred alternative, compared to existing conditions a total of 45 months (12.2 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the existing conditions. Additionally, 39 months (10.8 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for existing conditions. The overall conclusion from this analysis is, that while there are both movements of X2 greater than 0.5 KM eastward (12.2 percent of the months) and westward (10.8 percent of the months), on the balance for the vast majority of months (≥95 percent) these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect Delta smelt or other native resident species in the Delta.

On an annual average basis the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Preferred Alternative as compared to existing conditions. However, there would be, in many years, months critical to sensitive Delta species in which inflows to the Delta may be less than those for existing conditions. These changes would not result in impacts to habitat quantity and quality for resident native species in the Delta (Table B-19).

1.4 NON-NATIVE FISH

1.4.1 Affected Environment

1.4.1.1 Trinity River Basin and Lower Klamath River Basin/Coastal Area

Non-native fish species found in the Trinity River Basin are listed in Table B-1. Non-native species are identified in this table as "introduced" species. Except for the species found in the reservoirs, the following discussion primarily provides information on: American shad (*Alosa sapidissima*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*). Other non-native species found in the reservoirs are discussed in the Reservoir section.

Of the introduced species, striped bass has only been recently reported from the Trinity and Klamath River Basins (Gilroy, pers. comm.). Small numbers of other introduced fish including golden shiners, which may have been inadvertently introduced into Trinity Lake, are occasionally found in the Trinity River downstream of the Lewiston Dam (Aguilar, pers. comm.). American shad are known to occur in the lowermost portions of the Trinity River Basin and primarily in the lower Klamath River Basin. The abundance of all of these species in the Trinity and lower Klamath River Basins is unknown.

American shad were introduced to California from the eastern United States beginning with introductions into the Sacramento River in 1871 through 1881 (Moyle, 1976). This anadromous species has since established populations in the Sacramento and its southernmost tributaries and the San Joaquin River Basin, including the Mokelumne and Stanislaus Rivers. In addition, populations in the Russian, Eel, Klamath, and Trinity River Basins have become established. The adults of this species move into the estuary or fresh water in late spring or early summer and spawn upriver soon thereafter.

Brown trout have been known to occur in the Trinity River for decades. This species spawns in the fall in small- to medium-sized tributary streams but may spawn in larger riverine habitats. Migration to breeding areas begins in late summer and early fall, and spawning occurs in late October to early November. This species is known for predatory habits and is suspected to prey on naturally produced salmonid fry emerging from spawning gravels (Frederiksen, Kamine, and Associates, 1980).

Trinity River Basin brown trout (Loch Leven strain) were first introduced in 1911 (Frederiksen, Kamine, and Associates, 1980). Anadromous forms of brown trout were propagated in the TRSSH until 1977 when this practice was discontinued due to the small numbers and the lack of anadromous characteristics of the brown trout entering the TRSSH (TRSSH Report, 1979). Small numbers of small brown trout continued to enter the TRSSH from September to December each year until 1982, but these fish were not propagated after the 1976 brood year (California Department of Fish and Game, TRSSH Reports, 1979-1982).

Brook trout were first introduced into the Trinity River in 1909 (Frederiksen, Kamine, and Associates, 1980). This species provides a significant sport fishery in the tributary streams and high elevation lakes of the Trinity River Basin. Its life cycle and habitat requirements are similar to that of brown trout, with the exception of its preference for smaller and colder headwater streams; and it is less predatory than brown trout. After establishing in a watershed, this species is known to flourish at the expense of other less competitive salmonid species.

Factors which affect the abundance of these species in the Trinity and lower Klamath River Basins are generally unknown but may be similar to those factors affecting naturally produced anadromous species discussed previously.

1.4.1.2 Central Valley

There have been a large number of fish species introduced into the Central Valley. CDFG estimates at least 50 species of fish have been introduced at one time or another into the Delta and San Francisco Bay estuary. Moyle (1976) estimated that of 79 total species in the Central Valley, 32 were introduced species. Principal introduced gamefish species include: catfish (*Icaluridae*), including channel and white catfish; American shad (*Clupeidae*); and bass and sunfish (*Centrarchidae*), including black and white crappie, green and bluegill sunfish, and largemouth, smallmouth, and striped bass. American shad and striped bass are recreationally important gamefish in the lower Sacramento River and Delta and constitute major sport fisheries in the Central Valley. Notable non-gamefish include: threadfin shad, goldfish, carp, golden shiner, and fathead minnow (*Cyprinidae*); mosquitofish (*Poecilidae*); and yellowfin goby (*Gobiidae*) (Moyle, 1976).

1.4.2 Environmental Consequences

1.4.2.1 Methodology

Trinity River Basin. There are no direct methods to assess the effects of project alternatives on non-native fish species in the Trinity River. To evaluate the effects of the project on these species, the following assumptions were made:

- Increased coldwater releases to the Trinity River are beneficial for coldwater non-native fish species or are not adverse for warmwater tolerant non-native species.
- Increases in the Trinity River stream flows would improve habitat conditions and river system health for other non-native fish species within the Trinity River.
- Mechanical restoration of riverine habitat within the Trinity River would not affect non-native fish species within the Trinity River.
- Watershed protection activities in the Trinity River would improve habitat conditions and river system health for non-native fish species within the Trinity River.

In summary, for the purposes of this analysis, it was assumed that any benefits or adverse effects on non-native fish species in the Trinity River would be the same as those for naturally produced anadromous salmonid species. Using these assumptions, a qualitative assessment of the effects of project alternatives, as compared to No Action, was made.

Lower Klamath River Basin. There were no tools available to directly evaluate the effects of project alternatives on other non-native fish resources within the lower Klamath River. For this reason, several assumptions were made to assist in assessing changes or effects of project alternatives on these resources. These assumptions were:

- Increased coldwater releases to the Trinity River reduce Klamath River temperatures during mid-May through late-June (U.S. Fish and Wildlife Service, 1998) and are not harmful for coldwater non-native fish.
- Increases in Trinity River stream flows would improve habitat conditions and river system health for other non-native fish within the lower Klamath River and estuary.
- Mechanical restoration of riverine habitats within the Trinity River would not affect other non-native fish species within the lower Klamath River.
- Watershed protection activities in the Trinity River would improve habitat conditions and river system health for other non-native fish resources in the lower Klamath River.

In summary, for the purposes of this analysis, it was assumed that any benefits or adverse effects on non-native fish species in the Klamath River would be the same as those for naturally produced anadromous salmonid species in the Klamath River. Using these assumptions, a qualitative assessment of the effects of project alternatives, as compared to No Action, was made.

Coastal Area. It was assumed there would be no measurable effects to other non-native fish in the Coastal Areas. Furthermore, it was assumed that there would be no density-dependent effect of changes on food availability, rates of predation or survival, or other ecological consequences on other non-native fish in the adjacent Coastal Areas as a result of any of the project alternatives.

Central Valley. There are no direct methods for estimating the effects of project alternatives on non-native fish species in the Central Valley. For the purpose of estimating effects of the project alternatives, it was assumed that any adverse effects or benefits to other native anadromous and resident species in the Central Valley would similarly effect or benefit non-native fish species.

To evaluate the potential effects of the project alternatives on non-native fish species in the Central Valley, a comparison of the annual flows at various locations in the Sacramento River and Delta was conducted. For each project alternative, for the Sacramento River, average annual and average monthly discharges in cfs at Keswick, Grimes, and Verona were compared to flows for the No Action Alternative. Total annual outflow from the Delta, ratio of inflow to exports were evaluated. Position of X2 in the Delta were compared to the No Action Alternative to determine potential changes in habitat for non-native fish species principally striped bass.

It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for non-native species in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species.

1.4.2.2 Significance Criteria

Effects are considered significant for non-native fish species if they result in any of the following:

- Potential for reductions in the number, or restrictions of the range, of an endangered or threatened non-native fish species or a non-native fish species that is a candidate for state listing or proposed for federal listing as endangered or threatened
- Potential for substantial reductions in the habitat of any non-resident fish species other than those that are listed as threatened or endangered or are candidates (CESA) or proposed (ESA) for threatened or endangered status
- Potential for causing non-native fish population to drop below self-sustaining levels
- Substantial adverse effect, either directly or through habitat modifications, on any non-native fish species identified as a sensitive or special-status species in local or regional plans, policies, or regulations by the California Department of Fish and Game, the U.S. Fish and Wildlife Service, or the National Marine Fisheries Service
- Substantial interference with the movement of any non-native fish species
- A conflict with, or violation of, the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan relating to the protection of non-native fish species
- Mortality of state or federally listed non-native fish species, or non-native fish species that are candidates for listing (CESA) or proposed for listing (ESA)
- Reductions in the size of a non-native fish species' population sufficient to jeopardize is long-term persistence
- Temporary impacts to habitats such that listed or special-status species suffer increased mortality or lowered reproductive success that jeopardizes the long-term persistence of those local populations
- Permanent loss of essential habitat of a listed species or special-status fish species
- Reduction in the quantity or quality of habitats in which non-native fish populations occur sufficient to affect the abundance and productivity of local populations

1.4.2.3 Results

Summary. The results of the comparisons of the No Action Alternative to each project alternative are summarized in Table B-19. Compared to the No Action Alternative, all the Alternatives would benefit non-native species in the Trinity River and the Klamath River Basin. Except for the maximum flow and the 70 percent alternatives proposed alternatives would not adversely affect non-native fish species including striped bass and American Shad in the Central Valley.

In the Central Valley, there would be no measures to mitigate, to less than significant, the adverse effects to non-native resident species from implementing the maximum flow or 70 percent inflow alternatives.

1.4.2.4 No Action Alternative

Trinity River Basin. The effects on non-native species from the No Action Alternative would be similar to those for resident native species: increased stream flows in the Trinity River would provide river system benefits resulting in improved habitat conditions for the non-native species. Mechanical habitat restoration and watershed activities on the mainstem Trinity River would also improve habitat conditions and benefit non-native fish species in the Trinity River Basin. Thus, any benefits or adverse effects on non-native species in the Trinity River would be similar to those for native resident species.

The No Action Alternative performed poorly in meeting the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids or other anadromous and resident native fish species in the mainstem Trinity River (Tables B-10 and B-11). TRSAAM results indicate that, under the No Action Alternative, fishery habitats in the mainstem Trinity River in the year 2020 would not likely provide or enhance the habitat conditions necessary to allow non-native species to flourish.

Lower Klamath River Basin/Coastal Area. The benefits or adverse effects on non-native fish species in the Klamath River would be the same as those for native species. As shown in Tables B-10 and B-11, the No Action Alternative performed poorly in meeting the river system and habitat requirements necessary for restoring native species in the mainstem Trinity River. These results indicate that, under the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would also not likely enhance or restore the habitat conditions necessary to optimize non-native species' populations in the lower Klamath River and estuary.

These results indicate that, under the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would not likely provide the flow, temperature, and habitat conditions necessary to provide benefits to populations of non-native fish species in the lower Klamath River and estuary.

Central Valley. Habitat quantity and quality for non-native resident species in the Central Valley areas are affected by the quantity and quality of water moving through this region. Similar to resident native species, populations of non-native species in the portions of the Central Valley affected by operations of the TRD (Sacramento River and the Delta) would be expected to largely fluctuate in response to any changes in environmental conditions (e.g., flows and temperatures).

For the simulated period 1922-1993, the average annual discharge of the Sacramento River as estimated at Keswick, Grimes, and Verona was approximately 8,700 cfs; 11,300 cfs; and 19,300 cfs, respectively (Table B-21). Total average annual inflow and outflows for the Delta are approximately 29,200 cfs and 19,900 cfs, respectively (Tables B-22 and B-23). The average yearly estimates of Sacramento River discharges and Delta inflows and outflows can only be used to qualitatively evaluate changes in habitat for these species.

1.4.2.5 Maximum Flow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Maximum Flow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the Maximum Flow Alternative was scored 58 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, the Maximum Flow Alternative excelled in meeting the river system and habitat requirements necessary for restoring many naturally produced anadromous salmonids in the mainstem Trinity River. This would also likely enhance habitat conditions for non-native fish species in the Trinity Basin. Cooler water temperature in the spring and early summer may positively affect coldwater species such as brown trout, but may negatively affect growth and development of American shad in the Trinity River Basin. For most species, as compared to the No Action Alternative, river system health and fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under the Maximum Flow Alternative (Table B-19). This would likely result in increases in non-native fish populations, particularly brown trout, compared to those expected from the No Action Alternative.

Lower Klamath River Basin/Coastal Area. Improvements in habitat conditions and increases in flows in the Trinity River would result in more favorable conditions in the lower Klamath River, thus generally benefiting non-native species within the lower Klamath River and estuary. Increases in flows to the Trinity River would increase habitat quantity and benefit habitat conditions for cold-water non-native species in the lower Klamath River and estuary. Increases in flow in the Trinity River resulting from spring reservoir releases would provide cooler water temperature conditions in the Klamath River downstream of the confluence. However, this may negatively affect growth of species such as American shad and striped bass in the lower Klamath River and estuary.

Beneficial habitat conditions, as a result of more optimal temperatures and increased flows, would likely improve survival rates for young life stages of coldwater species such as brown trout. Improved habitat conditions would benefit juveniles rearing and adults of coldwater non-native species occupying the lower Klamath River and estuary (Table B-19). These benefits may result in increased populations of brown trout under the Maximum Flow Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for non-native species, including striped bass and American shad, in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Maximum Flow Alternative are approximately 7,700; 10,500; and 18,400 cfs, respectively (Table B-21). For the Maximum Flow Alternative, the total average annual discharges in the upper and middle reaches of the Sacramento River decreased approximately 12 and 9 percent at Keswick and Grimes respectively. The range of monthly average flows diminished from 5 to 22 percent at Keswick and 2 to 21 percent at Grimes (Table B-24). These average monthly flows included reductions of up to 9 percent (Keswick) and 8 percent (Grimes) for the months of May and June, important months for spawning for striped bass and American shad and up to 12 percent in July, important months for larval and fry rearing for striped bass and American shad (Table B-24). These flow reductions may result in reductions in habitat for non-native species including striped bass and American shad in the upper reaches of the Sacramento River.

The total average annual discharges in the lower reach of the Sacramento River decreased by approximately 6 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). Average monthly flows at Verona decreased from 1 to 13 percent compared to the No Action Alternative and included average reductions of 4, 5, and 7 percent in May, June, and July respectively. Considering the magnitude of the decreases in some of the monthly average discharges important to striped bass and American shad, it is un-likely that reductions in habitat quantity and quality may be sufficient to potentially impact some non-native species in the lower most reach of the Sacramento River.

The average annual inflow and outflow in the Delta for the Maximum Flow Alternative is estimated to be approximately 28,300 and 19,400 cfs, respectively (Tables B-22 and B-23). These flows are approximately 4 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-26).

For the months important for recreationally important striped bass in the Delta (February through June), Delta inflows ranged from 1 to 3 percent less than those for No Action. For these months, Delta outflows ranged from 0 to 3 percent less than those for No Action. However, the target compliance ratio of Delta inflows to exports, 35 percent for February through June and 65 percent for July through January, were not violated for any year simulated for the Maximum Flow Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. The average monthly position of X2 moved 0.3 kilometers or less for the period of simulation (approximately 0.4 percent or less relative to the No Action Alternative). During the months of February through June the average monthly X2 position ranged from 65.8 KM (April) to 71.6 KM (February) (Table B-27). During these months, X2 moved 0.3 kilometers or less for the years simulated (a change of 0.4 percent or less relative to that for No Action) (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and in Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Maximum Flow Alternative, a total of 55 months (15.3 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 23 months (6.4 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that while there are both movements of X2 greater than 0.5 KM eastward (15.3 percent of the months) and westward (6.4 percent of the months), on the balance for the vast majority of months these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect non-native resident species in the Delta.

The monthly ratio of Delta inflows to exports in the Delta would not significantly changed for the Max Flow Alternative.

On the average, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Maximum Flow Alternative. However, there would be reductions in flows in the Sacramento River that may affect striped bass and American shad, particularly during May and June when these species are migrating and spawning (Table B-19). There are no measures sufficient to mitigate to less than significant, these impacts in the Central Valley.

1.4.2.6 Flow Evaluation Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Flow Evaluation Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, this alternative was scored 49 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, the Flow Evaluation Alternative excelled in meeting the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. This would also likely enhance habitat conditions for many non-native, especially cold-water fish species in the Trinity Basin. Cooler water temperature in the spring and early summer may, however, negatively affect growth and development of American shad in the Trinity River Basin. For most species, as compared to the No Action Alternative, river system health and fishery habitat in the mainstem Trinity River in the year 2020 would greatly improve under the Flow Evaluation Alternative (Table B-19). This would likely result in increases in non-native fish populations, particularly brown trout, compared to those expected from the No Action Alternative.

Lower Klamath River Basin/Coastal Area. Improvements in habitat conditions and increases in flows in the Trinity River would result in more favorable conditions in the lower Klamath River, thus benefiting non-native cold-water species within the lower Klamath River and estuary. Increases in flows to the Trinity River would increase habitat quantity and benefit habitat conditions in the lower Klamath River and estuary. Increases in flow in the Trinity River resulting from spring reservoir releases would provide cooler water temperature conditions in the Klamath River downstream of the confluence. However, this may negatively affect growth of species such as American shad and striped bass in the lower Klamath River and estuary.

Beneficial habitat conditions, as a result of more optimal temperatures and increased flows, would likely improve survival rates for young life stages of coldwater species such as brown trout. Improved habitat conditions would benefit juveniles rearing and adults of many of these species occupying the lower Klamath River and estuary (Table B-19). These benefits may result in increased populations of brown trout for the Flow Evaluation Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for non-native species, including striped bass and American shad, in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Flow Evaluation Alternative are approximately 8,400; 11,000; and 19,000 cfs, respectively (Table B-21). For this alternative, the total average annual discharges in the upper and middle reaches of the Sacramento River decreased approximately 4 percent at Keswick and Grimes. The average monthly flows decreased 1 to 8 percent at Keswick and from no change to 6 percent at Grimes (Table B-24). These flow reductions are insufficient to result in habitat reductions for non-native species in the upper reaches of the Sacramento River.

The total average annual discharges in the lower reach of the Sacramento River decreased by approximately 2 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). The average monthly flows at Verona decreased up to 4 percent compared to the No Action Alternative. Considering the magnitude of the decreases in average annual and monthly discharges at these Sacramento River locations significant reductions in habitat quantity and quality are unlikely and no impacts to non-native species, including striped bass and American shad, would be expected to occur in the Sacramento River.

The average annual inflow and outflow in the Delta for the Flow Evaluation Alternative is estimated to be approximately 28,900 and 19,700 cfs, respectively (Tables B-22 and B-23). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-25).

For the months important for recreationally important striped bass in the Delta (February through June), Delta inflows range from 0 to 2 percent less than No Action(Table B-25). Similarly, Delta outflows ranged from 0 to 2 percent less than No Action (Table-B-26). The maximum ratio of Delta inflows to exports, 35 percent for February through June and 65 percent for July through January, were not violated for any year simulated for the Flow Evaluation Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. During the months of February through June the average monthly X2 position ranged from 65.8 KM (April) to 71.4 KM (February) (Table B-27). During these months, X2 moved 0.1 kilometers or less for the years simulated (a change of 0.1 percent or less relative to that for No Action) (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and in Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Flow Evaluation alternative, a total of 35 months (9.7 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 29 months (8.1 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that while there are both movements of X2 greater than 0.5 KM eastward (9.7 percent of the months) and westward (8.1 percent of the months), on the balance for the vast majority of months (≥90 percent) these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect non-native resident species in the Delta.

On average, the monthly ratio of Delta inflows to exports in the Delta nor X2 position in the Delta would not significantly change for the Flow Evaluation Alternative. There would be no impacts to non-native species in the Central Valley from implementing the Flow Evaluation Alternative (Table B-19).

1.4.2.7 70 Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the 70 Percent Inflow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the 70 Percent Inflow Alternative was scored 50 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative provided significant improvement to river system and habitat conditions necessary for restoring anadromous salmonids species in the mainstem Trinity River. These expected improvements would also provide significant benefits to habitat conditions for most non-native, especially cold-water, fish species in the Trinity Basin. Cooler water temperature in the spring and early summer may, however, negatively affect growth and development of American shad in the Trinity River Basin. These results indicated that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would significantly improve under the 70 Percent Inflow Alternative and would may result in increases in populations of non-native species, particularly brown trout, as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The 70 Percent Inflow Alternative would result in somewhat cooler water temperature conditions and increased Trinity River flows in many water years. In these years, increased annual flows and cooler water temperature conditions during spring and early summer could result in improved habitat conditions in the lower Klamath River and estuary for non-native species such as brown trout. However, species such as American shad and striped bass may not benefit from these cooler water temperatures. In many dry and critically dry water years, annual discharges would be less than those for the No Action Alternative. During these years, water temperature and habitat conditions in the Trinity River would be either similar or less beneficial to brown trout, but may be more beneficial to striped bass and American shad compared to conditions for the No Action Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for non-native species, including striped bass and American shad, in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species for the 70 Percent Inflow alternative. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the 70 Percent Inflow Alternative are approximately 8,000; 10,700; and 18,700cfs, respectively (Table B-21). For this alternative, the total average annual discharges in the upper and middle reaches of the Sacramento River decreased approximately 9 percent at Keswick and 6 percent at Grimes (Table B-24). The average monthly flows ranged from a decrease of 3 to 18 percent at Keswick and a decrease of 1 to 14 percent at Grimes (Table B-24). These average monthly flows included reductions of up to 7 percent (Keswick) and 6 percent (Grimes) for the months of May and June, important months for spawning and up to 8 percent in July, important months for larval and fry rearing for striped bass and American shad (Table B-24).

The total average annual discharge in the lower reach of the Sacramento River decreased by approximately 4 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). The average monthly flows at Verona decreased from 1 to

7 percent compared to the No Action Alternative. Considering the magnitude of the decreases of average monthly flows at those locations on the Sacramento River, there would likely be no significant reductions in habitat quantity and quality nor impacts to non-native species, including striped bass and American shad, in the Sacramento River.

The average annual inflow and outflow in the Delta for the 70 Percent Inflow Alternative is estimated to be approximately 28,600 and 19,400 cfs, respectively (Tables B-22 and B-23). These annual flows are approximately 3 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-26).

For the months important for recreationally important striped bass in the Delta (February through June), inflows range from 1 to 2 percent less than No Action (Table B-25). Similarly, Delta outflows range from 1 to 2 percent less than No Action (Table B-26). However, the maximum ratio of Delta inflows to exports, 35 percent for February through June and 65 percent for July through January, were not violated for any year simulated for the 70 Percent Inflow Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. The average monthly position of X2 moved 0.3 kilometers or less for the period of simulation (approximately 0.4 percent or less relative to the No Action Alternative) (Table B-28). During the months of February through June the average monthly X2 position ranged from 65.9 KM (April) to 71.6 KM (February) (Table B-27). During these months, X2 moved 0.3 kilometers or less for the years simulated (a change of 0.4 percent or less relative to that for No Action) (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and in Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the 70 Percent Inflow Alternative, a total of 54 months (15 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 12 months (3.3 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that there are both movements of X2 greater than 0.5 KM eastward (15 percent of the months) and westward (3.3 percent of the months), and on the balance these movements would likely reduce habitat quantity or quality sufficiently to adversely affect non-native resident species in the Delta.

On average, the monthly ratio of Delta inflows to exports, would not significantly change for the 70 Percent Inflow Alternative. However, X2 position in many months would significantly impact non-native species habitat in the Delta, (Table B-19), important for striped bass and American shad. There are no measures sufficient to mitigate, to less than significant, these impacts in the Central Valley

1.4.2.8 Mechanical Restoration Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Mechanical Restoration Alternative are shown in Table B-10 and summarized in Table B-11. As shown in these tables, the Mechanical Restoration Alternative was scored 13 out of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. A majority of the attribute objectives were determined to never or nearly never exceed threshold criteria for this alternative. This alternative was determined to provide only some small benefit in meeting river system attribute objectives compared to the No Action Alternative. Small and localized beneficial improvements in river system health and function would result in only small benefits to non-native fish populations as compared to No Action.

Lower Klamath River Basin/Coastal Area. The only changes in habitat conditions in the Trinity River Basin in the Mechanical Restoration Alternative are through mechanical means. Therefore, no benefits resulting from increased flows or cool water temperature would be expected in the lower Klamath River and estuary under the Mechanical Restoration Alternative. Habitat conditions for this alternative would remain the same as No Action for the lower Klamath River and estuary. It is likely that non-native fish populations in the lower Klamath River would remain unchanged under this project alternative.

Central Valley. This alternative would not affect habitats for non-native fish species in the Central Valley and therefore would result in no change from the No Action Alternative.

1.4.2.9 Revised Mechanical Restoration Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Revised Mechanic Restoration Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the Revised Mechanical Restoration Alternative was scored 37 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative provided improvement to river system and habitat conditions necessary for restoring anadromous salmonids species in the mainstem Trinity River. These expected improvements would also provide benefits to habitat conditions for non-native cold-water fish species such as brown trout in the Trinity Basin. Cooler water temperature in the spring and early summer may, however, negatively affect growth and development of American shad in the Trinity River Basin. These results indicated that, compared to the No Action Alternative, fishery habitat conditions in the mainstem Trinity River in the year 2020 would generally improve under the Revised Mechanical Restoration Alternative and would likely result in increases in populations of non-native cold-water species as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. Revised Mechanical Restoration Alternative would result in cooler water temperature conditions and increased Trinity River flows in some water years. In these years, increased annual flows and cooler water temperature conditions during spring and early summer could result in improved habitat conditions in the lower Klamath River and estuary for non-native species such as brown trout. However, species such as American shad may not benefit from these cooler water temperatures. In many dry and critically dry water years, annual discharges may be less than those for the No Action Alternative. During these years, water temperature and habitat conditions in the Trinity River would be either similar or less beneficial to brown trout, but may be more beneficial to American shad and striped bass compared to conditions for the No Action Alternative. In general, populations of non-native cold-water species in the lower Klamath River and estuary would benefit somewhat by this alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for non-native species, including striped bass and American shad, in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species for the Revised Mechanical Restoration Alternative. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Revised Mechanical Restoration Alternative are approximately 8,600, 11,200, and 19,200cfs, respectively (Table B-21). For this alternative, the total average annual discharges in these upper and middle reaches of the Sacramento River decreased approximately 1 percent at both Keswick and Grimes (Table B-24). The average monthly flows ranged from no change to a decrease of 3 percent at both Keswick and Grimes (Table B-24).

The total average annual discharge in the lower reach of the Sacramento River also decreased by approximately 1 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). The average monthly flows at Verona ranged from no change to a 3 percent decrease compared to the No Action Alternative. Considering the magnitude of the decreases of average monthly flows at Keswick and Grimes, there would not likely be significant reductions in habitat quantity and quality or impacts non-native species, including striped bass and American shad, in the Sacramento River.

The average annual inflow and outflow in the Delta for the Revised Mechanical Restoration Alternative is estimated to be approximately 29,100 and 19,800 cfs, respectively (Tables B-22 and B-23). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-26). For the months important for recreationally important striped bass in the Delta (February through June), Delta inflows range from 0 to 2 percent less than those for No Action (Table B-25). Similarly, Delta outflows range from 0 to 2 percent less than those for No Action (Table B-26). The maximum ratio of Delta inflows to exports, 35 percent for February through June and 65 percent for July through January, were not violated for any year simulated for the Revised Mechanical Restoration Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. During the months of February through June the average monthly X2 position ranged from 65.6 KM (April) to 71.3 KM (February) (Table B-27). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and as Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Revised Mechanical Restoration alternative, a total of 17 months (4.7 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 14 months (3.9 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that there are both movements of X2 greater than 0.5 KM eastward (4.7 percent of the months) and westward (3.3 percent of the months), and the balance these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect non-native resident species in the Delta.

On average, the monthly compliance target ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Revised Mechanical Alternative. The frequency and magnitude of these changes would not result in reductions in habitat conditions for striped bass and American shad (Table B-19).

1.4.2.10 Modified Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Modified Percent Inflow Alternative are shown in Table B-10 and are summarized in Table B-11. As shown in these tables, the Modified Percent Inflow Alternative was scored 51 of the total possible 70 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Compared to No Action, this alternative provided significant improvement to river system and habitat conditions necessary for restoring anadromous salmonids species in the mainstem Trinity River. Cooler water temperature in the spring and early summer may, however, may negatively affect growth and development of American shad in the Trinity River Basin. The expected improvements would provide significant benefits to habitat conditions for non-native cold-water fish species especially brown trout in the Trinity Basin. These results indicated that, compared to the No Action Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would significantly improve under the Modified Percent Inflow Alternative and would likely result in increases in populations of non-native species as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The Modified Percent Inflow Alternative would result in somewhat cooler water temperature conditions and increased Trinity River flows in many water years. In these years, increased annual flows and cooler water temperature conditions during spring and early summer could result in improved habitat conditions in the lower Klamath River and estuary for non-native cold-water species such as brown trout. However, species such as American shad may not benefit from these cooler water temperatures. In many dry and critically dry water years, annual discharges may be less than those for the No Action Alternative. During these years, water temperature and habitat conditions in the Trinity River would be either similar or less beneficial to brown trout, but may be more beneficial to American shad and striped bass compared to conditions for the No Action Alternative. In general, populations of non-native species in the lower Klamath River and estuary would likely benefit by this alternative.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for the No Action Alternative would significantly diminish habitat quality and quantity for non-native species, including striped bass and American shad, in the Central Valley. Increases in flows greater than 10 percent of those for the No Action Alternative were considered beneficial to these species for the Modified Percent Inflow Alternative. For the simulated period 1922-1993, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for this Alternative are approximately 8,500; 11,100; and 19,100 cfs, respectively (Table B-21). For this alternative, the total average annual discharges in the upper and middle reaches of the Sacramento River decreased approximately 2 percent at Keswick and Grimes (Table B-24). The average monthly flows ranged from an decrease of 1 to 5 percent at Keswick and no change to a decrease or 4 percent at Grimes (Table B-24).

The total average annual discharge in the lower reach of the Sacramento River decreased by approximately 1 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-24). The average monthly flows at Verona ranged from no change to a decrease of 3 percent compared to the No Action Alternative. Considering the magnitude of the decreases of average monthly flows at Keswick and Grimes, and Verona there likely would no significant reduction in habitat quantity and quality. There likely would no significant impacts non-native species, including striped bass and American shad, in the Sacramento River.

The average annual inflow and outflow in the Delta for the Modified Percent Inflow Alternative is estimated to be approximately 29,000 and 19,800 cfs, respectively (Tables B-22 and B-23). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-25 and B-26). For the months important for recreationally important striped bass in the Delta (February through June), Delta inflows range from 0 to 2 percent less than those for No Action (Table B-25). Similarly, Delta outflows range from 0 to 2 percent less than those for No Action (Table B-26). The maximum compliance target ratio of Delta inflows to exports, 35 percent for February through June and 65 percent for July through January, were not violated for any year simulated for the Modified Percent Inflow Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. During the months of February through June the average monthly X2 position ranged from 65.6 KM (April) to 71.3 KM (February) (Table B-27). On the average, for the months of February through June, X2 did not appreciably move (≤0.1 KM), relative to No Action, during the years simulated (Table B-28). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and in Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Modified Percent Inflow alternative, a total of 23 months (6.4 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the No Action alternative. Additionally, 19 months (5.3 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for the No Action alternative. The overall conclusion from this analysis is, that there are both movements of X2 greater than 0.5 KM eastward (6.4 percent of the months) and westward (5.3 percent of the months), and on the balance for the vast majority of months (≥93 percent) these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect non-native resident species in the Delta.

On an average annual basis, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Modified Percent Inflow Alternative. The frequency and magnitude of these changes would not result in reductions in habitat conditions for striped bass and American shad (Table B-19).

1.4.2.10 Existing Conditions versus Preferred (Flow Evaluation) Alternative

Trinity River Basin and Lower Klamath River Basin/Coastal Area. Trinity River impacts of the Preferred (Flow Evaluation) Alternative compared to existing conditions for resident non-native fish would be similar to the impacts of the Flow Evaluation Alternative compared to the No Action conditions in the year 2020. However, the watershed protection component of the Preferred Alternative would benefit non-native fish by reducing sediment inputs to the Trinity River.

Central Valley. It was assumed that decreases in monthly average stream flows greater than 10 percent of those for existing conditions would significantly diminish habitat quality and quantity for non-native species, including striped bass and American shad, in the Central Valley. Increases in flows greater than 10 percent of those for existing conditions were considered beneficial to these species. For existing conditions (for the simulated period 1922-1993), the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona are approximately 8,700; 11,300; and 19,300 cfs, respectively (Table B-21). For the Preferred Alternative, for the simulated period 1922-1993, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona are approximately 8,400; 11,000, and 19,000, respectively (Table B-21). The estimated changes in the average annual Sacramento River flows for Keswick, Grimes, and Verona for the Preferred Alternative as compared to existing conditions are shown in Table B-24. Changes in the estimated average annual Sacramento River flows at Keswick (upper reach of the river) and Grimes (middle reach of the river) for the Preferred Alternative each averaged approximately 4 percent less than Existing Conditions. Flows ranged from 1 to 10 percent less (Keswick) and no change to 8 percent less (Grimes) compared to existing conditions (Table B-24). These decreases in stream flows would not likely result in significant reduction in habitat for striped bass and American shad migration and spawning within the upper and middle reaches of the Sacramento River during their presence.

For the Preferred Alternative, the total average annual discharge (in cfs) for the lower reach of the Sacramento River at Verona decreased by an average of approximately 2 percent and ranged from an increase of 1 percent to a decrease of 4 percent compared to existing conditions (Table B-24). Considering the magnitude of these decreases in annual discharges, it is not likely that the quantity and quality of non-native species' (including striped bass and American shad) habitats would be significantly impacted in the lower Sacramento River reach.

For existing conditions, the total average annual inflow and outflows for the Delta are approximately 29,300 and 20,000 cfs, respectively (Tables B-22 and B-23). For the Preferred Alternative, the total average annual inflow and outflow for the Delta are approximately 28,900 and 19,700 cfs, respectively (Tables B-22 and B-23). The annual average change in Delta inflows and outflows for the Preferred Alternative are 2 percent and 3 percent, respectively, as compared to existing conditions.

For the months important for recreationally important striped bass in the Delta (February through June), Delta inflows ranged from 0 to 3 percent less than those for existing conditions (Table B-25). For these months, Delta outflows range are less than 3 less 10 percent than those for existing conditions (Table B-26). The maximum compliance target ratio of Delta inflows to exports, 35 percent for February through June and 65 percent for July through January, were not violated for any year simulated for the Flow Evaluation Alternative.

Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-27. During the months of February through June, X2 moved 0.1 kilometers or less for the years simulated (a change of 0.1 percent or less relative to that for existing conditions) (Table B-28). During the months of February through June the average monthly X2 position ranged from 65.6 KM (April) to 71.2 KM (February) (Table B-27). A summary of the evaluation of the frequency and the direction of changes of X2 position in the Delta are found in Table B-29 and in Attachment B10.

Of the 72 years (1922-1993) analyzed for the months from February through June for the Preferred alternative, a total of 26 months (7.2 percent) movement of the predicted X2 location was greater that 0.5 KM upstream (east) of the position predicted for the Existing Conditions. Additionally, 40 months (4.2 percent) movement of the predicted X2 position was greater than 0.5 KM downstream (west) of the predicted X2 position for Existing conditions. The overall conclusion from this analysis is, that there are both movements of X2 greater than 0.5 KM eastward (7.2 percent of the months) and westward (4.2 percent of the months), and on the balance for the vast majority of months (≥92 percent) these movements would not likely reduce habitat quantity or quality sufficiently to adversely affect non-native resident species in the Delta.

On an annual average basis the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Preferred Alternative as compared to existing conditions. These changes would not result in reduction in habitat quantity and quality for resident non-native species in the Delta (Table B-19).

1.5 RESERVOIRS

1.5.1 Affected Environment

1.5.1.1 Trinity River Basin (Trinity Lake and Lewiston Reservoirs)

Fish species found in the Lewiston Reservoirs and Trinity Lake are listed in Table B-2. Non-native reservoir species are identified in this table as “introduced” species. These reservoir fish include warmwater species: largemouth bass (*Micropterus salmoides*), small-mouth bass (*M. dolomieu*), green sunfish (*Lepomis cyanellus*), white catfish (*Ameiurus catus*), and black bullhead (*Ameiurus melus*). Coldwater reservoir fish include: kokanee salmon (*Oncorhynchus nerka*), rainbow trout (*O. mykiss*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalus*). Native species, including speckled dace, coast range sculpin, Klamath smallscale sucker, and river lamprey, inhabit both Trinity Lake and Lewiston Reservoir.

1.5.1.2 Reservoir Fish Populations and Habitat Conditions

Trinity Lake is located on the mainstem of the Trinity River, and is fed by Trinity and East Fork Trinity Rivers, Swift Creek, Stuart Fork, East Fork Stuart Fork, and ephemeral and intermittent streams (Larson & Associates, 1984). The fisheries in Trinity Lake include both coldwater and warmwater species. Trinity Lake supports a trophy smallmouth bass fishery and provides significant sport fishing for largemouth bass, as well as trout, kokanee, and other sportfish species. As is typical with most reservoirs, Trinity Lake is characterized by steep sides, with the upper one-fifth of the reservoir containing gentle slopes (Coleman, 1978). The maximum surface area of the reservoir is 16,500 acres, with an irregular shoreline of about 145 miles. Trinity Lake is considered relatively unproductive, with low standing crops of zooplankton. Thermal stratification occurs between May and November, while during the remainder of the year, the reservoir is relatively isothermal (i.e., water temperature is the same at all depths). The banks of Trinity Lake have high erosion potential and, under windy conditions, contribute to high turbidity in the littoral areas (Coleman, 1978).

Lewiston Reservoir is principally a trout fishery. Its total storage capacity is 14,600 af, covering about 610 acres, banded by 15 miles of shoreline. Because Lewiston Reservoir is fairly shallow, thermal stratification can develop quickly when the discharge from Trinity Lake is low. Diversions to Carr Powerplant are intermittent, which results in large, rapid swings in surface temperatures and reservoir elevations in Lewiston Reservoir.

1.5.1.3 Habitat and Life History Characteristics of Principal Species

Habitat conditions and food production for smallmouth bass in Trinity Lake appear to be nearly ideal. The cool water and the high percentage of gravel-rubble bottom found in Trinity Lake have resulted in record-sized smallmouth bass being taken (Frederiksen, Kamine, and Associates, 1980). This species requires clean sand, gravel, or debris-littered bottoms to spawn beginning in April at depths of 1-3 feet up to 23 feet. Optimal water temperatures for spawning are from 55-61°F. Optimal temperatures for growth and survival are approximately 68-81°F. Food organisms for young smallmouth bass include crustaceans, insects, and fish fry. Larger smallmouth feed extensively on fish, frogs, and crayfish.

Largemouth bass were also introduced into Trinity Lake, although not as successfully as smallmouth bass. Largemouth bass spawn, beginning in April and continuing though June, when water temperatures reach 61°F. Spawning occurs at depths of 3-6 feet on sand, gravel, or debris-littered bottom substrates. If nests are submerged under 15 feet or greater, egg mortality approaches 100 percent (Stuber et al., 1982). Largemouth bass fry feed primarily on rotifers and crustaceans. After reaching 2-3 inches in length they feed on aquatic insects and fish fry. Optimal growth and survival occurs at water temperatures of 68-86°F.

Kokanee salmon are the non-anadromous (land-locked) form of sockeye salmon and have become well established in both Trinity and Lewiston Reservoirs. This species has flourished in Trinity Lake (Frederiksen, Kamine, and Associates, 1980). This zooplankton feeding species makes its spawning migration into streams tributary to the reservoirs between early August and February. They prefer spawning in water temperatures of between 43 and 55°F.

Rainbow trout are the most abundant salmonid species found in Trinity Lake and Lewiston Reservoir. The cold, deep water of these reservoirs provides suitable rearing habitat for this species, although they do not spawn in the reservoirs. Like kokanee salmon, rainbow trout can spawn in streams tributary to Trinity and Lewiston Reservoirs. Rainbow trout usually spawn in the spring months, with specific timing dependent on reservoir elevations and water temperatures. Juvenile trout migrate out of the spawning streams to enter the reservoir to forage and mature. Benthic invertebrates and zooplankton are the preferred prey food of rainbow trout, but terrestrial insects are consumed if other food is scarce. Rainbow trout more than 12 inches in length are predatory and can consume small fish. Optimum temperatures for growth and for completion of most stages of their life histories are between 55 and 70°F. (Moyle, 1976).

Variable numbers of hatchery trout are stocked by CDFG into Trinity Lake and Lewiston Reservoir each year to support the sport fishery in these reservoirs. The timing and numbers of planted fish are dependent upon several factors including: water temperature, availability of hatchery fish, and reservoir surface acreage.

1.5.1.4 Factors Affecting Abundance

Fluctuating water level is frequently identified as the main adverse condition affecting reservoir fish production. Limited cover availability, associated with surface level fluctuation, has also been identified as a primary environmental problem limiting fish production in reservoirs. Rising reservoir elevations may submerge active largemouth bass nests during spring months. Severe drawdown of Trinity Lake may adversely affect both smallmouth and largemouth bass production in some years.

Temperatures within the reservoirs are dependent on season and reservoir storage conditions. Generally, temperatures are adequate in providing conditions required to sustain reservoir fisheries. However, the cool water temperature conditions in Trinity Lake may not have been optimal for largemouth bass (Frederiksen, Kamine, and Associates, 1980). Cold water in Trinity Lake, resulting in low zooplankton production and competition for food with Trinity Lake rainbow trout, may be responsible for the stunted size (6-8 inches) of kokanee salmon (Moyle, 1976; Coleman, 1978).

Except for periodic input of sediments from logging or road building activities in the watershed above the reservoirs, water quality in the reservoirs would not be expected to limit the fisheries within them.

The effects of fishing on reservoir fish communities are not well understood, although overfishing of naturally reproducing populations of reservoir game fish seldom seems to limit populations (Moyle, 1976).

Central Valley. The Central Valley contains numerous reservoirs containing both coldwater and warmwater sport fisheries. The principal reservoirs include: Shasta Lake and Keswick Reservoir, Whiskeytown Reservoir, Lake Oroville, Folsom Lake, and San Luis Reservoir. However, all major tributary streams to the Sacramento and San Joaquin Rivers in the Central Valley contain at least one or more reservoir. Each of these provide habitat for game and non-game fish species. The following discussion describes the fisheries in the principal Central Valley reservoirs most closely associated with and adjacent to the project area.

Shasta Lake. Waters from the McCloud, Pit, and Sacramento Rivers and tributaries are impounded by Shasta Dam. Discharges from Shasta Lake greatly influence temperatures in the upper Sacramento River below the dam. Shasta Lake is an outstanding fishery resource, with both coldwater and warmwater species. Coldwater sportfish include chinook and kokanee salmon and rainbow and brown trout. The warmwater gamefish species include largemouth and smallmouth bass, spotted bass, sunfish, black crappie, channel and white catfish, and bullhead.

Keswick Reservoir. Keswick Reservoir is a re-regulation reservoir immediately downstream of the Spring Creek Tunnel and Shasta Dam. The water quality within this reservoir, at times, can be greatly influenced by discharges of acid mine drainage and heavy metal inputs from the Spring Creek Debris Dam discharge and other mine waste discharges within the watershed. Gamefish found in Keswick Reservoir include chinook and kokanee salmon, rainbow and brown trout, largemouth and smallmouth bass, and sunfish species. Many of these species have been introduced, and most of the coldwater species are supplemented with periodic hatchery stocking by CDFG.

Whiskeytown Reservoir. Trinity River water is delivered to Whiskeytown Reservoir from Lewiston Reservoir via the Clear Creek Tunnel. Gamefish species found in Whiskeytown Reservoir include rainbow and brown trout, kokanee salmon, largemouth bass, crappie, sunfish, catfish, and bullhead.

Lake Oroville. Lake Oroville is a State Department of Water Resources (DWR) storage reservoir on the Feather River. Water is delivered out of the Reservoir to Thermolito forebay/afterbays and from there to downstream users. Drawdown averages approximately 75 feet per year. Both warmwater and coldwater sportfisheries (“two story fishery”) exist in Lake Oroville. Bass fishing is a popular sport and is recognized as a top bass angling fishery in the Western U.S. Species include spotted bass, largemouth, redeye, and smallmouth bass. In addition, black crappie, white crappie, and channel catfish up to 25 pounds are commonly caught in Lake Oroville. The principal coldwater species are planted brown trout and Chinook salmon. Brown trout up to 15 pounds and Chinook salmon up to 19+ pounds have been caught in Lake Oroville in recent years.

San Luis Reservoir. San Luis Reservoir principally serves to store and deliver water received from the Delta diversions for delivery to farmland in western Merced, Fresno, and Kings Counties. Due to water deliveries from this reservoir, drawdown averaging in excess of 60 feet occurs annually. In excess of 30 species of fish are known to or have occurred in San Luis Reservoir. These species were introduced principally by transport as larvae or fry from the Delta via the California Aqueduct. CDFG has periodically stocked catfish and bass into this reservoir, but the principal gamefish has been striped bass.

Folsom Lake. Folsom Lake is a Reclamation facility which impounds the American River near Sacramento California. Folsom contains a warmwater fishery consisting of largemouth and smallmouth bass, sunfish, and catfish. The coldwater fishery in Folsom is for rainbow trout stocked by CDFG on an annual basis.

1.5.2 Environmental Consequences

1.5.2.1 Methodology

Trinity River Basin.

Reservoir operations affect reservoir fish populations by changing reservoir water surface elevations and reservoir surface areas. For the 1999 DEIS/DEIR the Reservoir Habitat Assessment Model (RHAM) (Jones and Stokes Associates, 1999) spreadsheet method was used to assess the changes in reservoir habitat in Trinity Lake and Lewiston Reservoir. For the methodology and results of those analyses see B-17 of the Fishery Technical Appendix to the 1999 DEIS/DEIR. Reservoir fluctuations can strongly affect both the spawning and rearing life stages of bass species. Nests exposed to the air by receding reservoir levels become desiccated. Changing reservoir elevations can force fry and juvenile bass to move to less desirable habitats, increasing their vulnerability and loss to predators. Periods of reservoir bank substrate exposure affects habitat quality (plant community structure). Thus, reservoir water level fluctuations affects habitat quantity, and substrate exposure over some period of time affects habitat quality.

For this SEIS/SEIR the impacts of operations and the effects of fluctuating reservoirs on warmwater fish communities in Trinity Lake was qualitatively assessed by comparing the changes in surface area for each alternative to the No Action alternative. Mean reservoir surface area (in acres) for the months critical to principal warmwater reservoir species' spawning and rearing lifestages (March through July) for the historic simulation period of 1922-1993 were compared to evaluate operational changes affecting those species.

Trinity Reservoir

It was not possible to describe the effects of reservoir operations on coldwater fish communities except in a qualitative manner. Therefore, the evaluation on the effects of reservoir operations on coldwater species for Trinity Lake was determined based on knowledge of these species' habitat requirements. Lewiston Reservoir elevations and surface areas were not modeled for this SEIS/SEIR and therefore any effect of reservoir fluctuation on fisheries were unable to be assessed. However, Lewiston Reservoir is principally a coldwater fishery, and supplemented with hatchery planting. Therefore, operational effects of reservoir fluctuations on the warmwater fishery is likely irrelevant.

Central Valley. To qualitatively assess effects on reservoir species in the Central Valley, a comparison of changes in surface areas of Shasta Lake, Lake Oroville, and Folsom Lake and Whiskeytown, and San Luis Reservoirs comparing each alternative to the No Action Alternative was conducted. Mean reservoir surface area (in acres) for the months critical to principal warmwater reservoir species' spawning and rearing (March through July) for the historic simulation period of 1922-1993 were compared to evaluate operational changes affecting those species.

1.5.2.2 Significance Criteria

For this analysis, an impact on reservoir fisheries was considered significant when an alternative would:

- Potential for reductions in the number, or restrictions of the range, of an endangered or threatened reservoir fish or a reservoir fish that is a candidate for state listing or proposed for federal listing as endangered or threatened
- Potential for substantial reductions in the habitat of any reservoir fish other than those that are listed as endangered or threatened or are candidates (CESA) or proposed (ESA) for endangered or threatened status
- Potential for causing a reservoir fish population to drop below self-sustaining levels
- Substantial adverse effect, either directly or through habitat modifications, on any reservoir fish identified as a sensitive or special status species in local or regional plans, policies, or regulations
- Substantial interference with the movement of any reservoir fish
- A conflict with, or violation of, the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan relating to the protection of reservoir fish
- Mortality of state or federally listed reservoir fish, or species that are candidates for listing (CESA) or proposed for listing (ESA)
- Reductions in the size of a reservoir fish population sufficient to jeopardize its long-term persistence
- Temporary impacts to habitats such that reservoir fish suffer increased mortality or lowered reproductive success that jeopardizes the long-term persistence of those local populations
- Permanent loss of essential habitat of a listed species or special-status reservoir fish
- Reduction in the quantity or quality of habitats in which reservoir fish populations occur sufficient to reduce the long-term abundance and productivity of local populations

For the Trinity River Basin Reservoirs, significance thresholds are phrased in either qualitative or quantitative terms, indicating potential changes from the No Action Alternative. Changes in hydrology and reservoir operations result in variability in reservoir surface area as a surrogate for habitat area.

For all Trinity Basin and Central Valley Reservoirs, decreases in reservoir surface areas greater than 10 percent of those for No Action during key warmwater reservoir fish’s spawning and rearing months (March through July) were considered sufficient to significantly reduce spawning and rearing habitats. For those warmwater reservoir species, changes greater than 10 percent would constitute a significant adverse impact. Increases in reservoir surface areas greater than 10 percent of those for No Action during those key months were considered sufficient to significantly increase spawning and rearing habitats for reservoir species. For those reservoir species, this would be considered a significant benefit.

1.5.2.3 Results

Summary. The results of the comparisons of the No Action Alternative to each project alternative are summarized in Table B-19. The average monthly surface area for Trinity Lake are summarized as shown in Table B-30. For coldwater reservoir species, none of the project alternatives would significantly affect those species in Trinity Lake. The Maximum Flow and the 70 percent Inflow Alternatives would likely result in significant reductions in Trinity Lake surface area and spawning and rearing habitats for warmwater species during March through July. These reductions would result in reductions in habitat for warmwater species and possibly adversely effect the warmwater fishery in Trinity Lake (Table B-37). A summary of the changes in reservoir surface acres and percent change for all alternatives and all reservoirs are shown in Tables B-37 through B-43 and summarized for the months of March through July in Table B-44.

None of the project alternatives would adversely affect, to a significant extent, any reservoir fishery in the Central Valley compared to No Action.

Comparing the Preferred Alternative to existing conditions resulted in no significant differences and no impacts to reservoir fisheries in the Trinity/Klamath River Basins or the Central Valley. There was, however, a significant decrease in San Luis Reservoir storage for SWP operations for the Preferred Alternative when compared to Existing Conditions (Table B-43). This may result in adverse conditions in that reservoir for warmwater fisheries.

To reduce the impact on warmwater fish species to a less-than-significant level, Reclamation should implement a smallmouth and largemouth bass stocking program. This program would be similar to the existing stocking program for coldwater species in many of the reservoirs in the Central Valley.

1.5.2.4 No Action Alternative

Trinity Lake/Trinity River Basin.

Warmwater Species. On the average, surface acreage in Trinity Lake average approximately 12,000 acre annually (Table B-30) for the No Action Alternative. The months with the greatest storage (March through July) and the greatest surface acreage are the same months which are important for spawning and rearing of warmwater species in Trinity Lake.

Lewiston Reservoir. Coldwater fish habitat conditions under the No Action Alternative fluctuates because Lewiston Reservoir would continue to be operated as a re-regulating reservoir, and the CDFG's fish planting program is assumed to continue.

Central Valley. Simulated Central Valley reservoir surface areas in acres by month and their annual averages for the period 1922-1993 are shown in Tables B-30 through B-36. Similar to case for Trinity Lake, maximum storage and reservoir surface acreage occurs during months which are important to spawning and rearing lifestages of warmwater fishes in the Central Valley reservoirs.

1.5.2.5 Maximum Flow Alternative

Trinity Lake.

Warmwater Species. Under the Maximum Flow Alternative, Trinity Lake would be drawn down more frequently and to lower levels resulting in lower surface areas than under the No Action Alternative (Table B-30). Lake surface area, on an annual basis would diminish to approximately 7,900 acres (Table B-30). This is an average annual reduction of approximately 34 percent (Table B-37). The reduction of surface area ranged from 33 to 41 percent during the months of March through July as compared to No Action (Table B-37). The resulting reservoir fluctuations and reduced surface area would generally result in a decrease in habitat availability and an adverse effect to warmwater species.

Conditions for largemouth and smallmouth bass spawning and rearing under the Maximum Flow Alternative would be adversely affected during March through July with a reduction of nearly 5,500 surface acres of the Lake during those months on the average.

The change in operations under this alternative would result in significant adverse impacts (Table B-19) on both largemouth and smallmouth bass populations because these species support an important sport fishery in Trinity Lake and have economic and social value to the region.

To reduce the impact on warmwater fish species to a less-than-significant level, Reclamation should implement a smallmouth and largemouth bass stocking program. This program would be similar to the existing stocking program for coldwater species.

Coldwater Species. Under the Maximum Flow Alternative, Trinity Lake elevations would frequently be lower than those of the No Action Alternative, reducing the amount of habitat available to coldwater fish (Table B-30). Although coldwater fish species may be adversely affected, this impact would likely be less than significant because trout populations are currently supplemented by hatchery production and stocking. Any necessary adjustments to the stocking frequency and intensity would need to be determined on the basis of creel census surveys conducted by the CDFG. No additional mitigation would be necessary.

Lewiston Reservoir. Coldwater fish habitat conditions at Lewiston Reservoir under the Maximum Flow Alternative are expected to be the same as those under the No Action Alternative. Because Lewiston Reservoir would continue to be operated as a re-regulating reservoir and the coldwater fish stocking program is assumed to continue, no impacts on coldwater fisheries are expected under the Maximum Flow Alternative.

Central Valley. The average monthly reservoir surface areas in acres for the Maximum Flow Alternative for Whiskeytown, Shasta, Oroville, Folsom, and San Luis Reservoirs are shown in Tables B-31 through B-36. The percent differences in monthly surface area for these reservoirs are shown in Tables B-38 through B-43. Summaries of the expected changes in reservoir surface area for March through July, as compared to No Action are shown in Table B-44.

There would be no significant changes in the average monthly surface area of Whiskeytown Reservoir for the Maximum Flow Alternative during March through July compared the No Action Alternative (Table B-38). The change in monthly surface area of Shasta Lake would range from a decrease of approximately 1,260 to 1,840 acres during March through July (Table B-39) compared to the No Action Alternative, a decrease of 5 to 8 percent (Table B-39). The average monthly surface area for Lake Oroville ranged from a decrease of approximately 10 to 50 acres during March through July (Table B-40) compared to No Action, an increase of less than 1 percent (Table B-40). The change in monthly surface area of Folsom Lake would range, on average, from a decrease of approximately 30 to 130 acres during March through July (Table B-41) compared to the No Action Alternative, a decrease of less than 1 percent (Table B-41).

Finally, the changes in average monthly storage in San Luis Reservoir (for CVP operations) would range, on average, from an increase of approximately 5 to 50 TAF during March through July (Table B-42), an increase of approximately 1 to 16 percent (Table B-42) compared to the No Action Alternative. The average monthly storage in San Luis Reservoir (for SWP operations) area would decrease approximately 15 acres during March through July (Table B-43) a decrease of approximately 2 to 4 percent (Table B-44) compared to the No Action Alternative. The small changes in reservoir surface areas or storage would not result in significant reductions in reservoir habitats or impacts to warmwater reservoir fish populations in the Central Valley. The small but significant increase of up to approximately 15 percent in San Luis Reservoir (SWP operation) surface area during June and July may provide beneficial rearing conditions for young warmwater fishes in this reservoir.

1.5.2.6 Flow Evaluation Alternative

Trinity Lake/Trinity River Basin.

Warmwater Species. Under the Flow Evaluation Alternative, Trinity Lake would be drawn down similarly to conditions under the No Action Alternative (Table B-30). Lake surface area, on an annual basis would only diminish to approximately 11,700 acres. This is an average annual reduction of approximately 3 percent with reductions of surface acres ranging from 1 to 6 percent during the months of March through July as compared to No Action (Table B-37). The resulting reservoir fluctuations and reduced surface area would not result in a significant decrease in habitat availability for warmwater species.

Habitat conditions for largemouth and smallmouth bass spawning and rearing under the Flow Evaluation Alternative would be not be adversely affected during March through July. A reduction of approximately 90 to 700 surface acres of Trinity Lake would occur during those months on the average (Table B-37).

Impacts on warmwater species are considered less than significant because habitats for largemouth and smallmouth bass would diminish less than 10 percent on average (Table B-37).

Coldwater Species. Under this alternative, Trinity Lake elevations and surface areas would be similar to those under the No Action Alternative (Table B-30). On an annual basis, the amount of habitat area available for fish year round would be similar to that for the No Action Alternative. Therefore, coldwater fish in Trinity Lake are un-likely to be adversely affected by this alternative.

Lewiston Reservoir. Coldwater fish habitat conditions at Lewiston Reservoir under the Flow Evaluation Alternative are expected to be nearly the same as those under the No Action Alternative. Because Lewiston Reservoir would continue to be operated as a re-regulating reservoir and the coldwater fish stocking program is assumed to continue, no impacts on coldwater fisheries are expected under the Flow Evaluation Alternative.

Central Valley. For the Flow Evaluation Alternative, the average monthly reservoir surface areas in acres for Shasta, Oroville, and Folsom Lakes and Whiskeytown and San Luis Reservoirs are shown in Tables B-30 through B-36. The differences in monthly and average surface area, from No Action, for these reservoirs are shown in Tables B-38 through B-43. The summaries of the expected changes in reservoir conditions, as compared to No Action from March through July, are shown in Table B-44.

There would be no significant changes in the average monthly surface area of Whiskeytown Reservoir for the Flow Evaluation Alternative during March through July compared the No Action Alternative (Table B-38). The small changes in monthly surface area of Lake Shasta during March through July would range from a decrease of approximately 250 to 400 acres during March through July (Table B-39) compared to the No Action Alternative, a decrease of less than 2 percent. Monthly Lake Oroville surface areas ranged from a decrease of approximately 20 to 60 acres during March through July (Table B-40) compared to No Action, an decrease of less than 1 percent. Monthly Folsom Lake surface area ranged from a decrease of approximately 25 to an increase of approximately 20 acres during March through July (Table B-41) compared to No Action, a change of less than ±1 percent.

The average changes in San Luis Reservoir (CVP operations) average monthly surface area would range from a decrease of approximately of 6 acres to increase of 2 acres during March through July (Table B-42) a change of approximately less than ±1 percent (Table B-42) compared to the No Action Alternative. The change in average monthly surface area in San Luis Reservoir (SWP operations) would range ±8 acres or less from March through July (Table B-43). This is a decrease of less than approximately ±2 percent compared to the No Action Alternative (Table B-43). The small changes in surface areas within all of these reservoirs would not result in significant reductions in reservoir habitats quantity or impacts to warmwater reservoir fish populations in the Central Valley.

1.5.2.7 70 Percent Inflow Alternative

Trinity Lake/Trinity River Basin.

Warmwater Species. Under the 70 Percent Inflow Alternative, Trinity Lake would be drawn down somewhat more than conditions under the No Action Alternative (Table B-30). The annual average Trinity Lake surface area would diminish by approximately 1,000 acres to a surface area of approximately 11,000 acres. This is an average annual reduction of approximately 8 percent with reductions of surface area ranging from 9 to 13 percent during the months of March through July as compared to No Action (Table B-37). The resulting reservoir fluctuations and reduced surface area may result in a decrease in habitat availability for warmwater species and an adverse impact to that fishery. Habitat area for largemouth and smallmouth bass spawning and rearing under the 70 Percent Inflow Alternative would decrease during March through July by approximately 1,100 to 1,800 surface acres (Table B-37).

Coldwater Species. Under the 70 Percent of Inflow Alternative, Trinity Lake elevations would frequently be lower and surface area less than those of the No Action Alternative, reducing the amount of habitat available to coldwater fish (Table B-30). Although coldwater fish species may be adversely affected, this impact would likely be less than significant because trout populations are currently supplemented by hatchery production. Any necessary adjustments to the stocking frequency and intensity would need to be determined on the basis of creel census surveys conducted by the CDFG. No additional mitigation would be necessary.

Lewiston Reservoir. Coldwater fish habitat conditions at Lewiston Reservoir under the 70 Percent Inflow Alternative are expected to be the same as those under the No Action Alternative. Because Lewiston Reservoir would continue to be operated as a re-regulating reservoir with a coldwater fish stocking program assumed to continue, no impacts on coldwater fisheries are expected under the this alternative.

Central Valley. The average monthly reservoir surface areas in acres for the 70 Percent Inflow Alternative for Whiskeytown, Shasta, Oroville, Folsom, and San Luis Reservoirs are shown in Tables B-30 through B-36. The differences in mean monthly surface area from No Action for these reservoirs are shown in Tables B-38 through B-43. The summary of the expected changes in reservoir conditions, as compared to No Action from March through July, are shown in Table B-44.

There would be no significant changes in the average monthly surface area of Whiskeytown Reservoir for the 70 Percent Inflow Alternative during March through July compared the No Action Alternative (Table B-38). The change in monthly surface area of Shasta Lake would range from a decrease of approximately 800 to 1,300 acres during March through July (Table B-39) compared to the No Action Alternative, a decrease of 3 to 6 percent (Table B-39). The monthly surface area for Oroville Reservoir ranged from a decrease of approximately 25 to 70 acres during March through July (Table B-40) compared to No Action, a decrease of less than 1 percent (Table B-40). The change in monthly surface area of Folsom Lake would decrease approximately 5 to 80 acres during March through July compared to the No Action Alternative, a decrease of less than 1 percent (Table B-41).

Finally, the changes in average monthly surface area in San Luis Reservoir (for CVP operations) would range, on average, approximately ± 10 to 20 acres during March through July (Table B-42), a change of less than approximately ±1 to 4 percent (Table B-42) compared to the No Action Alternative. The average monthly surface area in San Luis Reservoir (for SWP operations) area would decrease, on average, approximately 15 to 25 acres during March through July (Table B-43) a decrease of approximately 2 to 6 percent (Table B-43) compared to the No Action Alternative.

The small changes in reservoir surface areas would not result in significant reductions in reservoir habitats or impacts to warmwater reservoir fish populations in the Central Valley.

1.5.2.8 Mechanical Restoration Alternative

Reservoir storage and flows under the Mechanical Restoration Alternative would be identical to those under the No Action Alternative. Therefore, habitat conditions for warmwater and coldwater fish species at Trinity Lake and coldwater fish species at Lewiston Reservoir would be the same as under the No Action Alternative.

This alternative would not affect operations on the Central Valley reservoirs and therefore would not result in any affects on reservoir habitats or fish populations within these reservoirs.

1.5.2.9 Revised Mechanical Restoration Alternative

Trinity Lake/Trinity River Basin.

<u>Warmwater Species</u>. Under the Revised Mechanical Restoration Alternative, Trinity Lake would be drawn down slightly more than conditions under the No Action Alternative (Table B-30). The annual average Trinity Lake surface area would diminish by approximately 400 acres to approximately 11,600 acres. This is an average annual reduction of approximately 3 percent with reductions of surface acres ranging from 2 to 4 percent during the months of March through July as compared to No Action (Table B-37). The resulting reservoir fluctuations and reduced surface area would not result in a significant decrease in habitat availability for warmwater species. There would likely be no adverse impact to that fishery from this alternative.

Conditions for largemouth and smallmouth bass spawning and rearing under the Revised Mechanical Restoration Alternative would not be adversely affected during March through July with a reduction of only 250 to 500 surface acres of the Lake during those months on the average (Table B-37).

<u>Coldwater Species</u>. Because changes in surface area would be minimal under this alternative relative to the No Action Alternative, and because the existing coldwater fish stocking program would continue, no impacts on coldwater fish species are expected under this alternative.

Lewiston Reservoir. Coldwater fish habitat conditions at Lewiston Reservoir under the Revised Mechanical Restoration Alternative are expected to be the same as those under the No Action Alternative. Because Lewiston Reservoir would continue to be operated as a re-regulating reservoir and the coldwater fish hatchery stocking program is assumed to continue, no impacts on coldwater fisheries are expected under the Revised Mechanical Restoration Alternative.

Central Valley. The average monthly reservoir surface areas in acres for the Revised Mechanical Restoration Alternative for Shasta Lake, Lake Oroville, and Folsom Lake and Whiskeytown and San Luis Reservoirs are shown in Tables B-30 through B-36. The differences in mean monthly surface area from No Action for these reservoirs are shown in Tables B-38 through B-43. The summary of the expected changes in reservoir conditions, as compared to No Action from March through July, are shown in Table B-44.

There would be no significant changes in the average monthly surface area of Whiskeytown Reservoir for the Revised Mechanical Restoration Alternative during March through July compared the No Action Alternative (Table B-38). The change in monthly surface area of Lake Shasta would range from a decrease of approximately 85 to 160 acres during March through July (Table B-39) compared to the No Action Alternative, a decrease of less than

1 percent (Table B-39). The monthly surface area for Lake Oroville increased approximately 10 to 50 acres during March through July (Table B-40) compared to No Action, an increase of less than 1 percent (Table B-40). The change in monthly surface area of Folsom Lake would diminish, on average, less than approximately 30 acres during March through July (Table B-41) compared to the No Action Alternative, a decrease of less than 1 percent (Table B-41).

The average monthly storage in San Luis Reservoir (for CVP operations) would change, on average, less than 5 TAF during March through July (Table B-42), less than approximately 1 percent (Table B-3) compared to the No Action Alternative. The average monthly storage in San Luis Reservoir (for SWP operations) area would decrease, on average, less than approximately 15 TAF during March through July (Table B-43), less than 3 percent (Table B-43) compared to No Action.

For this alternative the small changes in reservoir surface areas and storage would not result in significant reductions in reservoir habitats or adverse impacts to warmwater reservoir fish populations in the Central Valley.

1.5.2.10 Modified Percent Inflow

Trinity Lake/Trinity River Basin.

Warmwater Species. Under the Modified Percent Inflow Alternative, Trinity Lake would be drawn down slightly more than conditions under the No Action Alternative (Table B-30). The annual average Trinity Lake surface area would diminish by approximately 350 acres compared to No Action. This is an average annual reduction of approximately 3 percent. Surface acre reductions ranged from 2 to 4 percent during the months of March through July as compared to No Action (Table B-37). The resulting reservoir fluctuations and reduced surface area would not result in a significant decreases in habitat availability for warmwater species. There would likely be no adverse impact to that fishery. Conditions for largemouth and smallmouth bass spawning and rearing under the Modified Percent Inflow Alternative would not be adversely affected during March through July with a reduction of approximately 180 to 550 surface acres during those months on the average (Table B-37).

Coldwater Species. Because changes in surface area would be minimal under this alternative relative to the No Action Alternative, and because the existing coldwater fish stocking program would continue, no impacts on coldwater fish species are expected under this alternative.

Lewiston Reservoir. Coldwater fish habitat conditions at Lewiston Reservoir under the Modified Percent Inflow Alternative are expected to be the same as those under the No Action Alternative. Because Lewiston Reservoir would continue to be operated as a re-regulating reservoir and the coldwater fish stocking program is assumed to continue, no impacts on coldwater fisheries are expected under the Modified Percent Inflow Alternative.

Central Valley. The average monthly reservoir surface areas in acres for the Modified Percent Inflow Alternative for Lake Shasta, Lake Oroville, and Folsom Lake, and Whiskeytown, and San Luis Reservoirs are shown in Tables B-30 through B-36. The differences in surface area from No Action for these reservoirs are shown in Tables B-38 through B-43. The summary of the expected changes in reservoir conditions, as compared to No Action from March through July, are shown in Table B-44.

There would be no significant changes in the average monthly surface area of Whiskeytown Reservoir for the Modified Percent Inflow Alternative during March through July compared the No Action Alternative (Table B-38). The change in monthly surface area of Shasta Lake would range from a decrease of approximately 160 to 250 acres during March through July (Table B-39) compared to the No Action Alternative, a decrease of less than approximately 1 percent (Table B-39). The monthly surface area for Lake Oroville ranged from a increase of approximately 15 to 55 acres during March through July (Table B-40) compared to No Action, a increase of less than 1 percent (Table B-40). The changes in monthly surface area of Folsom Lake would range from a decrease of 30 acres to an increase of 35 acres during March through July (Table B-41) compared to the No Action Alternative, changes of less than ±1 percent (Table B-41).

The changes in average monthly storage in San Luis Reservoir (for CVP operations) would change, on average, less than 10 TAF during March through July (Table B-42), less than approximately 2 percent (Table B-42). The average monthly storage in San Luis Reservoir (for SWP operations) would decrease, on average, approximately less than 10 TAF during March through July (Table B-43) a decrease of less than approximately 4 percent (Table B-43.

The small changes in reservoir surface areas would not result in significant reductions in reservoir habitats or impacts to warmwater reservoir fish populations in the Central Valley for this alternative.

1.5.2.11 Existing Conditions versus Preferred (Flow Evaluation) Alternative

Trinity Lake/Trinity River Basin. The difference between existing conditions and the Preferred Alternative would be nearly identical to the difference between the Flow Evaluation Alternative and No Action. The average surface area for Trinity Lake would be similar for Preferred Conditions compared to existing conditions (Table B-30).

Warmwater Species. Trinity Lake would rarely be lower under the Preferred Alternative than under existing conditions. Largemouth and smallmouth bass spawning and rearing conditions would not be significantly different between the Preferred Alternative and existing conditions during May through July.

Impacts on largemouth and smallmouth bass are considered less than significant because the percent difference in Trinity Lake surface area between the Preferred Alternative and Existing Conditions is less than approximately 5 percent (<700 acres) during March through July (Table B-37).

Coldwater Species. Under the Preferred Alternative, Trinity Lake elevations would typically be similar to those under existing conditions, resulting in similar amounts of habitat area available for fish year round. Coldwater fish are neither likely to be adversely nor beneficially affected by the Preferred Alternative compared to existing conditions.

Lewiston Reservoir. Coldwater fish habitat conditions in Lewiston Reservoir under the Preferred Alternative are expected to be the same as those under existing conditions. Because Lewiston Reservoir would continue to be operated as a re-regulating reservoir and the coldwater fish stocking program is assumed to continue, no impacts on coldwater fisheries are expected under the Preferred Alternative.

Central Valley. The average monthly reservoir surface areas in acres for the Preferred Alternative for Lake Shasta, Lake Oroville, and Folsom Lake, and Whiskeytown and San Luis Reservoirs are shown in Tables B-30 through B-36. Summaries of the expected changes in reservoir area, as compared to existing conditions on a monthly basis, are shown in Tables B-38 through B-43.

The surface area of Whiskeytown Reservoir for the Preferred Alternative during March through July would range from an increase of 3 to a decrease of 3 acres, on average, compared the No Action Alternative (Table B-38) a change of less than 0.1 percent (Table B-38). The ranges in average monthly surface area of Lake Shasta would decrease on the average approximately 200 to 350 acres during March through July compared to the No Action Alternative, a reduction of less than 2 percent (Table B-39). The average monthly decreases in Lake Oroville's surface area for the Preferred Alternative would range from approximately 210 to 230 acres during March through July compared to No Action (Table B-40), a decrease of less than 2 percent (Table B-40). The decreases in monthly Folsom Lake surface areas would range from approximately 10 to 190 acres during March through July compared to No Action (Table B-41), a decrease of less than approximately 2 percent (Table B-42). Finally, the changes in average monthly San Luis Reservoir storage (CVP operations) would range, on average, from an increase of approximately 12 to 35 TAF from March through July compared to the No Action Alternative (Table B-42). These changes represent a difference of up to 6 percent increase in the reservoir storage compared to No Action (Table B-42). The changes in average monthly San Luis Reservoir storage (SWP operations) would range, on average, from a decrease of approximately 20 to 100 TAF from March through July compared to the No Action Alternative (Table B-43). These changes represent a decrease of up to nearly 17 percent of the reservoir storage compared to No Action in May (Table B-43). The apparent net change in storage of San Luis Reservoir's from the combined operations of the CVP and the SWP would result in an approximate reduction of approximately 10 percent.

1.5.2.12 Fisheries Cumulative Effects

Impacts Relative to the Preferred Alternative. Except for fall, winter, and spring-run Chinook salmon, the cumulative effects of the implementation of the Trinity Preferred alternative and CVP OCAP alternative would result in relatively small (less than 1 percent) increases in losses of early lifestages of Sacramento River chinook salmon. Cumulative effects would result in fall and winter chinook salmon losses increasing an additional 1 percent over the Preferred Alternative alone due to increased water temperatures in the upper Sacramento River (Table B-17). Cumulative effects would result in Spring-run Chinook salmon losses increasing an additional 3 percent over the Preferred Alternative alone due to increased water temperatures in the upper Sacramento River (Table B-17). These additional losses would be significant.

The cumulative effects of the implementation of the Trinity Preferred alternative and the CVP OCAP alternative on Delta species would also be generally minor compared to the Trinity Preferred alternative alone. The average absolute change in the position of X2 (in KM) in the Delta during February through June would be less than 0.3 KM, a relative change of less than 0.4 percent (Table B-28). These changes are likely not sufficient in magnitude to result in adverse effects to Delta smelt and other native or important gamefish in the Delta. The changes in the position of X2 would not generally be sufficiently large enough to transport larvae and juvenile smelt and other species into areas where they would be subject to increased entrainment at the Delta Pumps. These changes in X2 position may however, potentially affect Delta species by more frequently relocating them into less productive areas or areas of lower habitat value within the Delta (Table B-29). The position of X2 in the Delta would move eastward greater than 26 percent of the months from February through June compared to the Trinity Preferred Alternative (Table B-29). These changes may result in adverse effects to these species.

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Tables

Table B-1
Fish Species Found in the Trinity River Basin

Name		Aquatic Environment				
Common	**Scientific**	**Introduced**	**Trinity River and Major Tributaries**	**Lewiston Reservoir**	**Trinity Reservoir**	**Status**
Anadromous						
Pacific lamprey	*Lampetra tridentata*		X	X	X	--/--
American shad	*Alosa sapidissima*	X	X			--/--
Chinook salmon (spring and fall runs)	*Oncorhynchus tshawytscha*		X			--/--
Coho salmon[a]	*Oncorhynchus kisutch*	X[b]	X			FT[c] /--
Steelhead[d] (sum-mer and winter runs)	*Oncorhynchus mykiss irideus*	X[e]	X			--/--
Brown trout[f]	*Salmo trutta*	X	X			--/--
White sturgeon	*Acipenser transmontanus*		X			--/--
Green sturgeon	*Acipenser medirostris*		X			--/--
Eulachon	*Thaleichthys pacificus*		X			--/--
Resident						
Rainbow trout	*Oncorhynchus mykiss*		X[g]	X	X	--/--
Brown trout	*Salmo trutta*	X	X	X	X	--/--
Brook trout	*Salvelinus fontinalis*	X	X	X		--/--
Kokanee	*Oncorhynchus nerka*	X		X	X	--/--
Speckled dace	*Rhinichthys osculus*		X	X	X	--/--
Klamath smallscale sucker	*Catostomus rimiculus*		X	X	X	--/--
Coast range sculpin	*Cottus aleuticus*		X	X	X	--/--
Smallmouth bass	*Micropterus dolomieu*	X	X		X	--/--
Largemouth bass	*Micropterus salmoides*	X			X	--/--
Green sunfish	*Lepomis cyanellus*	X			X	--/--
Brown bullhead	*Ameiurus nebulosus*	X			X	--/--

[a] Southern Oregon/Northern California Evolutionary Significant Unit (ESU) coho salmon was listed as Threatened by NOAA Fisheries in 1997.
[b] TRSSH coho stocks include introductions from stocks from Oregon, as well as other California watersheds.
[c] Federal threatened.
[d] Klamath Mountains Province Evolutionary Significant Unit (ESU) steelhead was proposed for as Threatened but was found to not warrant listing (U.S. National Marine Fisheries Service, 2001).
[e] TRSSH steelhead stocks include introductions from stocks from Washington and Oregon, as well as other California watersheds.
[f] Historically were suspected to be anadromous; current status is uncertain (Fry, 1973 as cited by Moyle, 1976).
[g] Stocked into Lewiston and Trinity Reservoirs by CDFG and since transported downstream into Trinity River.

Table B-2
Life History and Habitat Characteristics of Anadromous Salmonid Fish in the Trinity River Basin

Name	Migration	Spawning	Rearing	Rearing Habitat Description
Chinook (spring)	Spring-Summer	Early Fall	Winter-Spring-Summer	Shallow, slow-moving waters adjacent to higher water velocities for feeding.
Chinook (fall)	Fall	Fall	Spring-Summer-Fall	Shallow, slow-moving waters adjacent to higher water velocities for feeding.
Steelhead (winter)	Fall-winter	February-April	Year round	Areas of clean cobble where there is refuge from high velocities; juveniles overwinter for 1-2 or more years.
Steelhead (summer)	Spring-Summer	February-April	Year round	Areas of clean cobble where there is refuge from high velocities; juveniles overwinter for 1-2 or more years.

Table B-3
Inriver and Hatchery Restoration Goals for the Trinity River

Species	Inriver Goals	Hatchery Goals	Total
Fall chinook salmon	62,000	9,000	71,000
Spring chinook salmon	6,000	3,000	9,000
Coho salmon	1,400	2,100	3,500
Steelhead	40,000	10,000	50,000

Table B-4
Estimated Fall Chinook Salmon Inriver Spawner Escapement for the Trinity River

	Pre-dam (<1964)		Post-dam (1982-2002)	
Area	**Mean**	**Range**	**Mean**	**Range**
Above Lewiston	23,250	9,000-37,800	N/A[a]	N/A
Below Lewiston[b]	22,350	10,000-37,800	31,850[c]	5,250-113,000[c]
Total	45,600[d]	19,000-75,600	31,850	5,250 113,000
Total of naturally produced fish (total minus hatchery-produced fish spawning inriver)[c]	N/A	N/A	12,050	2,350-41,400

[a] N/A= Not applicable
[b] North Fork to Lewiston
[c] Upstream of Willow Creek to Lewiston, exclusive of fish returning to hatchery
[d] Upstream of the North Fork confluence for years 1944, 1945, 1955, 1956, and 1963

Table B-5
Post-dam Chinook and Coho Salmon and Winter Steelhead Run-size, Spawning Escapement, and Angler Harvest Estimates for the Mainstem Trinity River[a]

Species	Run-size Estimate	Total Basin Escapement	Inriver Spawner Escapement	TRSSH Hatchery Escapement	Inriver Angler Harvest	Naturally Produced Inriver Spawner Escapement	Hatchery-produced Inriver Spawner Escapement
Years	1977-2002					1982-2002	
Fall Chinook	43,016	39,664	30,214	9,450	3,352	12,047	30,377
Years	1978-1982, 1984-1994, 1996-2002			1977-2002		1982,1984-1994, 1996-2002	
Spring Chinook	17,770	15,854	10,971	4,757	1,916	3,217	14,135
Years	1977-2002					1991-1995, 1997-2002	
Coho	16,567	16,095	10,330	5,765	473	582	11,332
Years	1980, 1982-1984, 1988-2002			1977-2002	1980, 1982-1984, 1989-2002	1980, 1982, 1992-1995, 2002	
Winter Steelhead	10,395	9,378	7,880	1,464	1,073	4,711	2,549
Years	1992-2002					1992-1995, 2002	
Winter Steelhead	7,150	6,780	5,139	1,641	370	2,326	2,354

[a] (personal communication, W. Sinnen, DFG, 2003)

Table B-6

Trinity River Salmon and Steelhead Hatchery Operational Rearing and Stocking Goals and Constraints Criteria for Salmonid Species

Species	Egg Allotment	Release Type	Number	Minimum Release Size	Target Release Dates[a]
Spring Chinook		Smolt	1,000,000	90 to a lb.	June 1 to 15
	3,000,000	Yearling	400,000		October 1 to 15
Fall Chinook		Smolt	2,000,000	90 to a lb.	June 1 to 15
	6,000,000	Yearling	900,000		October 1 to 15
Coho	1,200,000	Yearling	500,000	10-20 to a lb.	March 15 to May 1
Steelhead	2,000,000	Yearling	800,000	6 inches[b]	March 15 to May 1

[a] If unusual circumstances dictate, releases may deviate from the target release dates on approval from the Regional Manager.

[b] Steelhead less than 6 inches fork length shall be held at the hatchery for an additional year and released as 2-year-old fish between March 15 and May 1 of the following year.

Source: From Final Goals and Constraints for Iron Gate and Trinity River hatcheries, January 7, 1997.

Table B-7
Trinity River Salmon and Steelhead Hatchery (TRSSH) Salmonid Introductions into the Trinity River since 1963

	Species and Source:			
Year Planted	**Chinook (Fall)**	**Coho**	**Steelhead (Winter)**	**Steelhead (Summer)**
1963	none	none	American River Hatchery	none
1965	none	Eel River, CA	none	none
1970	none	Cascade, OR	Cowlitz River, WA	none
		Noyo River,CA		
		Alsea River, OR		
1971	Iron Gate Hatchery	Alsea River, OR	Roaring River, OR	Eel River
			Iron Gate Hatchery	Washougal River, WA
1972	none	none	none	Eel River
				Washougal River, WA
1973	none	none	none	Eel River
1974	none	none	none	Eel River
				Washougal River, WA
1975	none	none	Iron Gate Hatchery	none
1976	none	none	Iron Gate Hatchery	Washougal River, WA
1977	Iron Gate Hatchery	none	Iron Gate Hatchery	none
1978	none	none	Iron Gate Hatchery	none
1979	none	none	Iron Gate Hatchery	none
1980	none	none	Iron Gate Hatchery	none
1981	none	none	Iron Gate Hatchery	none
1982	none	none	Iron Gate Hatchery	none
1983	Iron Gate Hatchery	none	Iron Gate Hatchery	none
1984	none	none	Iron Gate Hatchery	none
1985	none	none	Iron Gate Hatchery	none
1986	none	none	Iron Gate Hatchery	none
1987	none	none	Iron Gate Hatchery	none

Source: CDFG Trinity River Hatchery Records, 1963-1994

Table B-8
Trinity River Ecosystem Attributes, Objectives, and Thresholds

Attribute Number	River System Attribute Description	Objective Number	River System Objectives Description	River System Objective Threshold
1	Spatially complex channel geomorphology	1	Restore alluvial channel (able to form its own bed, particle, and bank dimensions)	Dependent on an integration of all attributes
		2	Create and/or maintain structural complexity of alternate bar sequences	Dependent on an integration of all attributes
		3	Create and maintain functional floodplains	Dependent on an integration of all attributes
		4	Increase diversity of channelbed particle size	
		5	Greater topographic complexity in side channels	
2	Flows and water quality are predictably unpredictable	1	Provide inter- and intra-annual flow variation for summer baseflows (July 1-October 1)	Based on flow schedule's emulation of pre-dam hydrograph components
		2	Provide inter- and intra-annual flow variation for winter baseflows (January 1-April 1)	Based on flow schedule's emulation of pre-dam hydrograph components
		3	Provide inter- and intra-annual flow variation for winter flood (October 1-April 30)	Based on flow schedule's emulation of pre-dam hydrograph components
		4	Provide inter- and intra-annual flow variation for snowmelt peak floods (April1-June 30)	Based on flow schedule's emulation of pre-dam hydrograph components
		5	Provide inter- and intra-annual flow variation for snowmelt recession (May 1-July 31)	Based on flow schedule's emulation of pre-dam hydrograph components
3	Frequently mobilized channelbed surface	1	Exceed incipient motion for mobile active channel alluvial features (median bars, pool tails, spawning gravel deposits) every 2 of 3 years	Bed mobilization of the mobile active channel features occurs > 3,000 cfs
		2	Achieve incipient motion for most channelbed surfaces (riffles, face of point bars) every 2 of 3 years	Bed mobilization of most of the channelbed surface occurs > 6,000 cfs (Target Value)
		3	Exceed threshold for transporting sand through most pools every 2 of 3 years	Transport of substantial volumes of sand through pools requires flows > 3,000 cfs
4	Periodic channelbed scour and fill	1	Scour/redeposit spawning gravel deposits (at least 2 D_{84} thicknesses) every 2-3 years	Bed scour (> 2 D_{84} particle thickness) in mobile active channel features occurs at > 6,000 cfs
		2	Scour/redeposit faces of alternate bars (at least 2 D_{84} thicknesses) every 3-5 years	Bed scour (> 2 D_{84} particle thickness) on face of alternate bar surfaces occurs at > 8,500 cfs
		3	Deposit fine sediment onto upper alternate bar and floodplain surfaces every 2-3 years	Bed scour (> 2 D_{84} particle thickness) on face of alternate bar surfaces occurs at > 6,000 cfs
		4	Maintain scour channels on alternate bar surfaces every 3-5 years	Bed scour (> 2 D_{84} particle thickness) in mobile active channel features occurs at > 8,500 cfs
5	Balanced fine and coarse sediment budgets	1	Reduce fine sediment storage in mainstem	Ability of combined flow magnitude and duration to transport fine sediment through the system
		2	Maintain coarse sediment budget in the mainstem	Ability of combined flow magnitude and duration to achieve zero net coarse sediment budget
		3	Route mobilized D84 gravel through alternate bar sequences every 2 of 3 years	Exceeded by flows greater than 6,000 cfs
		4	Prevent excessive aggradation of tributary-derived material in the mainstem	Mechanically excavated and distributed downstream and/or maintained by flows; distribution of delta begins at flows > 6,000 cfs; coarser particles require flows > 14,000 cfs
6	Periodic channel migration	1	Channel migrates in alluvial reaches	Requires partial removal of riparian berm and flows greater than 6,000 cfs
		2	Maintain channel geometry as channel migrates	Requires adequate coarse sediment supply and flows greater than 6,000 cfs
		3	Create channel avulsions every 10 years	Flows must be greater than 30,000 cfs for channel avulsions
7	Functional floodplain	1	Inundate the floodplain on average every 2 to 3 years	Flows greater than 6,000 cfs
		2	Encourage local floodplain surface scour and deposition by infrequent (every 3-5 years) but larger floods	Flows greater than 8,500 cfs
		3	Floodplain construction keeps pace with floodplain loss on opposite bank	Requires fine sediment supply and flows greater than 6,000 cfs and depths > 1' on floodplain
8	Infrequent channel resetting floods	1	Major reorganization of alternate bar sequences every 10-20 years	Flows estimated to be greater than 30,000 cfs
		2	Remove upstream bedload impedance by distributing tributary delta materials	Flows estimated to be greater than 24,000 cfs
		3	Infrequent (once in 5-10 years) deep scour on floodplain surfaces	Flows greater than 24,000 cfs
		4	Construct and maintain/rejuvenate side channels	Flows estimated to be greater than 11,000 cfs or mechanically maintained side channels
		5	Deposit fine sediment on lower terrace surfaces	Flows greater than 11,000-14,000 cfs causing inundation of pre-dam floodplains (which now function as terraces)
9	Self-sustaining diverse riparian plant communities	1	Prevent seedling germination on lower bar surfaces	Bar inundation of seed dispersal period (1,500-2,000 cfs) in June and July
		2	Scour or remove most initiating seedlings (0- to 1-year old plants)	Surficial bed scour on lower bar surfaces requires flows greater than 6,000 cfs, or mechanical removal
		3	Scour of most established seedling (2- to 3-year old plants)	Deep bed scour on bar surfaces requires flows greater than 8,500-14,000 cfs
		4	Periodic removal of individual mature riparian trees at least every 10 years	Individual alder trees require at least 14,000 cfs; widespread removal of alders requires >30,000 cfs; or mechanical removal of mature riparian alders
		5	Seed deposition on floodplains every 2-3 years	Floodplain access begins at 5,000-6,000 cfs; flows needed May 5th to June 5th
10	Naturally fluctuating groundwater table	1	Groundwater recharge of gravel bars	Exceed by flows greater than 1,500-2,000 cfs
		2	Groundwater recharge of floodplains and off-channel wetland habitats	Exceeded by flows greater than 6,000 cfs
		3	Groundwater recharge of terraces and associated wetland habitats	Flows greater than 10,000-14,000 cfs

Table B-9

Water Temperature Requirements and Approximate Emigration Dates for Steelhead and Coho and Chinook Salmon Smolts

Species	Approximate Date of 80 Perent Emigration	Optimal (ºF)	Marginal (ºF)	Unsuitable (ºF)
Steelhead	May 22	42.8-55.4	55.4-59	>59
Coho salmon	June 4	50-59	59-62.9	>62.6
Chinook salmon	July 9	50-62.6	62.6-68	>68

Source: U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999

Table B-10
Scoring Results of the Trinity River System Attribute Analysis (TRSAAM) Evaluation

		Alternative							
Attribute Number	**Objective Number**	**No Action**	**Maximum Flow**	**Flow Evaluation**	**70% Inflow**	**Mechanical Restoration**	**Revised Mechanical Restoration**	**Mod. % inflow**	**Existing Conditions**
1	1	NS	NS	NS	NS	NS	NS	NS	NS
	2	NS	NS	NS	NS	NS	NS	NS	NS
	3	NS	NS	NS	NS	NS	NS	NS	NS
	4	NS	NS	NS	NS	NS	NS	NS	NS
	5	NS	NS	NS	NS	NS	NS	NS	NS
	subtotal score	NS	NS	NS	NS	NS	NS	NS	NS
2	1	0	0	0	2	0	0	0	0
	2	0	0	0	2	0	0	0	0
	3	0	0	0	1	0	0	0	0
	4	1	2	2	2	1	2	2	1
	5	1	2	2	2	1	2	2	1
	subtotal score	2	4	4	9	2	4	4	2
3	1	0	2	2	2	0	2	2	0
	2	0	2	2	2	0	2	2	0
	3	0	2	2	2	1	2	2	0
	subtotal score	0	6	6	6	1	6	6	0
4	1	0	2	2	2	0	2	2	0
	2	0	1	2	1	0	0	2	0
	3	0	2	2	2	0	1	2	0
	4	0	1	2	1	0	0	2	0
	subtotal score	0	6	8	6	0	3	8	0
5	1	0	2	2	2	1	2	2	0
	2	0	2	2	1	0	1	2	0
	3	0	2	2	2	0	2	2	0
	4	0	2	2	2	0	2	2	0
	subtotal score	0	8	8	7	1	7	8	0
6	1	0	1	1	1	0	1	1	0
	2	0	2	2	2	0	1	2	0
	3	0	2	0	0	0	0	0	0
	subtotal score	0	5	3	3	0	2	3	0
7	1	0	2	2	2	0	1	2	0
	2	0	1	2	1	0	0	2	0
	3	0	2	2	2	0	0	2	0
	subtotal score	0	5	6	5	0	1	6	0
8	1	0	2	0	0	0	0	0	0
	2	0	2	2	2	2	2	2	0
	3	0	2	0	0	0	0	0	0
	4	0	2	1	1	2	2	2	0
	5	0	2	0	1	0	0	0	0
	subtotal score	0	10	3	4	4	4	4	0
9	1	0	1	1	1	0	1	1	0
	2	0	2	2	2	1	1	2	0
	3	0	2	1	1	1	1	1	0
	4	0	2	0	0	1	1	1	0
	5	0	2	2	2	0	2	2	0
	subtotal score	0	9	6	6	3	6	7	0
10	1	2	2	2	2	2	2	2	2
	2	0	2	2	1	0	2	2	0
	3	0	1	1	1	0	0	1	0
	subtotal score	2	5	5	4	2	4	5	2
	Grand Total	**4**	**58**	**49**	**50**	**13**	**37**	**51**	**4**

NS = Not scored
2 = Always or nearly always exceeds thresholds
1 = Sometimes exceeds thresholds
0 = Never or rarely exceeds thresholds

Table B-11
Summary of Trinity River System Attribute Scoring from TRSAAM Evaluation

Attribute Number	Ecosystem Attribute Description	No Action	Maximum Flow	Flow Evaluation	70% Inflow	Mechanical Restoration	Revised Mechanical Restoration	Mod. % inflow	Existing Conditions
1	Spatially complex channel geomorphology	NS	NS	NS	NS	NS	NS	NS	NS
2	Flows and water quality are predictably unpredictable	2	4	4	9	2	4	4	2
3	Frequently mobilized channelbed surface	0	6	6	6	1	6	6	0
4	Periodic channelbed scour and fill	0	6	8	6	0	3	8	0
5	Balanced fine and coarse sediment budgets	0	8	8	7	1	7	8	0
6	Periodic channel migration	0	5	3	3	0	2	3	0
7	Functional floodplain	0	5	6	5	0	1	6	0
8	Infrequent channel resetting floods	0	10	3	4	4	4	4	0
9	Self-sustaining diverse riparian plant communities	0	9	6	6	3	6	7	0
10	Naturally fluctuating groundwater table	2	5	5	4	2	4	5	2
	Total Score	**4**	**58**	**49**	**50**	**13**	**37**	**51**	**4**

NS = Not scored

Table B-12
Summary of the Results of the Analysis of Trinity River System Attribute Performance for Each of the Proposed Project Alternatives

River System Attribute	River System Objective	Project Alternative: No Action	Project Alternative: Maximum Flow	Project Alternative: Flow Evaluation	Project Alternative: 70% Inflow	Project Alternative: Mechanical Restoration	Project Alternative: Revised Mechanical Restoration	Project Alternative: Mod. % inflow	Existing Conditions
Spatially complex channel geomorphology	Restore alluvial channel (self-forming bed particle and bank dimensions)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
	Create and/or maintain structural complexity of alternate bar sequences	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
	Create and maintain functional floodplains	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
	Increase diversity of channelbed particle size	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
	Greater topographic complexity in side channels	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Flows and water quality are predictably unpredictable	Provide inter- and intra-annual flow variation for summer baseflows (July 1-October 1)	**N**	**N**	**N**	**A**	**N**	**N**	**N**	**N**
	Provide inter- and intra-annual flow variation for winter baseflows (January 1-April 1)	**N**	**N**	**N**	**A**	**N**	**N**	**N**	**N**
	Provide inter- and intra-annual flow variation for winter flood (October 1-April 30)	**N**	**N**	**N**	**S**	**N**	**N**	**N**	**N**
	Provide inter- and intra-annual flow variation for snowmelt peak floods (April 1-June 30)	**S**	**A**	**A**	**A**	**S**	**A**	**A**	**S**
	Provide inter- and intra-annual flow variation for snowmelt recession (May 1-July 31)	**S**	**A**	**A**	**A**	**S**	**A**	**A**	**S**
Frequently mobilized channelbed surface	Exceed incipient motion for mobile, active channel alluvial features (median bars, pool tails, spawning gravel deposits) every 2 of 3 years	**N**	**A**	**A**	**A**	**N**	**A**	**A**	**N**
	Achieve incipient motion for most of channelbed surface (riffles, face of point bars) every 2 of 3 years	**N**	**A**	**A**	**A**	**N**	**A**	**A**	**N**
	Exceed threshold for transporting sand through most pools every 2 of 3 years	**N**	**A**	**A**	**A**	**S**	**A**	**A**	**N**
Periodic channelbed scour and fill	Scour/redeposit spawning gravel deposits (at least 2 D_{84} thicknesses) every 2-3 years	**N**	**A**	**A**	**A**	**N**	**A**	**A**	**N**
	Scour/redeposit faces of alternate bars (at least 2 D_{84} thicknesses) every 3-5 years	**N**	**S**	**A**	**S**	**N**	**N**	**A**	**N**
	Deposit fine sediment onto upper alternate bar and floodplain surfaces every 2-3 years	**N**	**A**	**A**	**A**	**N**	**S**	**A**	**N**
	Maintain scour channels on alternate bar surfaces every 3-5 years	**N**	**S**	**A**	**S**	**N**	**N**	**A**	**N**
Balanced fine and coarse sediment budgets	Reduce fine sediment storage in mainstem	**N**	**A**	**A**	**A**	**S**	**A**	**A**	**N**
	Maintain coarse sediment budget in the mainstem	**N**	**A**	**A**	**S**	**N**	**S**	**A**	**N**
	Route mobilized D_{84} gravel through alternate bar sequences every 2 of 3 years	**N**	**A**	**A**	**A**	**N**	**A**	**A**	**N**
	Prevent excessive aggradation of tributary-derived material in the mainstem	**N**	**A**	**A**	**A**	**N**	**A**	**A**	**N**
Periodic channel migration	Channel migrates in alluvial reaches	**N**	**S**	**S**	**S**	**N**	**S**	**S**	**N**
	Maintain channel geometry as channel migrates	**N**	**A**	**A**	**A**	**N**	**S**	**A**	**N**
	Create channel avulsions every 10 years	**N**	**A**	**N**	**N**	**N**	**N**	**N**	**N**
Functional floodplain	Inundate the floodplain on average every 2 or 3 years	**N**	**A**	**A**	**A**	**N**	**S**	**A**	**N**
	Encourage local floodplain surface scour and deposition by infrequent (every 3-5 years) but larger floods	**N**	**S**	**A**	**S**	**N**	**N**	**A**	**N**
	Floodplain construction keeps pace with floodplain loss on opposite bank	**N**	**A**	**A**	**A**	**N**	**N**	**A**	**N**
Infrequent channel resetting floods	Major reorganization of alternate bar sequences every 10-20 years	**N**	**A**	**N**	**N**	**N**	**N**	**N**	**N**
	Remove upstream bedload impedance by distributing tributary delta materials	**N**	**A**	**A**	**A**	**A**	**A**	**A**	**N**
	Infrequent (once every 5-10 years) deep scour on floodplain surfaces	**N**	**A**	**N**	**N**	**N**	**N**	**N**	**N**
	Construct and maintain/rejuvenate side channels	**N**	**A**	**S**	**S**	**A**	**A**	**A**	**N**
	Deposit fine sediment on lower terrace surfaces	**N**	**A**	**N**	**S**	**N**	**N**	**N**	**N**
Self-sustaining diverse riparian plant communities	Prevent seedling germination on lower bar surfaces	**N**	**S**	**S**	**S**	**N**	**S**	**S**	**N**
	Scour of most initiating seedlings (0- to 1-year old plants)	**N**	**A**	**A**	**A**	**S**	**S**	**A**	**N**
	Scour of most established seedling (2- to 3-year old plants)	**N**	**A**	**S**	**S**	**S**	**S**	**S**	**N**
	Periodic removal of individual mature riparian trees at least every 10 years	**N**	**A**	**N**	**N**	**S**	**S**	**S**	**N**
	Seed deposition on floodplains every 2-3 years	**N**	**A**	**A**	**A**	**N**	**A**	**A**	**N**
Naturally fluctuating groundwater table	Groundwater recharge of gravel bars	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**
	Groundwater recharge of floodplains and off-channel wetland habitats	**N**	**A**	**A**	**S**	**N**	**A**	**A**	**N**
	Groundwater recharge of terraces and associated wetland habitats	**N**	**S**	**S**	**S**	**N**	**N**	**S**	**N**

Table B-13
Summary of Salmonid Smolt Temperature Suitability/Survivability Analysis Results

Alternative:	**Average Index (%):**			
	Chinook (smolt suitability)	**Coho (smolt suitability)**	**Steelhead (smolt suitability)**	**Steelhead (parr survivability)**
No Action	41%	84%	60%	88%
Mechanaical Restoration	41%	84%	60%	88%
Maximum Flow	76%	99%	81%	96%
Flow Evaluation	60%	95%	80%	95%
70 % Inflow	54%	94%	74%	93%
Revised Mechanical Restoration	51%	91%	67%	91%
Modified % Inflow	49%	91%	58%	92%

Table B-14
Percentage Change from No Action Alternative for Instream Release Volumes, Steelhead Survival Index, Coho Survival Index, Chinook Survival Index, and Chinook Harvest for Each Alternative

Measure/Assumption	Revised Mechanical A	Revised Mechanical B	Flow Evaluation	Mod. Percent Inflow	70% Inflow	Maximum Flow
Instream Volumes	34%	34%	75%	47%	175%	260%
Assumption of Increase in Habitat Conditions	50%	100%	100%	100%	100%	100%
Steelhead Survival Index	12%	12%	33%	-3%	23%	35%
Coho Survival Index	8%	8%	13%	8%	12%	18%
Chinook Survival Index	23%	23%	47%	21%	33%	86%
Increase to Chinook Harvest Index	370%	634%	919%	606%	755%	1427%

Table B-15
Summary of Change in Trinity River Fluvial River System Health (TRAASM results) from No Action

Parameter	Alternative: No Action	Alternative: Maximum Flow	Alternative: Flow Evaluation	Alternative: 70% Inflow	Alternative: Mechanical Restoration	Alternative: Revised Mechanical Restoration	Alternative: Modified % Inflow	Pref. Alt. Compared to Exist.Conds.
Total Score	**4**	**58**	**49**	**50**	**13**	**37**	**51**	**49**
Possible Score	70	70	70	70	70	70	70	70
Percent of Maximum	6	83	70	71	19	53	73	70
Percent Change from No Action	0	1350	1125	1150	225	825	1175	1125
Qualitative Rating[a]	**--**	**HB**	**HB**	**HB**	**B**	**HB**	**HB**	**HB**

[a] Rating based on following scale:
nc = no change from No Action attribute score
B = beneficial change (>No Action score but less than 5 times the No Action score)
HB = highly beneficial change (equal to or greater than 5 times the No Action score)

Table B-16
Summary of Estimated Average Annual Losses of Early Life Stages of Chinook Salmon and Steelhead in the Upper Sacramento River (Version 1 revised)

	Simulated Average Loss (Percent)								
Species	**No Action**	**Maximum Flow**	**Flow Evaluation**	**70 % Inflow**	**Mechanical Restoration**	**Revised Mechanical Restoration**	**Modified % Inflow**	**Exist. Cond.**	**Cumulative (OCAP Future)**
Fall chinook	17.5	26.6	20.6	24.7	17.5	18.2	19.1	17.4	21.4
Late-fall chinook	1.4	1.8	1.6	1.8	1.4	1.4	1.5	1.4	1.6
Winter chinook	8.0	16.5	8.6	11.2	8.0	8.5	8.5	7.8	10.0
Spring chinook	23.9	55.0	31.8	47.2	23.9	25.3	27.5	24.1	34.4
Steelhead	1.4	1.8	1.6	1.8	1.4	1.4	1.5	1.4	1.6

Table B-17

Change in Temperature-related Losses (%)[a] to Early Life Stages of Salmonids in the Sacramento River

Species	Maximum Flow	Flow Evaluation	70 % Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Exist. Cond. vs. Pref. Flow	Cumul. Effects vs. Pref Flow
Fall chinook	9	3.0	7	0	1	2	3	1
Late-fall chinook	0	0.2	0	0	0	0	0	0
Winter chinook	8	0.6	3	0	0	0	1	1
Spring chinook	31	7.8	23	0	1	4	8	3
Steelhead	0	0.2	0	0	0	0	0	0

a Estimated average annual losses rounded to the nearest percentile for the 1922-1993 simulation period.

Table B-18
Summary of Percent Change from No Action for Each Project Alternative for Estimated Losses of Early Life Stages of Anadromous Salmonids in the Sacramento River

Species	Maximum Flow	Flow Evaluation	70 % Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Pref. Alt. Vs. Exist.Conds.[a]
Fall chinook							
Percent loss change[b]	9	3	7	0	1	2	3
Results[c]	A	A	A	NC	A	A	A
Late-fall chinook							
Percent loss change[b]	0	0	0	0	0	0	0
Results[c]	NC	NC	NC	NC	NC	NC	NC
Winter chinook							
Percent loss change[b]	8	1	3	0	0	0	1
Results[c]	A	A	A	NC	NC	NC	A
Spring chinook							
Percent loss change[b]	31	8	23	0	1	4	8
Results[c]	A	A	A	NC	A	A	A
Steelhead							
Percent loss change[b]	0	0	0	0	0	0	0
Results[c]	NC	NC	NC	NC	NC	NC	NC

[a] Compared to the preferred alternative.
[b] Average annual losses estimated for the entire 1922-1993 simulation period (negative value = lower losses than No Action).
[c] NC = no change; A = significantly adverse effect; B = beneficial effect.

Table B-19
Summary of Impact Analysis for Fisheries Resources (Comparing Each Alternative to the No Action Alternative)

Resource Concern	Geographical Area	Alternative: Maximum Flow	Flow Evaluation	70 % Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Preferred Alternative Compared to Existing Conditions
Native anadromous salmonids	Trinity River Basin	HB	HB	HB	B	HB	HB	HB
	Lower Klamath Basin	B	B	B	nc	B	B	B
	Central Valley	A	A	A	nc	nc	A	A
Other native anadromous species	Trinity River Basin	HB	HB	HB	B	HB	HB	HB
	Lower Klamath Basin	B	B	B	nc	B	B	B
	Central Valley	A	A	A	nc	A	A	A
Resident native species	Trinity River Basin	B	B	B	B	B	B	B
	Lower Klamath Basin	B	B	B	nc	B	B	B
	Central Valley	A	A	A	nc	A	A	A
Non-native species	Trinity River Basin	B	B	B	B	B	B	B
	Lower Klamath Basin	B	B	B	nc	B	B	B
	Central Valley	A	A	A	nc	A	A	A
Reservoir species-Trinity Basin	Warmwater Species	A	nc	A	nc	nc	nc	nc
	Coldwater Species	nc	nc	nc	nc	nc	nc	nc
Reservoir species-Central Valley	All Species	nc	nc	nc	nc	nc	nc	nc

A = adverse change
nc = no change
B = benefical change
HB = highly beneficial change

Table B-20
Life History and Habitat Characteristics of Non-salmonid Native Anadromous Fish in the Project Affected Area

Name	Migration	Spawning	Rearing	Rearing Habitat Descriptions
Pacific lamprey	April-July	Spring-early summer	Year round	Developing larvae burrow into silty river-bottom substrates, where they remain for 4-5 years before emigrating to the ocean.
Sturgeon (green and white sturgeon)	February- July	March –July	Year round	Juveniles inhabit estuarine environments for 4-6 years before migrating to the ocean.
Eulachon	March-April	March-April	--	Adhesive eggs anchored to bottom until hatched; larvae quickly transported to ocean.

Table B-21
Average Monthly Flows (cfs) in the Sacramento River at Keswick, Grimes, and Verona (1922-1993)

	Alternative																							
	No Action			Maximum Flow			Flow Evaluation			70% Inflow			Mechanical Restoration			Revised Mechanical Restoration			Modified % Inflow			Existing Conditions		
Location	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**
Month																								
October	5,928	6,643	10,416	4,767	5,453	9,208	5,552	6,262	10,068	5,099	5,822	9,712	5,928	6,643	10,416	5,758	6,468	10,234	5,737	6,449	10,210	6,038	6,723	10,482
November	5,444	8,169	12,524	4,272	7,029	11,236	5,035	7,792	12,046	4,455	7,232	11,498	5,444	8,169	12,524	5,386	8,116	12,420	5,252	7,984	12,268	5,604	8,212	12,525
December	7,138	13,627	21,560	5,795	12,668	20,212	6,751	13,344	21,158	5,822	12,751	20,272	7,138	13,627	21,560	7,050	13,541	21,476	6,903	13,462	21,372	7,124	13,546	21,507
January	7,892	16,387	29,293	7,481	16,130	28,835	7,778	16,336	29,151	7,538	16,190	29,013	7,892	16,387	29,293	7,851	16,361	29,195	7,822	16,357	29,212	7,872	16,342	29,352
February	10,133	19,890	35,114	9,354	19,414	34,539	9,940	19,757	34,989	9,589	19,560	34,653	10,133	19,890	35,114	10,090	19,845	35,079	10,026	19,807	35,032	10,139	19,846	35,101
March	8,105	16,691	30,693	7,657	16,279	30,251	8,009	16,599	30,576	7,599	16,218	30,122	8,105	16,691	30,693	8,053	16,643	30,653	8,084	16,668	30,651	8,135	16,662	30,469
April	7,213	12,282	21,063	6,807	11,981	20,611	7,153	12,265	21,097	6,970	12,076	20,825	7,213	12,282	21,063	7,134	12,228	21,022	7,118	12,211	20,999	7,309	12,282	20,895
May	8,809	8,959	16,365	7,988	8,296	15,712	8,396	8,594	15,994	8,172	8,384	15,766	8,809	8,959	16,365	8,639	8,822	16,207	8,485	8,662	16,081	8,741	9,002	16,310
June	11,135	8,642	14,702	10,261	7,991	13,982	10,673	8,245	14,270	10,669	8,264	14,213	11,135	8,642	14,702	10,847	8,386	14,311	10,797	8,337	14,153	11,152	8,850	14,661
July	13,921	9,965	15,127	12,414	8,745	14,141	13,373	9,484	14,846	13,075	9,217	14,584	13,921	9,965	15,127	13,676	9,758	15,023	13,561	9,643	15,092	13,960	10,277	15,045
August	11,279	7,761	13,186	9,611	6,501	12,289	10,882	7,416	12,981	10,596	7,157	12,803	11,279	7,761	13,186	11,104	7,613	13,094	11,110	7,619	13,104	10,982	7,722	13,190
September	7,444	6,472	11,462	5,910	5,082	10,028	7,101	6,149	11,105	6,494	5,597	10,648	7,444	6,472	11,462	7,299	6,336	11,412	7,278	6,306	11,349	7,380	6,575	11,614
average	**8,703**	**11,290**	**19,292**	**7,693**	**10,464**	**18,420**	**8,387**	**11,020**	**19,023**	**8,007**	**10,706**	**18,675**	**8,703**	**11,290**	**19,292**	**8,574**	**11,177**	**19,177**	**8,514**	**11,125**	**19,127**	**8,703**	**11,337**	**19,263**

Table B-22 Average Monthly Delta Inflow (CFS) for 1922 to 1993.								
	No Action	Maximum Flow	Flow Evaluation	70 % Inflow	Mechanical Resstoration	Revised Mechanical Restoration	Modified % Inflow	Existing Conditions
Month	**Monthly Inflow**	**Monthly Inflow**	**Monthly Inflow**	**Monthly Inflow**	**Monthly Inflow**	**Monthly Inflow**	**Monthly Inflow**	**Monthly Inflow**
October	15,297	14,215	14,982	14,640	15,297	15,129	15,101	15,374
November	18,101	16,842	17,638	17,095	18,101	18,027	17,851	18,028
December	31,091	29,482	30,620	29,527	31,091	30,978	30,851	30,970
January	44,697	44,032	44,434	44,272	44,697	44,577	44,556	45,005
February	56,107	55,235	55,915	55,445	56,107	56,066	56,016	56,229
March	47,937	47,445	47,835	47,282	47,937	47,904	47,915	47,796
April	33,597	33,195	33,628	33,353	33,597	33,555	33,568	33,390
May	26,675	26,027	26,305	26,084	26,675	26,512	26,389	26,697
June	22,987	22,318	22,561	22,539	22,987	22,621	22,471	23,216
July	21,060	20,102	20,848	20,619	21,060	20,983	21,062	21,170
August	17,096	16,160	16,868	16,689	17,096	16,959	16,948	17,169
September	15,897	14,549	15,571	15,084	15,897	15,859	15,808	16,453
Total	**29,212**	**28,300**	**28,934**	**28,552**	**29,212**	**29,097**	**29,045**	**29,291**

Table B-23
Average Monthly Delta Outflow (CFS) for 1922 to 1993.

Month	No Action	Maximum Flow	Flow Evaluation	70 % Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Existing Conditions
	Monthly Outflow	Monthly Outflow	Monthly Outflow	Monthly Outflow	Monthly Outflow	Monthly Outflow	Monthly Outflow	Monthly Outflow
October	6,061	5,440	5,833	5,657	6,061	5,909	5,914	6,219
November	9,614	8,881	9,251	8,953	9,614	9,528	9,431	9,592
December	22,421	21,163	22,008	21,150	22,421	22,304	22,185	22,618
January	36,568	36,045	36,411	36,051	36,568	36,459	36,436	36,785
February	47,894	47,524	47,713	47,526	47,894	47,928	47,888	48,226
March	39,195	39,132	39,180	38,724	39,195	39,154	39,267	39,305
April	28,033	27,875	28,004	27,860	28,033	27,988	28,009	27,947
May	20,520	20,180	20,289	20,071	20,520	20,461	20,295	20,685
June	12,218	11,908	11,993	11,934	12,218	11,976	11,934	12,307
July	7,047	7,108	7,112	7,100	7,047	7,093	7,107	7,199
August	4,162	4,030	4,161	4,120	4,162	4,178	4,212	4,140
September	4,612	3,702	4,371	3,998	4,612	4,527	4,503	4,990
Average	**19,862**	**19,416**	**19,694**	**19,429**	**19,862**	**19,792**	**19,765**	**20,001**

Table B-24

Comparison of the Average Monthly Flows in the Sacramento River (CFS) from 1922 to 1993.

	Maximum Flow: Average Absolute Change from No Action Alternative[a] (percent)			Flow Evaluation: Average Absolute Change from No Action Alternative[a] (percent)			70% Inflow: Average Absolute Change from No Action[a] (percent)			Mechanical Restoration: Average Absolute Change from No Action Alternative[a] (percent)			Revised Mechanical Restoration: Average Absolute Change from No Action Alternative[a] (percent)			Modified % Inflow: Average Absolute Change from No Action Alternative[a] (percent)			Existing Conditions: Average Absolute Change of Preferred Alternative from Existing Conditions[a] (percent)		
Month	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**
October	-20	-18	-12	-6	-6	-3	-14	-12	-7	0	0	0	-3	-3	-2	-3	-3	-2	-8	-7	-4
November	-22	-14	-10	-8	-5	-4	-18	-11	-8	0	0	0	-1	-1	-1	-4	-2	-2	-10	-5	-4
December	-19	-7	-6	-5	-2	-2	-18	-6	-6	0	0	0	-1	-1	0	-3	-1	-1	-5	-1	-2
January	-5	-2	-2	-1	0	0	-4	-1	-1	0	0	0	-1	0	0	-1	0	0	-1	0	-1
February	-8	-2	-2	-2	-1	0	-5	-2	-1	0	0	0	0	0	0	-1	0	0	-2	0	0
March	-6	-2	-1	-1	-1	0	-6	-3	-2	0	0	0	-1	0	0	0	0	0	-2	0	0
April	-6	-2	-2	-1	0	0	-3	-2	-1	0	0	0	-1	0	0	-1	-1	0	-2	0	1
May	-9	-7	-4	-5	-4	-2	-7	-6	-4	0	0	0	-2	-2	-1	-4	-3	-2	-4	-5	-2
June	-8	-8	-5	-4	-5	-3	-4	-4	-3	0	0	0	-3	-3	-3	-3	-4	-4	-4	-7	-3
July	-11	-12	-7	-4	-5	-2	-6	-8	-4	0	0	0	-2	-2	-1	-3	-3	0	-4	-8	-1
August	-15	-16	-7	-4	-4	-2	-6	-8	-3	0	0	0	-2	-2	-1	-1	-2	-1	-1	-4	-2
September	-21	-21	-13	-5	-5	-3	-13	-14	-7	0	0	0	-2	-2	0	-2	-3	-1	-4	-6	-4
Average	-12	-9	-6	-4	-3	-2	-9	-6	-4	0	0	0	-1	-1	-1	-2	-2	-1	-4	-4	-2

[a] Change relative to the No Action Alternative. Values represent the average change for the 73 years modeled, rather than the difference between the 73-year average flow values for each month under these two cases.

Table B-25

Percent Change in the Average Monthly Inflows (cfs) to the Delta (1922-1993) [a]

Compared to No Action Alternative

Month	Maximum Flow	Flow Evaluation	70 % Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Preferred vs. Exist. Cond.
October	-7	-2	-4	0	-1	-1	-3
November	-7	-3	-6	0	0	-1	-2
December	-5	-2	-5	0	0	-1	-1
January	-1	-1	-1	0	0	0	-1
February	-2	0	-1	0	0	0	-1
March	-1	0	-1	0	0	0	0
April	-1	0	-1	0	0	0	1
May	-2	-1	-2	0	-1	-1	-1
June	-3	-2	-2	0	-2	-2	-3
July	-5	-1	-2	0	0	0	-2
August	-5	-1	-2	0	-1	-1	-2
September	-8	-2	-5	0	0	-1	-5
Average	-4	-1	-3	0	-1	-1	-2

[a] Areas shaded are values for months critical for senstitive species in the Delta.

Table B-26
Percent Change in the Average Monthly Outflows (CFS) from the Delta (1922-1993) [a]

	Compared to No Action Alternative						
Month	Maximum Flow	Flow Evaluation	70% Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Preferred vs. Exist. Cond.
October	-10	-4	-7	0	-3	-2	-6
November	-8	-4	-7	0	-1	-2	-4
December	-6	-2	-6	0	-1	-1	-3
January	-1	0	-1	0	0	0	-1
February	-1	0	-1	0	0	0	-1
March	0	0	-1	0	0	0	0
April	-1	0	-1	0	0	0	0
May	-2	-1	-2	0	0	-1	-2
June	-3	-2	-2	0	-2	-2	-3
July	1	1	1	0	1	1	-1
August	-3	0	-1	0	0	1	1
September	-20	-5	-13	0	-2	-2	-12
Average	-4	-1	-3	0	-1	-1	-3

[a]Areas shaded are values for months critical for senstitive species in the Delta.

Table B-27

Estimated Monthly Average Position of X2 in the Delta (in km from the Golden Gate Bridge) for the Period 1922-1993[a]

Month	Alternative								
	No Action	Maximum Flow	Flow Evaluation	70% Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Existing Conditions	OCAP Cumulative
October	86.0	87.2	86.3	86.8	86.0	86.1	86.1	85.5	86.5
November	84.6	85.5	84.9	85.2	84.6	84.7	84.7	84.3	85.5
December	82.0	82.7	82.4	82.6	82.0	82.1	82.2	82.0	82.2
January	76.8	77.2	76.9	77.1	76.8	76.8	76.9	76.7	77.6
February	71.3	71.6	71.4	71.6	71.3	71.3	71.3	71.2	71.6
March	66.2	66.3	66.2	66.3	66.2	66.2	66.1	66.1	66.4
April	65.7	65.8	65.8	65.9	65.7	65.8	65.7	65.6	65.9
May	67.7	67.7	67.7	67.8	67.7	67.7	67.7	67.6	67.8
June	70.5	70.6	70.6	70.7	70.5	70.5	70.6	70.4	70.3
July	75.1	75.2	75.1	75.2	75.1	75.2	75.2	75.0	75.2
August	79.3	79.3	79.3	79.3	79.3	79.3	79.3	79.2	79.2
September	84.4	84.6	84.4	84.5	84.4	84.4	84.3	84.4	83.7

[a] Areas shaded are values for months critical for sensitive species in the Delta.

Table B-28 Estimated Average Monthly Change in Delta X2 Position (KM) from the No Action Alternative for the Period 1922-1993																
	Maximum Flow		**Flow Evaluation**		**70 Percent Inflow**		**Mechanical Restoration**		**Revised Mechanical Restoration**		**Modified Percent Inflow**		**Existing Conditions Compared to Preferred Alternative**		**Cumulative Effects Compared to Preferred Alternative**	
Month	**Average Absolute Change (km)**	**Average Relative Change (Percent)**	**Average Absolute Change (km)**	**Average Relative Change (Percent)**	**Average Absolute Change (km)**	**Average Relative Change (Percent)**	**Average Absolute Change (km)**	**Average Relative Change (Percent)**	**Average Absolute Change (km)**	**Average Relative Change (Percent)**	**Average Absolute Change (km)**	**Average Relative Change (Percent)**	**Average Absolute Change (km)**	**Average Relative Change (Percent)**	**Average Absolute Change (km)**	**Average Relative Change (Percent)**
October	-1.1	-1.3	-0.2	-0.3	-0.8	-0.9	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.8	-0.9	0.2	0.2
November	-1.0	-1.1	-0.3	-0.3	-0.6	-0.7	0.0	0.0	-0.1	-0.2	0.0	-0.1	-0.5	-0.6	0.7	0.8
December	-0.7	-0.8	-0.3	-0.4	-0.6	-0.7	0.0	0.0	-0.1	-0.1	0.0	-0.1	-0.4	-0.4	-0.2	-0.2
January	-0.4	-0.6	-0.1	-0.2	-0.4	-0.5	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.2	0.7	0.9
February	-0.3	-0.4	-0.1	-0.1	-0.3	-0.4	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.2	0.3
March	-0.1	-0.2	0.0	-0.1	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.2	0.3
April	-0.1	-0.1	0.0	-0.1	-0.2	-0.3	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.2	0.2
May	-0.1	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.1	0.2	0.2
June	-0.1	-0.1	0.0	0.0	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.3	-0.4
July	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	0.0	0.0	-0.1	-0.2	0.0	-0.1	-0.1	-0.1	0.1	0.1
August	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2
September	-0.2	-0.2	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.7	-0.9
Mean Annual Change (km)	-0.3	-0.4	-0.1	-0.1	-0.3	-0.4	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.2	-0.2	0.1	0.1

Table 29
Summary of the Change in X2 Position in the Delta compared to the No Action Alternative (1922-1993)

	Compared to No Action Alternative							
Alternative	Max Flow	Flow Eval	70% inflow	Mechanical	Enhanced Mech	Mod. % Inflow	Pref. vs. Exist. Cond.	OCAP Cumulative vs Preferred (2020)
February								
# years > 0.5 Km upstream	20	8	18	0	3	5	9	30
% years > 0.5km upstream	27.8%	11.1%	25.0%	0.0%	4.2%	6.9%	12.5%	41.7%
# years > 0.5 Km downstream	3	11	1	0	3	4	7	14
% years > 0.5km downstream	4.2%	15.3%	1.4%	0.0%	4.2%	5.6%	9.7%	19.4%
March								
# years > 0.5 Km upstream	7	5	7	0	1	2	6	21
% years > 0.5km upstream	9.7%	6.9%	9.7%	0.0%	1.4%	2.8%	8.3%	29.2%
# years > 0.5 Km downstream	2	2	2	0	1	2	8	5
% years > 0.5km downstream	2.8%	2.8%	2.8%	0.0%	1.4%	2.8%	11.1%	6.9%
April								
# years > 0.5 Km upstream	8	5	9	0	4	2	5	20
% years > 0.5km upstream	11.1%	6.9%	12.5%	0.0%	5.6%	2.8%	6.9%	27.8%
# years > 0.5 Km downstream	5	4	2	0	1	4	6	2
% years > 0.5km downstream	6.9%	5.6%	2.8%	0.0%	1.4%	5.6%	8.3%	2.8%
May								
# years > 0.5 Km upstream	6	4	6	0	2	3	10	12
% years > 0.5km upstream	8.3%	5.6%	8.3%	0.0%	2.8%	4.2%	13.9%	16.7%
# years > 0.5 Km downstream	3	4	2	0	2	3	8	0
% years > 0.5km downstream	4.2%	5.6%	2.8%	0.0%	2.8%	4.2%	11.1%	0.0%
June								
# years > 0.5 Km upstream	14	13	14	0	7	11	14	11
% years > 0.5km upstream	19.4%	18.1%	19.4%	0.0%	9.7%	15.3%	19.4%	15.3%
# years > 0.5 Km downstream	10	8	5	0	7	6	10	23
% years > 0.5km downstream	13.9%	11.1%	6.9%	0.0%	9.7%	8.3%	13.9%	31.9%
All Months (Feb-June)								
# months > 0.5 Km upstream	**55**	**35**	**54**	**0**	**17**	**23**	**44**	**94**
% months > 0.5km upstream	**15.3%**	**9.7%**	**15.0%**	**0.0%**	**4.7%**	**6.4%**	**12.2%**	**26.1%**
# months > 0.5 Km downstream	**23**	**29**	**12**	**0**	**14**	**19**	**39**	**44**
% months > 0.5km downstream	**6.4%**	**8.1%**	**3.3%**	**0.0%**	**3.9%**	**5.3%**	**10.8%**	**12.2%**

Table B-30
Estimated Average Monthly Surface Area of Trinity Lake (Acres) for the Period 1922-1993 [a]

Month	Alternative							
	No Action	Maximum Flow	Flow Evaluation	70% Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Existing Conditions
October	10,703	7,259	10,429	10,279	10,703	10,252	10,532	10,679
November	10,709	7,517	10,511	10,351	10,709	10,296	10,578	10,702
December	10,996	8,119	10,824	10,540	10,996	10,607	10,834	10,984
January	11,269	8,131	11,118	10,680	11,269	10,927	11,122	11,244
February	11,808	8,214	11,700	10,967	11,808	11,510	11,677	11,775
March	12,419	8,342	12,326	11,257	12,419	12,146	12,304	12,388
April	13,166	8,491	13,037	11,542	13,166	12,917	12,942	13,146
May	13,523	8,101	12,988	11,776	13,523	13,126	13,144	13,505
June	13,461	7,903	12,756	11,675	13,461	13,006	13,029	13,442
July	12,729	7,545	12,028	11,241	12,729	12,263	12,348	12,711
August	11,896	7,298	11,295	10,683	11,896	11,416	11,538	11,885
September	11,070	7,135	10,654	10,345	11,070	10,585	10,803	11,055
Average	12,062	7,902	11,728	10,999	12,062	11,679	11,823	12,042

[a] months critical to principal warmwater reservoir species' spawning and rearing (March through July).

Table B-31
Estimated Average Monthly Surface Area of Whiskeytown Reservoir (Acres) for the Period 1922-1993

	Alternative							
Month	**No Action**	**Maximum Flow**	**Flow Evaluation**	**70% Inflow**	**Mechanical Restoration**	**Revised Mechanical Restoration**	**Modified % Inflow**	**Existing Conditions**
October	3,073	2,922	3,059	3,031	3,073	3,068	3,068	3,073
November	2,923	2,857	2,916	2,903	2,923	2,922	2,921	2,923
December	2,923	2,865	2,915	2,904	2,923	2,923	2,922	2,923
January	2,919	2,872	2,912	2,910	2,919	2,919	2,919	2,919
February	2,927	2,893	2,921	2,920	2,927	2,927	2,927	2,927
March	3,031	3,000	3,031	3,020	3,031	3,032	3,031	3,034
April	3,259	3,155	3,261	3,238	3,259	3,254	3,255	3,258
May	3,233	3,146	3,232	3,215	3,233	3,233	3,228	3,233
June	3,241	3,133	3,241	3,221	3,241	3,239	3,241	3,242
July	3,240	3,087	3,241	3,224	3,240	3,234	3,242	3,241
August	3,241	3,028	3,236	3,195	3,241	3,237	3,241	3,241
September	3,207	2,981	3,192	3,151	3,207	3,203	3,203	3,207
Average	3,101	2,995	3,096	3,078	3,101	3,099	3,100	3,102

Table B-32
Estimated Average Monthly Surface Area of Shasta Lake (Acres) for the Period 1922-1993

Month	Alternative							
	No Action	Maximum Flow	Flow Evaluation	70% Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Existing Conditions
October	20,487	18,162	19,923	18,798	20,487	20,391	20,202	20,529
November	20,784	18,679	20,286	19,283	20,784	20,672	20,514	20,754
December	21,476	19,763	21,087	20,344	21,476	21,382	21,268	21,454
January	22,901	21,183	22,530	21,780	22,901	22,791	22,710	22,880
February	24,227	22,757	23,923	23,282	24,227	24,132	24,073	24,224
March	26,048	24,681	25,747	25,200	26,048	25,953	25,898	26,017
April	27,199	25,939	26,937	26,407	27,199	27,114	27,066	27,151
May	27,066	25,798	26,752	26,236	27,066	26,941	26,900	27,034
June	25,735	24,255	25,338	24,667	25,735	25,575	25,509	25,690
July	23,295	21,454	22,893	21,998	23,295	23,160	23,086	23,228
August	21,279	19,248	20,853	19,802	21,279	21,172	21,071	21,304
September	20,657	18,349	20,101	18,915	20,657	20,558	20,388	20,720
Average	23,430	21,689	23,031	22,226	23,430	23,320	23,224	23,415

Table B-33
Estimated Average Monthly Surface Area of Lake Oroville (Acres) for the Period 1922-1993

Month	Alternative							
	No Action	Maximum Flow	Flow Evaluation	70% Inflow	Mechanical Restoration	Revised Mechanical Restoration	Modified % Inflow	Existing Conditions
October	10,512	10,515	10,459	10,369	10,512	10,513	10,475	10,626
November	10,706	10,709	10,666	10,563	10,706	10,717	10,681	10,816
December	11,133	11,130	11,094	10,998	11,133	11,138	11,097	11,212
January	11,691	11,740	11,673	11,601	11,691	11,712	11,666	11,753
February	12,349	12,382	12,331	12,268	12,349	12,368	12,323	12,366
March	12,985	13,006	12,968	12,934	12,985	12,997	12,961	12,981
April	13,843	13,890	13,816	13,790	13,843	13,854	13,818	13,852
May	14,192	14,231	14,166	14,145	14,192	14,208	14,166	14,200
June	13,488	13,540	13,471	13,464	13,488	13,530	13,511	13,567
July	12,165	12,176	12,109	12,095	12,165	12,194	12,132	12,342
August	10,961	10,946	10,884	10,856	10,961	10,981	10,917	11,143
September	10,639	10,657	10,593	10,526	10,639	10,639	10,599	10,771
Average	12,055	12,077	12,019	11,967	12,055	12,071	12,029	12,136

Table B-34
Estimated Average Monthly Surface Area of Folsom Lake (Acres) for the Period 1922-1993

	Alternative							
Month	**No Action**	**Maximum Flow**	**Flow Evaluation**	**70% Inflow**	**Mechanical Restoration**	**Revised Mechanical Restoration**	**Modified % Inflow**	**Existing Conditions**
October	7,346	7,151	7,295	7,201	7,346	7,329	7,334	7,611
November	7,351	7,142	7,292	7,214	7,351	7,321	7,347	7,502
December	7,408	7,363	7,385	7,411	7,408	7,389	7,427	7,495
January	7,616	7,599	7,649	7,622	7,616	7,602	7,648	7,625
February	7,785	7,756	7,798	7,765	7,785	7,776	7,817	7,804
March	8,631	8,601	8,639	8,608	8,631	8,624	8,652	8,651
April	9,532	9,475	9,544	9,526	9,532	9,531	9,540	9,603
May	10,007	9,960	10,019	9,997	10,007	10,007	10,015	10,093
June	9,625	9,552	9,645	9,602	9,625	9,617	9,622	9,746
July	8,489	8,357	8,465	8,406	8,489	8,463	8,464	8,655
August	7,878	7,746	7,875	7,798	7,878	7,882	7,875	8,150
September	7,440	7,310	7,422	7,331	7,440	7,437	7,443	7,660
Average	8,259	8,168	8,252	8,207	8,259	8,248	8,265	8,383

Table B-35 Estimated Average Monthly Storage (TAF) for San Luis Reservoir (CVP operations) for the Period 1922-1993								
	Alternative							
Month	**No Action**	**Maximum Flow**	**Flow Evaluation**	**70% Inflow**	**Mechanical Restoration**	**Revised Mechanical Restoration**	**Modified % Inflow**	**Existing Conditions**
October	316	357	316	318	316	323	323	307
November	431	459	429	421	431	437	435	421
December	576	588	568	557	576	581	577	557
January	701	720	691	692	701	705	708	687
February	790	806	783	783	790	792	795	773
March	856	862	852	846	856	858	861	833
April	818	828	818	813	818	822	825	787
May	663	688	665	668	663	667	672	630
June	470	522	472	490	470	475	481	445
July	314	363	309	327	314	313	316	297
August	209	258	205	224	209	206	207	190
September	259	307	263	272	259	265	267	247
Average	534	563	531	534	534	537	539	514

Table B-36 Estimated Average Monthly Storage (TAF) in San Luis Reservoir (SWP operations) for the Period 1922-1993								
	Alternative							
Month	**No Action**	**Maximum Flow**	**Flow Evaluation**	**70% Inflow**	**Mechanical Restoration**	**Revised Mechanical Restoration**	**Modified % Inflow**	**Existing Conditions**
October	306	291	303	300	306	301	307	352
November	330	310	327	323	330	326	332	385
December	394	385	397	388	394	393	400	455
January	597	594	592	586	597	595	594	664
February	707	697	705	689	707	707	703	776
March	766	753	762	750	766	766	760	838
April	610	596	611	594	610	611	607	713
May	453	438	454	437	453	452	452	545
June	422	407	414	398	422	410	401	467
July	305	292	304	288	305	299	301	323
August	268	255	265	250	268	262	267	287
September	290	284	288	280	290	286	290	316
Average	454	442	452	440	454	451	451	510

Table B-37 Comparison of Trinity Lake Water Surface Area (Acres) for the Simulated Period 1922-1993														
	Compared to No Action Alternative												Pref. Alt. vs. Ex. Cond.	
	Maximum Flow		Flow Evaluation		70 Percent Inflow		Mechanical Restoration		Revised Mechanical Restoration		Modified % Inflow			
Month	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)
October	-32	-3444	-3	-274	-4	-425	0	0	-4	-452	-2	-171	-2	-250
November	-30	-3191	-2	-197	-3	-358	0	0	-4	-413	-1	-131	-2	-190
December	-26	-2877	-2	-172	-4	-456	0	0	-4	-388	-1	-162	-1	-160
January	-28	-3138	-1	-151	-5	-589	0	0	-3	-342	-1	-146	-1	-126
February	-30	-3594	-1	-109	-7	-841	0	0	-3	-298	-1	-131	-1	-75
March	-33	-4077	-1	-93	-9	-1162	0	0	-2	-273	-1	-115	0	-61
April	-36	-4675	-1	-129	-12	-1624	0	0	-2	-249	-2	-224	-1	-109
May	-40	-5421	-4	-535	-13	-1747	0	0	-3	-397	-3	-379	-4	-517
June	-41	-5557	-5	-705	-13	-1786	0	0	-3	-455	-3	-432	-5	-686
July	-41	-5184	-6	-701	-12	-1488	0	0	-4	-466	-3	-381	-5	-683
August	-39	-4598	-5	-601	-10	-1213	0	0	-4	-480	-3	-358	-5	-590
September	-36	-3935	-4	-416	-7	-726	0	0	-4	-485	-2	-267	-4	-401
Average	-34	-4141	-3	-340	-8	-1035	0	0	-3	-391	-2	-241	-3	-321

Table B-38 Comparison of Whiskeytown Reservoir Water Surface Area (Acres) for the Simulated Period 1922-1993														
	Compared to No Action Alternative												Pref. Alt. vs. Ex. Cond.	
	Maximum Flow		Flow Evaluation		70 Percent Inflow		Mechanical Restoration		Revised Mechanical Restoration		Modified % Inflow			
Month	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)
October	-5	-150	0	-14	-1	-42	0	0	0	-5	0	-4	0	-14
November	-2	-66	0	-7	-1	-20	0	0	0	-1	0	-2	0	-7
December	-2	-58	0	-8	-1	-19	0	0	0	0	0	-1	0	-8
January	-2	-48	0	-8	0	-9	0	0	0	0	0	0	0	-8
February	-1	-35	0	-6	0	-7	0	0	0	0	0	0	0	-6
March	-1	-30	0	0	0	-10	0	0	0	2	0	0	0	-3
April	-3	-104	0	2	-1	-22	0	0	0	-5	0	-5	0	3
May	-3	-87	0	-1	-1	-18	0	0	0	0	0	-5	0	-2
June	-3	-108	0	0	-1	-20	0	0	0	-3	0	-1	0	-1
July	-5	-153	0	1	-1	-17	0	0	0	-6	0	2	0	0
August	-7	-214	0	-6	-1	-47	0	0	0	-4	0	0	0	-6
September	-7	-226	0	-15	-2	-57	0	0	0	-4	0	-5	0	-15
Average	-3	-107	0	-5	-1	-24	0	0	0	-2	0	-2	0	-5

Table B-39
Comparison of Shasta Lake Water Surface Area (Acres) for the Simulated Period 1922-1993

Month	Compared to No Action Alternative												Pref. Alt. vs. Ex. Cond.	
	Maximum Flow		Flow Evaluation		70 Percent Inflow		Mechanical Restoration		Revised Mechanical Restoration		Modified % Inflow			
	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)
October	-11	-2324	-3	-563	-8	-1689	0	0	0	-96	-1	-284	-3	-606
November	-10	-2105	-2	-498	-7	-1501	0	0	-1	-113	-1	-270	-2	-468
December	-8	-1712	-2	-389	-5	-1132	0	0	0	-94	-1	-207	-2	-367
January	-8	-1718	-2	-372	-5	-1121	0	0	0	-110	-1	-191	-2	-351
February	-6	-1470	-1	-304	-4	-946	0	0	0	-95	-1	-154	-1	-301
March	-5	-1367	-1	-301	-3	-848	0	0	0	-95	-1	-150	-1	-271
April	-5	-1259	-1	-262	-3	-791	0	0	0	-85	0	-132	-1	-214
May	-5	-1268	-1	-315	-3	-831	0	0	0	-126	-1	-167	-1	-282
June	-6	-1480	-2	-397	-4	-1068	0	0	-1	-160	-1	-225	-1	-352
July	-8	-1841	-2	-402	-6	-1297	0	0	-1	-134	-1	-208	-1	-336
August	-10	-2031	-2	-426	-7	-1478	0	0	-1	-108	-1	-208	-2	-451
September	-11	-2308	-3	-556	-8	-1743	0	0	0	-99	-1	-269	-3	-619
Average	-8	-1740	-2	-399	-5	-1204	0	0	0	-110	-1	-206	-2	-385

Table B-40
Comparison of Lake Oroville Water Surface Area (Acres) for the Simulated Period 1922-1993

Month	Compared to No Action Alternative												Pref. Alt. vs. Ex. Cond.	
	Maximum Flow		Flow Evaluation		70 Percent Inflow		Mechanical Restoration		Revised Mechanical Restoration		Modified % Inflow			
	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)
October	0	3	-1	-54	-1	-143	0	0	0	1	0	-37	-2	-167
November	0	3	0	-40	-1	-143	0	0	0	11	0	-25	-1	-150
December	0	-3	0	-39	-1	-135	0	0	0	5	0	-36	-1	-118
January	0	50	0	-18	-1	-90	0	0	0	21	0	-25	-1	-80
February	0	33	0	-18	-1	-81	0	0	0	19	0	-26	0	-35
March	0	22	0	-17	0	-51	0	0	0	13	0	-24	0	-12
April	0	47	0	-26	0	-53	0	0	0	11	0	-25	0	-36
May	0	39	0	-26	0	-47	0	0	0	16	0	-26	0	-33
June	0	52	0	-16	0	-23	0	0	0	43	0	23	-1	-95
July	0	11	0	-57	-1	-70	0	0	0	28	0	-34	-2	-234
August	0	-14	-1	-76	-1	-105	0	0	0	20	0	-44	-2	-259
September	0	19	0	-46	-1	-113	0	0	0	1	0	-39	-2	-178
Average	0	22	0	-36	-1	-88	0	0	0	16	0	-26	-1	-117

Table B-41 Comparison of Folsom Lake Water Surface Area (Acres) for the Simulated Period 1922-1993														
	Compared to No Action Alternative												Pref. Alt. vs. Ex. Cond.	
	Maximum Flow		Flow Evaluation		70 Percent Inflow		Mechanical Restoration		Revised Mechanical Restoration		Modified % Inflow			
Month	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)	Percent Change in Surface Area	Change in Area (acres)
October	-3	-195	-1	-51	-2	-145	0	0	0	-17	-0.2	-12	-4	-316
November	-3	-209	-1	-59	-2	-137	0	0	0	-29	-0.1	-4	-3	-210
December	-1	-45	0	-23	0	3	0	0	0	-19	0.3	19	-1	-110
January	0	-17	0	34	0	7	0	0	0	-14	0.4	33	0	25
February	0	-30	0	13	0	-20	0	0	0	-10	0.4	31	0	-5
March	0	-30	0	8	0	-23	0	0	0	-7	0.2	21	0	-12
April	-1	-57	0	12	0	-6	0	0	0	-1	0.1	7	-1	-59
May	0	-47	0	12	0	-10	0	0	0	0	0.1	8	-1	-74
June	-1	-72	0	20	0	-23	0	0	0	-8	0.0	-3	-1	-101
July	-2	-132	0	-24	-1	-83	0	0	0	-26	-0.3	-25	-2	-190
August	-2	-132	0	-3	-1	-80	0	0	0	4	0.0	-3	-3	-275
September	-2	-130	0	-18	-1	-109	0	0	0	-3	0.0	3	-3	-239
Average	-1	-91	0	-7	-1	-52	0	0	0	-11	0.1	6	-2	-131

Table B-42
Comparison of Estimated Average Monthly Storage (taf) in San Luis Reservoir (CVP operations) for 1922-1993

	Compared to No Action Alternative													
	Maximum Flow		Flow Evaluation		70 Percent Inflow		Mechanical Restoration		Revised Mechanical Restoration		Modified % Inflow		Existing Conditions	
Month	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF
October	12.7	40	0	0	1	2	0	0	2	6	2	7	3	9
November	6.5	28	-1	-2	-2	-10	0	0	1	6	1	4	2	8
December	2.2	13	-1	-8	-3	-19	0	0	1	5	0	1	2	11
January	2.7	19	-1	-10	-1	-9	0	0	1	4	1	7	1	5
February	2.0	16	-1	-7	-1	-7	0	0	0	2	1	5	1	10
March	0.7	6	-1	-4	-1	-11	0	0	0	2	1	5	2	19
April	1.2	10	0	0	-1	-5	0	0	0	3	1	6	4	31
May	3.8	25	0	2	1	5	0	0	1	4	1	9	6	35
June	11.0	52	0	2	4	19	0	0	1	5	2	11	6	27
July	15.6	49	-2	-6	4	13	0	0	0	-1	0	1	4	12
August	23.6	49	-2	-4	7	15	0	0	-1	-3	-1	-2	8	14
September	18.7	48	2	4	5	14	0	0	2	6	3	9	6	16
Average	8.4	30	-1	-3	1	1	0	0	1	3	1	5	4	16

Table B-43
Comparison of Estimated Average Monthly Storage (taf) in San Luis Reservoir (SWP operations) for 1922-1993

	Compared to No Action Alternative												Pref. Alt. vs. Ex. Cond.	
	Maximum Flow		Flow Evaluation		70 Percent Inflow		Mechanical Restoration		Revised Mechanical Restoration		Modified % Inflow			
Month	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF	Percent Change in Acre Feet	Change in TAF
October	-5	-14	-1	-3	-2	-6	0	0	-2	-5	0	1	-14	-49
November	-6	-20	-1	-3	-2	-7	0	0	-1	-4	1	3	-15	-58
December	-2	-9	1	4	-1	-6	0	0	0	-1	2	6	-13	-58
January	-1	-3	-1	-4	-2	-11	0	0	0	-1	0	-3	-11	-72
February	-1	-11	0	-2	-3	-19	0	0	0	-1	-1	-4	-9	-71
March	-2	-13	0	-4	-2	-16	0	0	0	0	-1	-5	-9	-76
April	-2	-13	0	1	-3	-15	0	0	0	1	0	-3	-14	-102
May	-3	-15	0	2	-3	-15	0	0	0	0	0	-1	-17	-90
June	-4	-16	-2	-8	-6	-24	0	0	-3	-13	-5	-22	-11	-53
July	-4	-13	0	-1	-6	-17	0	0	-2	-6	-1	-4	-6	-19
August	-5	-13	-1	-4	-7	-18	0	0	-2	-6	-1	-1	-8	-22
September	-2	-6	-1	-3	-3	-10	0	0	-1	-4	0	0	-9	-28
Average	-3	-12	-1	-2	-3	-14	0	0	-1	-3	-1	-3	-11	-58

Table B-44
Summary of the Comparison of Changes in Reservoir Surface Area/Storage during Key Warmwater Fish Spawning and Rearing Months (March through July) for 1922 to 1993

	Compared to No Action Alternative												Pref. Alt. vs. Ex. Cond.	
	Maximum Flow		Flow Evaluation		70 % Inflow		Mechanical Restoration		Revised Mechanical Restoration		Modified % Inflow			
	Range of Mean Changes in Reservoir Area (March through July)													
Reservoir	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**
Trinity	-32.8 to -41.3	-4077 to -5557	-0.7 to -5.5	-93 to -705	-9.4 to 13.3	-1162 to -1786	0	0	-1.9 to -3.7	-249 to -466	-1 to -3	-115 to - 432	-0.6 to -5.4	-18 to -31
Whiskeytown	-1.0 to -4.7	-30 to -153	0.0 to + 0.1	-1 to +2	-0.3 to -0.7	-10 to -22	0	0	-0.2 to + 0.1	-6 to +2	0	-5 to 2	+0.0 to -0.5	-1 to +3
Shasta	-4.6 to -7.9	-1259 to -1841	-1.0 to -1.7	-262 to -402	-2.8 to -5.6	-791 to -1297	0	0	-0.3 to - 0.6	-85 to -160	0 to -1	-284 to -132	-0.8 to -3.0	-30 to -66
Oroville	+0.1 to +0.4	+11 to + 52	-0.1 to -0.5	-16 to -0.1	-0.2 to -0.6	-23 to -70	0	0	+0.1 to + 0.3	+11 to +43	0	-44 to 23	-0.1 to -2.3	-4 to +177
Folsom	-0.3 to -1.6	-30 to -132	-0.3 to +0.2	+8 to -24	-0.1 to -1.0	-6 to -83	0	0	-0.3 to 0.0	0 to -26	0	-29 to 4	-01 to -4.1	+20 to +166
	Range of Mean Changes in Reservoir Storage (March through July)													
Reservoir	**Percent**	**TAF**	**Percent**	**TAF**	**Percent**	**TAF**	**Percent**	**TAF**	**Percent**	**TAF**	**Percent**	**TAF**	**Percent**	**TAF**
San Luis (CVP)	+0.7 to +15.6	+6 to +49	0.0 to -1.8	0 to -6	-1.2 to +4.1	-11 to +19	0	0	-0.5 to +1.0	-1 to +5	-1 to 3	-2 to 11	+0.7 to +7.5	-17 to -33
San Luis (SWP)	-1.6 to -4.2	-13 to -16	-2.0 to +0.3	-8 to +2	-2.0 to -5.6	-15 to -24	0	0	-3.0 to 0.0	-13 to +1	-5 to 2	-22 to 6	-6.0 to -16.6	+18 to + 103

Figures

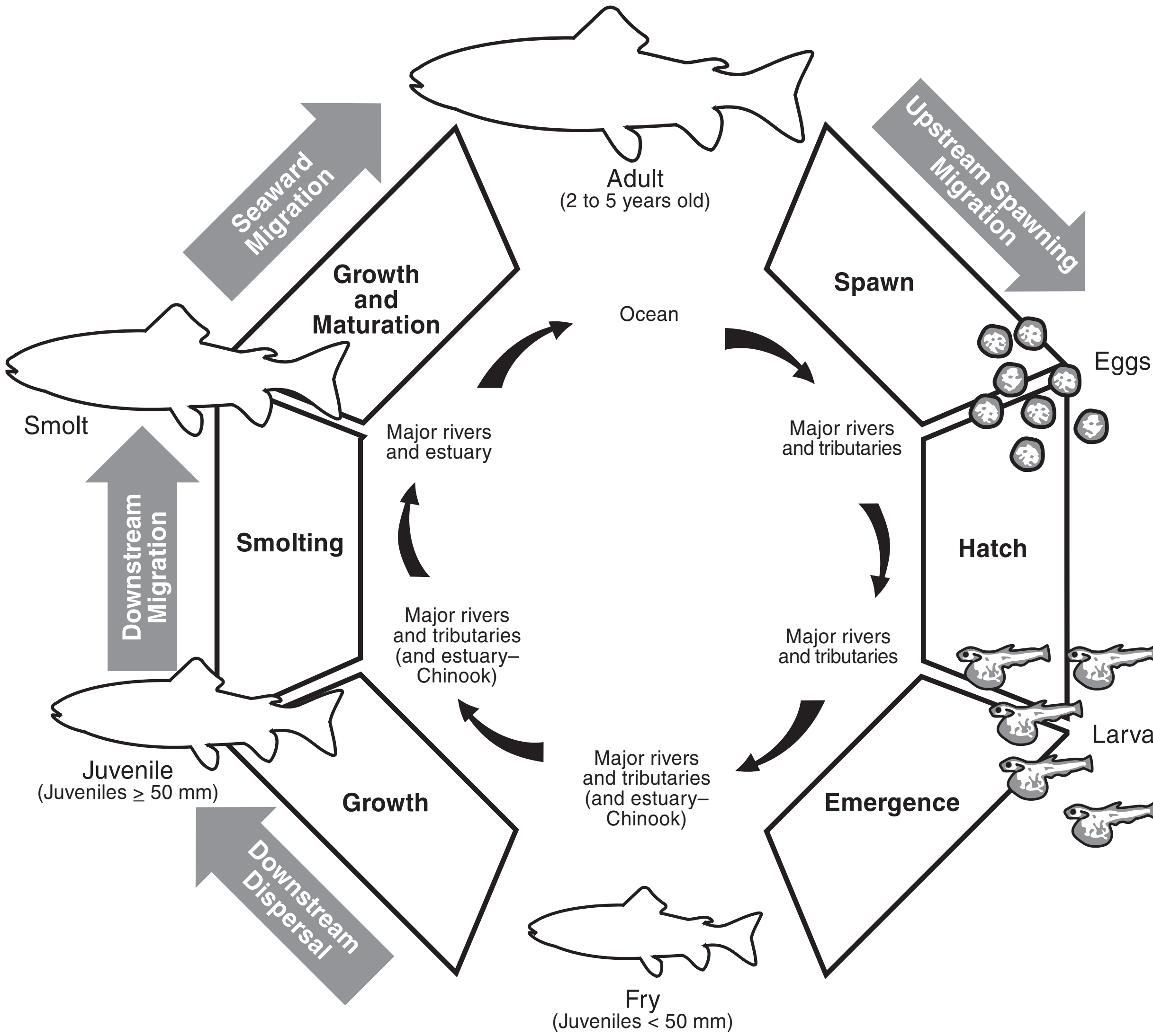


FIGURE B-1
GENERAL LIFE HISTORY
OF ANADROMOUS SALMONIDS
TRINITY RIVER FISHERY RESTORATION SUPPLEMENTAL EIS/EIR

W022004007RDD_05 (4/12/04)

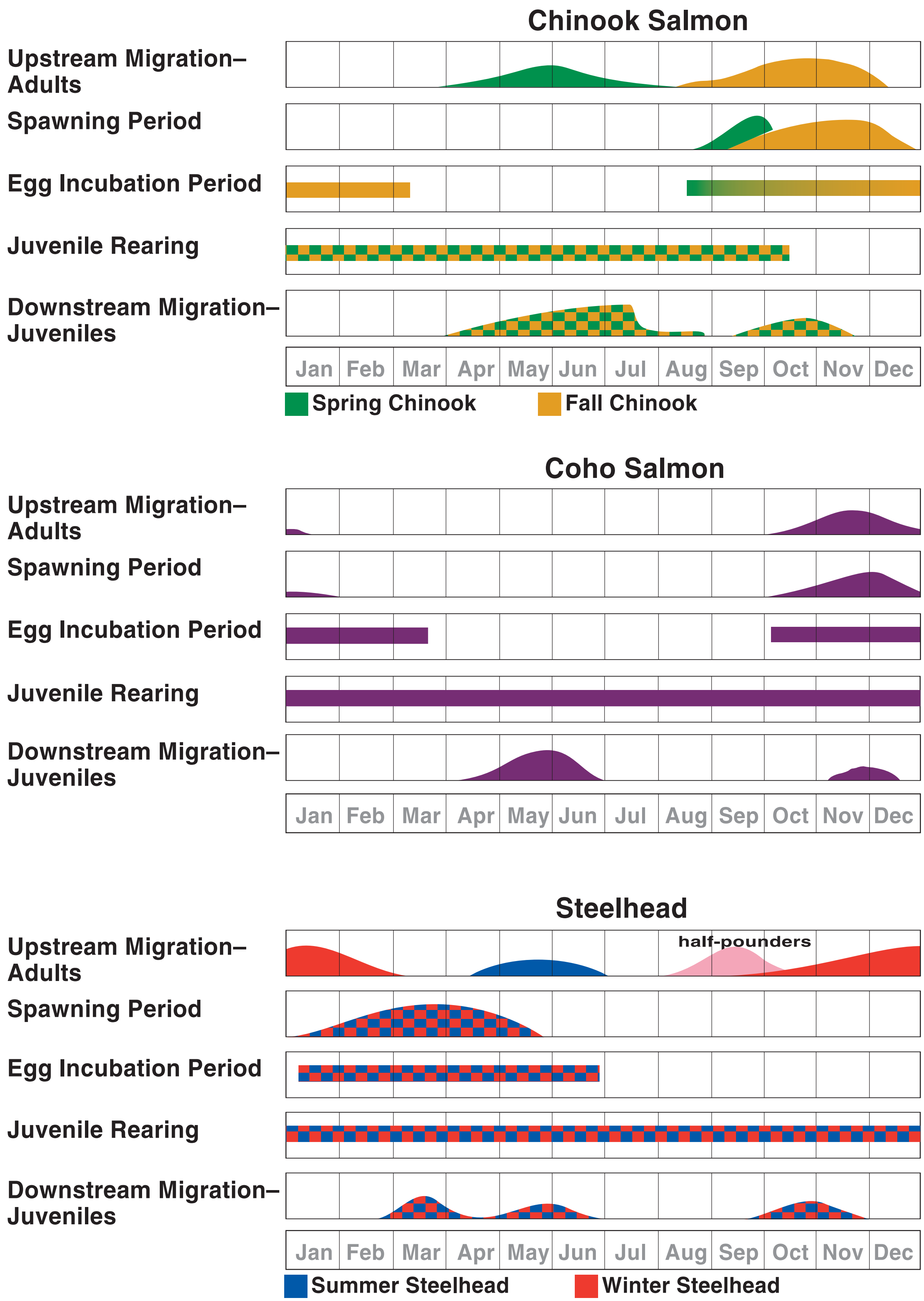


FIGURE B-2
TEMPORAL DISTRIBUTION
OF ANADROMOUS SALMONID
TRINITY RIVER FISHERY RESTORATION SUPPLEMENTAL EIS/EIR

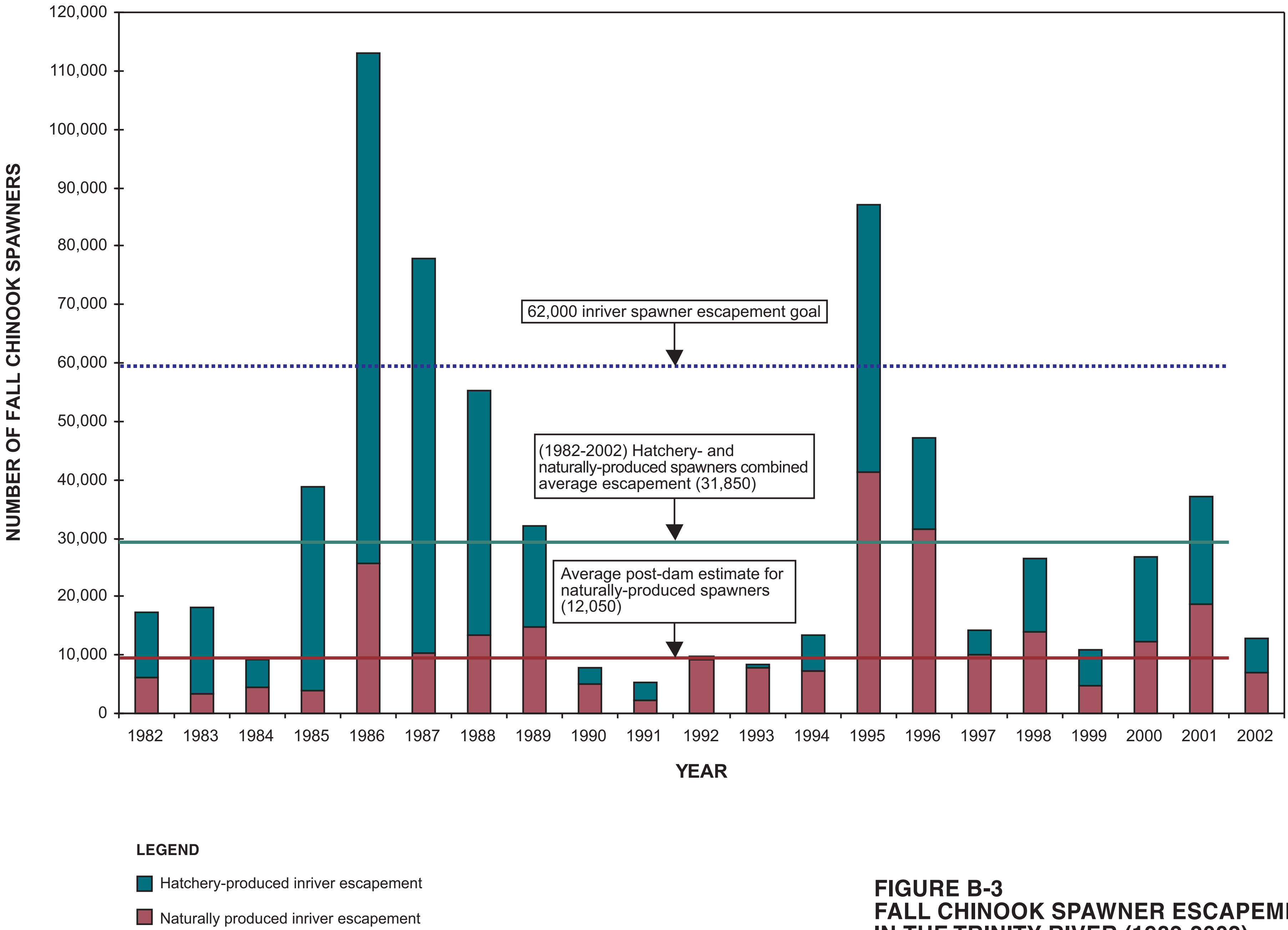
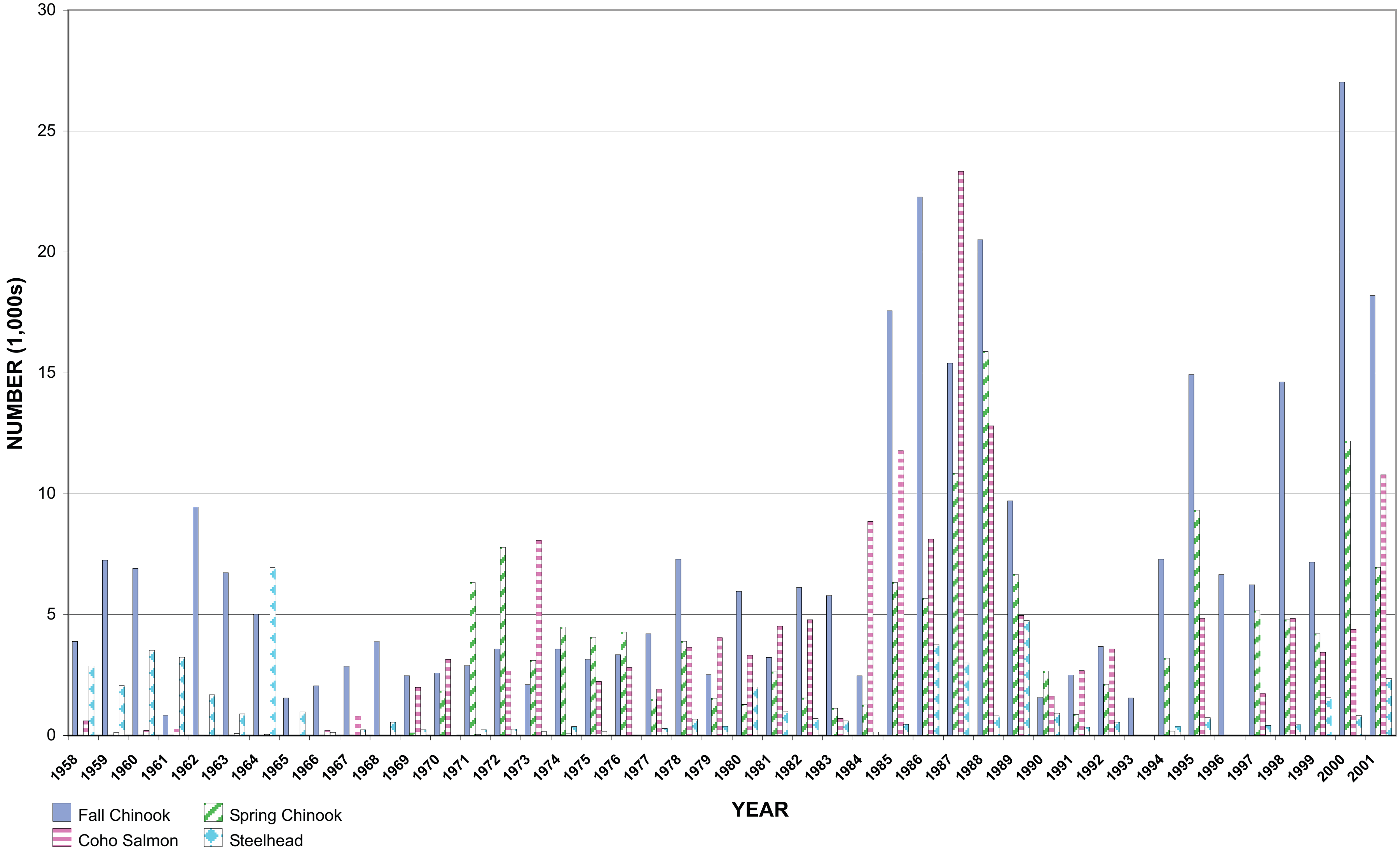


FIGURE B-3
FALL CHINOOK SPAWNER ESCAPEMENT IN THE TRINITY RIVER (1982-2002)
TRINITY RIVER FISHERY RESTORATION SUPPLEMENTAL EIS/EIR

W022004007RDD_08 (4/12/04)



(a) 1993 and 1996 Data Missing for Coho and Steelhead; 1958-1968, 1993, and 1996 for Spring Chinook

FIGURE B-4
NUMBER (ADULTS AND JACKS) OF CHINOOK AND COHO SALMON AND STEELHEAD ENTERING TRSSH (1958-2001)[a]
TRINITY RIVER FISHERY RESTORATION SUPPLEMENTAL EIS/EIR

W022004007RDD_03 (4/12/04)

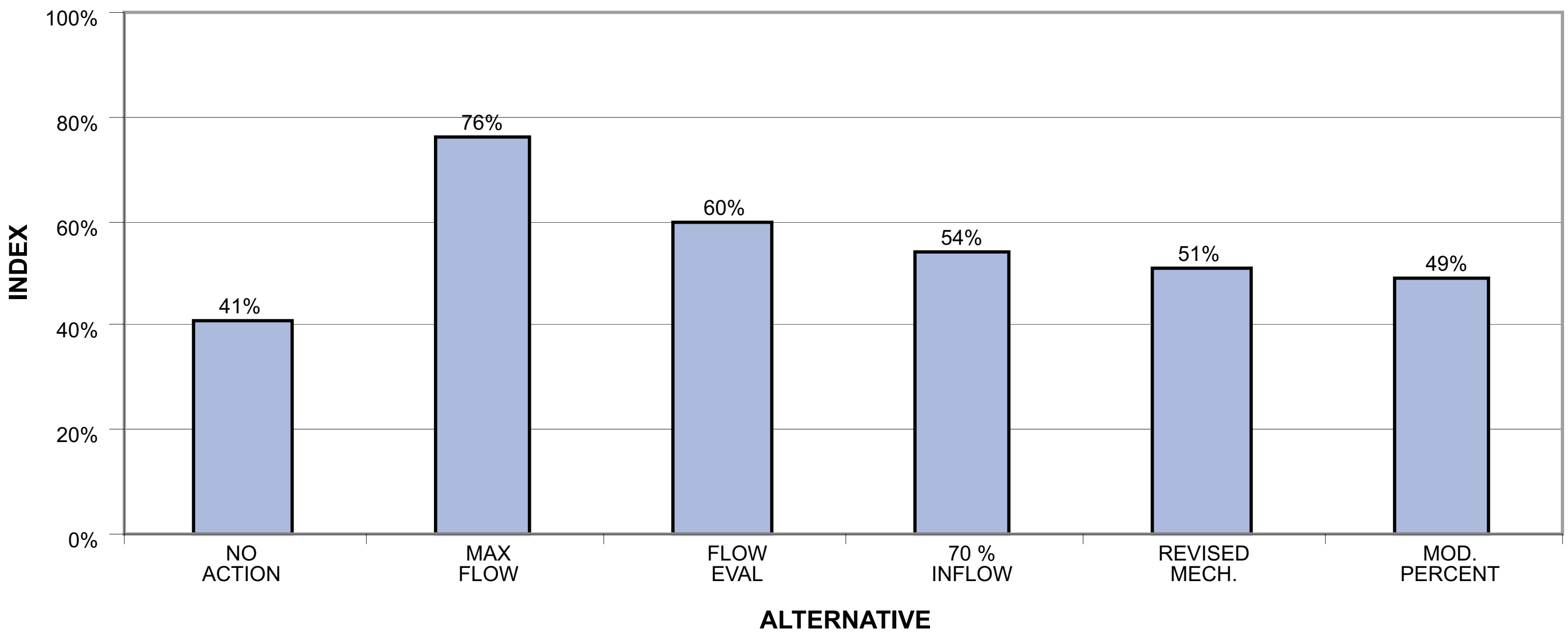


FIGURE B-5A
TRINITY RIVER CHINOOK SMOLT TEMPERATURE SUITABILITY INDICES
TRINITY RIVER FISHERY RESTORATION SUPPLEMENTAL EIS/EIR

W022004007RDD_04 (4/12/04)

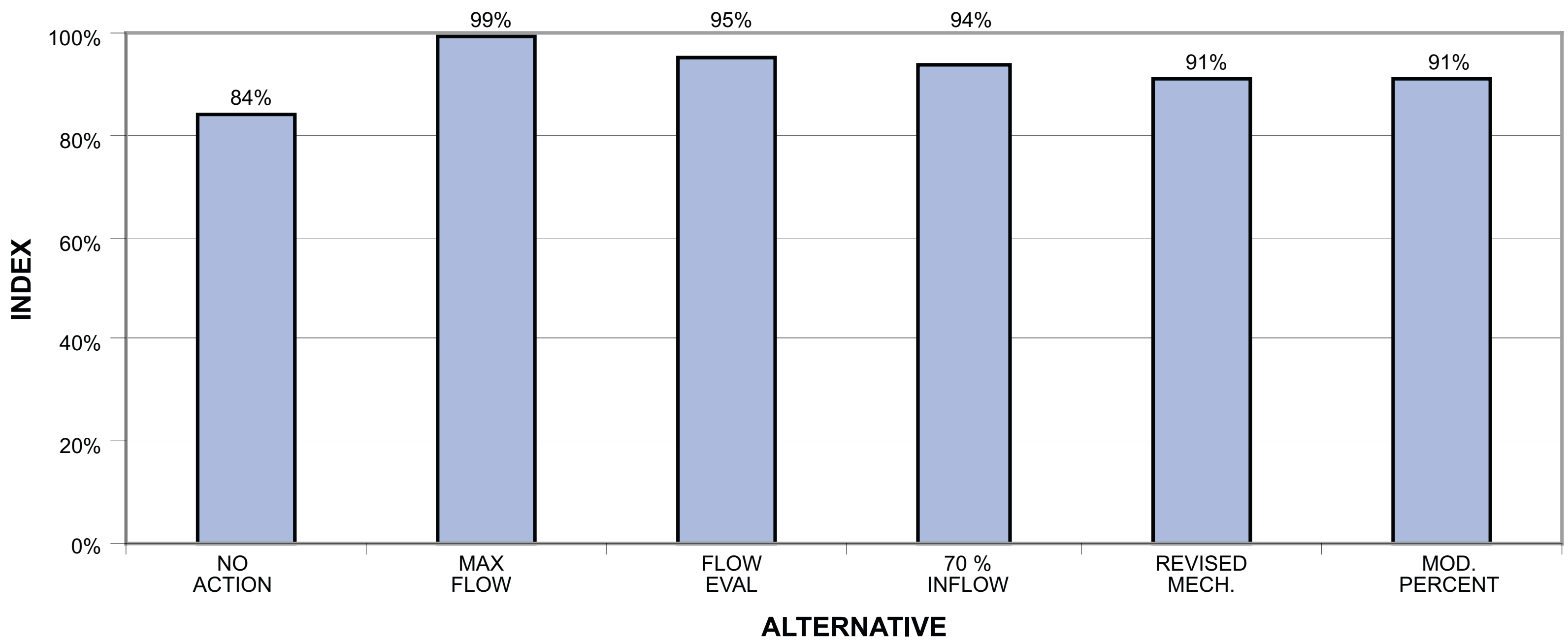


FIGURE B-5B
TRINITY RIVER COHO SMOLT TEMPERATURE SUITABILITY INDICES
TRINITY RIVER FISHERY RESTORATION SUPPLEMENTAL EIS/EIR

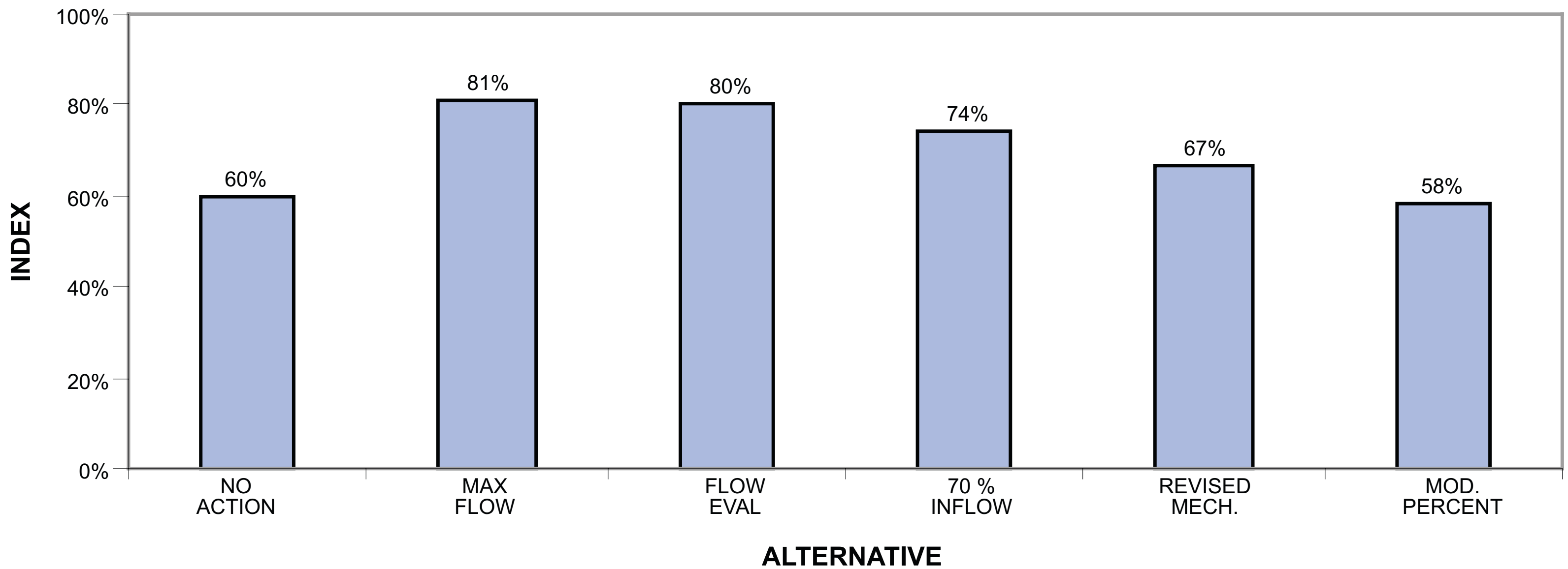


FIGURE B-5C
TRINITY RIVER STEELHEAD SMOLT TEMPERATURE SUITABILITY, SURVIVABILITY INDICES
TRINITY RIVER FISHERY RESTORATION SUPPLEMENTAL EIS/EIR

W022004007RDD_10 (4/12/04)

Attachment B1
Chinook and Coho Salmon and Steelhead Run-size, Spawner Escapements, Angler Harvest, and Origin of Spawner Estimates.

Table B1-1.

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-2002 a

SPAWNER ESCAPEMENT

	1978			1979			1980		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	915	6,925	7,840	257	2,301	2,558	451	2,412	2,863
Trinity River Hatchery (TRH)	1,325	6,034	7,359	964	1,335	2,299	2,256	4,099	6,355
Subtotals	2,240	12,959	15,199	1,221	3,636	4,857	2,707	6,511	9,218
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	4,712	31,052	35,764	3,936	8,028	11,964	16,837	7,700	24,537
Salmon River basin	1,400	2,600	4,000	150	1,000	1,150	200	800	1,000
Scott River basin	1,909	3,423	5,332	428	3,396	3,824	2,245	2,032	4,277
Shasta River basin	6,707	12,024	18,731	1,040	7,111	8,151	4,334	3,762	8,096
Bogus Creek basin	651	4,928	5,579	494	5,444	5,938	1,749	3,321	5,070
Main Stem Klamath River (excluding IGH)	300	1,700	2,000	466	4,190	4,656	867	2,468	3,335
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	735	2,765	3,500	147	1,068	1,215	500	1,000	1,500
Hoopa and Yurok Reservation tribs.	-- b/	-- b/	-- b/	100 c/	400 c/	500 c/	250 c/	400 c/	650 c/
Subtotals	16,414	58,492	74,906	6,761	30,637	37,398	26,982	21,483	48,465
Total Spawner Escapement	18,654	71,451	90,105	7,982	34,273	42,255	29,689	27,994	57,683

IN-RIVER HARVEST

	1978			1979			1980		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	122	854	976	216	484	700	835	727	1,562
Trinity River basin (above Willow Creek)	-- d/	-- d/	-- d/	765	1,157	1,922	2,456	998	3,454
Balance of Klamath system	1,960	840	2,800	1,200	500	1,700	2,600	2,771	5,371
Subtotals	2,082	1,694	3,776	2,181	2,141	4,322	5,891	4,496	10,387
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	--	--	--	--	--	--	495	9,605	10,100
Klamath River (Hwy 101 to Trinity mouth)	--	--	--	--	--	--	272	1,528	1,800
Trinity River (Hoopa Reservation)	--	--	--	--	--	--	220	880	1,100
Subtotals	1,800	18,200	20,000	1,350	13,650	15,000	987	12,013	13,000
Total In-river Harvest	3,882	19,894	23,776	3,531	15,791	19,322	6,878	16,509	23,387

IN-RIVER RUN

	1978			1979			1980		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	22,536	91,345	113,881	11,513	50,064	61,577	36,567	44,503	81,070
Angling Mortality (2% of harvest) f/	42	34	76	44	43	87	118	90	208
Net Mortality (8% of harvest) f/	144	1,456	1,600	108	1,092	1,200	79	961	1,040
Total In-river Run	22,722	92,835	115,557	11,665	51,199	62,864	36,764	45,554	82,318

(continued next page)

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates
1978-2002 a/

SPAWNER ESCAPEMENT

	1981			1982			1983		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	540	2,055	2,595	1,833	8,353	10,186	514	8,371	8,885
Trinity River Hatchery (TRH)	1,004	2,370	3,374	4,235	2,058	6,293	271	5,494	5,765
Subtotals	1,544	4,425	5,969	6,068	10,411	16,479	785	13,865	14,650
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	5,906	15,340	21,246	8,149	9,274	17,423	853	17,284	18,137
Salmon River basin	450	750	1,200	300	1,000	1,300	75	1,200	1,275
Scott River basin	3,409	3,147	6,556	4,350	5,826	10,176	170	3,398	3,568
Shasta River basin	4,330	7,890	12,220	1,922	6,533	8,455	753	3,119	3,872
Bogus Creek basin	912	2,730	3,642	2,325	4,818	7,143	335	2,713	3,048
Main Stem Klamath River (excluding IGH)	1,000	3,000	4,000	1,000	3,000	4,000	200	1,800	2,000
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	500	1,000	1,500	600	1,500	2,100	140	1,270	1,410
Hoopa and Yurok Reservation tribs.	-- b/	-- b/	-- b/	-- b/	-- b/	-- b/	-- b/	-- b/	-- b/
Subtotals	16,507	33,857	50,364	18,646	31,951	50,597	2,526	30,784	33,310
Total Spawner Escapement	18,051	38,282	56,333	24,714	42,362	67,076	3,311	44,649	47,960

IN-RIVER HARVEST

	1981			1982			1983		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	536	1,714	2,250	1,252	3,539	4,791	60	750	810
Trinity River basin (above Willow Creek)	1,456	3,174	4,630	2,554	2,321	4,875	116	2,360	2,476
Balance of Klamath system	5,260	1,095	6,355	8,678	2,479	11,157	175	1,125	1,300
Subtotals	7,252	5,983	13,235	12,484	8,339	20,823	351	4,235	4,586
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	912	23,097	24,009	290	4,547	4,837	12	800	812
Klamath River (Hwy 101 to Trinity mouth)	1,104	8,405	9,509	1,195	8,424	9,619	121	5,700	5,821
Trinity River (Hoopa Reservation)	449	1,531	1,980	314	1,511	1,825	30	1,390	1,420
Subtotals	2,465	33,033	35,498	1,799	14,482	16,281	163	7,890	8,053
Total In-river Harvest	9,717	39,016	48,733	14,283	22,821	37,104	514	12,125	12,639

IN-RIVER RUN

	1981			1982			1983		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	27,768	77,298	105,066	38,997	65,183	104,180	3,825	56,774	60,599
Angling Mortality (2% of harvest) f/	145	120	265	250	167	417	7	85	92
Net Mortality (8% of harvest) f/	197	2,643	2,840	144	1,159	1,303	13	631	644
Total In-river Run	28,110	80,061	108,171	39,391	66,509	105,900	3,845	57,490	61,335

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates 1978-2002 a/

SPAWNER ESCAPEMENT

	1984			1985			1986		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	764	5,330	6,094	2,159	19,951	22,110	1,461	17,096	18,557
Trinity River Hatchery (TRH)	766	2,166	2,932	18,166	2,583	20,749	3,609	15,795	19,404
Subtotals	1,530	7,496	9,026	20,325	22,534	42,859	5,070	32,891	37,961
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	3,416	5,654	9,070	29,454	9,217	38,671	20,459	92,548	113,007
Salmon River basin	216 g/	1,226 g/	1,442 g/	905	2,259	3,164	949	2,716	3,665
Scott River basin	358	1,443	1,801	1,357	3,051	4,408	4,865	3,176	8,041
Shasta River basin	480	2,362	2,842	2,227	2,897	5,124	683	3,274	3,957
Bogus Creek basin	465	3,039	3,504	1,156	3,491	4,647	1,184	6,124	7,308
Main Stem Klamath River (excluding IGH)	200	1,350	1,550	156	468	624	196	603	799
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	150	990	1,140	646	4,214	4,860	606	4,919	5,525
Hoopa and Yurok Reservation tribs.	-- b/	-- b/	-- b/	50 h/	80 h/	130 h/	-- b/	-- b/	-- b/
Subtotals	5,285	16,064	21,349	35,951	25,677	61,628	28,942	113,360	142,302
Total Spawner Escapement	6,815	23,560	30,375	56,276	48,211	104,487	34,012	146,251	180,263

IN-RIVER HARVEST

	1984			1985			1986		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	175	548	723	1,479	2,427 i/	3,906	704	2,456	3,160
Trinity River basin (above Willow Creek)	393	736	1,129	5,442	154 i/	5,596	3,438	12,039	15,477
Balance of Klamath system	384	2,056	2,440	4,274	1,001 i/	5,275	5,266	6,532	11,798
Subtotals	952	3,340	4,292	11,195	3,582 i/	14,777	9,408	21,027	30,435
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	132	11,878	12,010	132	5,700	5,832	191	15,286	15,477
Klamath River (Hwy 101 to Trinity mouth)	183	5,622	5,805	476	3,925	4,401	377	5,033	5,410
Trinity River (Hoopa Reservation)	140	1,170	1,310	947 j/	1,941 j/	2,888 j/	286	4,808	5,094
Subtotals	455	18,670	19,125	1,555	11,566	13,121	854	25,127	25,981
Total In-river Harvest	1,407	22,010	23,417	12,750	15,148	27,898	10,262	46,154	56,416

IN-RIVER RUN

	1984			1985			1986		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	8,222	45,570	53,792	69,026	63,359	132,385	44,274	192,405	236,679
Angling Mortality (2% of harvest) f/	19	67	86	224	72	296	188	421	609
Net Mortality (8% of harvest) f/	36	1,494	1,530	124	925	1,049	68	2,010	2,078
Total In-river Run	8,277	47,131	55,408	69,374	64,356	133,730	44,530	194,836	239,366

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates 1978-2002 a/

SPAWNER ESCAPEMENT

	1987			1988			1989		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	1,825	15,189	17,014	609	16,106	16,715	831	10,859	11,690
Trinity River Hatchery (TRH)	2,453	13,934	16,387	4,752	17,352	22,104	239	11,132	11,371
Subtotals	4,278	29,123	33,401	5,361	33,458	38,819	1,070	21,991	23,061
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	5,949	71,920	77,869	10,626	44,616	55,242	2,543	29,445	31,988
Salmon River basin	118	3,832	3,950	327	3,273	3,600	695	2,915	3,610
Scott River basin	797	7,769	8,566	473	4,727	5,200	1,188	3,000	4,188
Shasta River basin	398	4,299	4,697	256	2,586	2,842	137	1,440	1,577
Bogus Creek basin	1,208	9,748	10,956	225	16,215	16,440	444	2,218	2,662
Main Stem Klamath River (excluding IGH)	65	863	928	164	2,982	3,146	214	1,011	1,225
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	237	3,286	3,523	418	4,167	4,585	248	3,239	3,487
Hoopa and Yurok Reservation tribs.	-- b/	-- b/	-- b/	55 k/	820 k/	875 k/	40 k/	600 k/	640 k/
Subtotals	8,772	101,717	110,489	12,544	79,386	91,930	5,509	43,868	49,377
Total Spawner Escapement	13,050	130,840	143,890	17,905	112,844	130,749	6,579	65,859	72,438

IN-RIVER HARVEST

	1987			1988			1989		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	146	2,455	2,601	124	3,367	3,491	137	1,328	1,465
Trinity River basin (above Willow Creek)	923	9,433	10,356	2,735	9,341	12,076	209	3,054	3,263
Balance of Klamath system	4,367	8,281	12,648	2,552	9,495	12,047	1,921	4,393	6,314
Subtotals	5,436	20,169	25,605	5,411	22,203	27,614	2,267	8,775	11,042
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	36	39,978	40,014	138	36,914	37,052	0	37,130	37,130
Klamath River (Hwy 101 to Trinity mouth)	117	8,136	8,253	173	9,667	9,840	120	4,961	5,081
Trinity River (Hoopa Reservation)	262	4,982	5,244	267	5,070	5,337	71	3,474	3,545
Subtotals	415	53,096	53,511	578	51,651	52,229	191	45,565	45,756
Total In-river Harvest	5,851	73,265	79,116	5,989	73,854	79,843	2,458	54,340	56,798

IN-RIVER RUN

	1987			1988			1989		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	18,901	204,105	223,006	23,894	186,698	210,592	9,037	120,199	129,236
Angling Mortality (2% of harvest) f/	109	403	512	108	444	552	45	176	221
Net Mortality (8% of harvest) f/	33	4,248	4,281	46	4,132	4,178	15	3,645	3,660
Total In-river Run	19,043	208,756	227,799	24,048	191,274	215,322	9,097	124,020	133,117

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates 1978-2002 a/

SPAWNER ESCAPEMENT

	1990			1991			1992		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	321	6,704	7,025	65	4,002	4,067	3,737	3,581	7,318
Trinity River Hatchery (TRH)	371	1,348	1,719	205	2,482	2,687	211	3,779	3,990
Subtotals	692	8,052	8,744	270	6,484	6,754	3,948	7,360	11,308
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	241	7,682	7,923	382	4,867	5,249	2,563	7,139	9,702
Salmon River basin	596 l/	4,071 l/	4,667 l/	143	1,337	1,480	547	778	1,325
Scott River basin	236	1,379	1,615	146	2,019	2,165	965	1,873	2,838
Shasta River basin	118	415	533	10	716	726	66	520	586
Bogus Creek basin	53	732	785	20	1,261	1,281	556	598	1,154
Main Stem Klamath River (excluding IGH)	59	505	564	8	572	580	234	366	600
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	30	694	724	9	495	504	153	280	433
Hoopa and Yurok Reservation tribs.	17 k/	118 k/	135 k/	0 k/	382 k/	382 k/	59 k/	474 k/	533 k/
Subtotals	1,350	15,596	16,946	718	11,649	12,367	5,143	12,028	17,171
Total Spawner Escapement	2,042	23,648	25,690	988	18,133	19,121	9,091	19,388	28,479

IN-RIVER HARVEST

	1990			1991			1992		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	58	291	349	19	314	333	13	20	33
Trinity River basin (above Willow Creek)	22	328	350	94	1,177	1,271	158	314	472
Balance of Klamath system	2,020	2,934	4,954	573	1,892	2,465	3,949	668	4,617
Subtotals	2,100	3,553	5,653	686	3,383	4,069	4,120	1,002	5,122
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	13	3,648	3,661	7	3,902	3,909	124	1,152	1,276
Klamath River (Hwy 101 to Trinity mouth)	141	3,447	3,588	25	5,016	5,041	200	3,687	3,887
Trinity River (Hoopa Reservation)	36	811	847	30	1,280	1,310	42	946	988
Subtotals	190	7,906	8,096	62	10,198	10,260	366	5,785	6,151
Total In-river Harvest	2,290	11,459	13,749	748	13,581	14,329	4,486	6,787	11,273

IN-RIVER RUN

	1990			1991			1992		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	4,332	35,107	39,439	1,736	31,714	33,450	13,577	26,175	39,752
Angling Mortality (2% of harvest) f/	42	71	113	14	68	82	82	20	102
Net Mortality (8% of harvest) f/	15	632	647	5	816	821	29	463	492
Total In-river Run	4,389	35,810	40,199	1,755	32,598	34,353	13,688	26,658	40,346

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates 1978-2002 a/

SPAWNER ESCAPEMENT

	1993			1994			1995		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	883	20,828	21,711	758	11,475 m/	12,233	259	13,749 m/	14,008
Trinity River Hatchery (TRH)	736	815	1,551	4,442	3,264	7,706	76	15,178	15,254
Subtotals	1,619	21,643	23,262	5,200	14,739	19,939	335	28,927	29,262
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	2,465	5,905	8,370	2,505	10,906	13,411	9,262	77,876	87,138
Salmon River basin	456	3,077	3,533	277	3,216	3,493	1,335	4,140	5,475
Scott River basin	265	5,035	5,300	505	2,358	2,863	3,279	11,198	14,477
Shasta River basin	85	1,341	1,426	1,840	3,363	5,203	695	12,816	13,511
Bogus Creek basin	431	3,285	3,716	443	7,817	8,260	1,207	45,225	46,432
Main Stem Klamath River (excluding IGH)	31 n/	647 n/	678 n/	625 n/	3,249 n/	3,874 n/	768 n/	6,472 n/	7,240 n/
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	92	2,470	2,562	50	1,202	1,252	744 o/	3,654 o/	4,398 o/
Hoopa and Yurok Reservation tribs.	0 h/	98 h/	98 h/	0 h/	222 h/	222 h/	34 p/	413 p/	447 p/
Subtotals	3,825	21,858	25,683	6,245	32,333	38,578	17,324	161,794	179,118
Total Spawner Escapement	5,444	43,501	48,945	11,445	47,072	58,517	17,659	190,721	208,380

IN-RIVER HARVEST

	1993			1994			1995		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	23	669	692	246	662	908	323	956	1,279
Trinity River basin (above Willow Creek)	172	391	563	547	260	807	554	2,779	3,333
Balance of Klamath system	1,730	2,112	3,842	1,763	910	2,673	3,543	2,346 q/	5,889
Subtotals	1,925	3,172	5,097	2,556	1,832	4,388	4,420	6,081	10,501
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	62	3,017	3,079	81	4,362	4,443	137	5,119	5,256
Klamath River (Hwy 101 to Trinity mouth)	80	5,127	5,207	118	5,064	5,182	152	7,055	7,207
Trinity River (Hoopa Reservation)	33	1,492	1,525	94	2,266	2,360	268	3,383	3,651
Subtotals	175	9,636	9,811	293	11,692	11,985	557	15,557	16,114
Total In-river Harvest	2,100	12,808	14,908	2,849	13,524	16,373	4,977	21,638	26,615

IN-RIVER RUN

	1993			1994			1995		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	7,544	56,309	63,853	14,294	60,596	74,890	22,636	212,359	234,995
Angling Mortality (2% of harvest) f/	39	63	102	51	37	88	88	122	210
Net Mortality (8% of harvest) f/	14	771	785	23	935	958	45	1,245	1,290
Total In-river Run	7,597	57,143	64,740	14,368	61,568	75,936	22,769	213,726	236,495

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates 1978-2002 a/

SPAWNER ESCAPEMENT

	1996			1997			1998		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	543	13,622	14,165	452	13,275	13,727	403	14,923	15,326
Trinity River Hatchery (TRH)	249	6,411	6,660	820	5,387	6,207	192	14,296	14,488
Subtotals	792	20,033	20,825	1,272	18,662	19,934	595	29,219	29,814
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	4,478	42,646	47,124	2,845	11,507	14,352	1,974	24,460	26,434
Salmon River basin	274	5,189	5,463	217	5,783	6,000	116	1,337	1,453
Scott River basin	145	11,952	12,097	277	8,284	8,561	266	3,061	3,327
Shasta River basin	46	1,404	1,450	334	1,667	2,001	76	2,466	2,542
Bogus Creek basin	377	10,420	10,797	221	9,809	10,030	205	6,630	6,835
Main Stem Klamath River (excluding IGH)	218 n/	2,790 n/	3,008 n/	104 n/	3,472 n/	3,576 n/	109 n/	2,913 n/	3,022 n/
Misc. Klamath-Trinity tributaries (above Hoopa and Yurok Reservations)	581 o/	5,804 o/	6,385 o/	174 o/	5,174 o/	5,348 o/	83 o/	1,232 o/	1,315 o/
Hoopa and Yurok Reservation tribs.	55 p/	1,121 p/	1,176 p/	53 p/	448 p/	501 p/	26 p/	389 p/	415 p/
Subtotals	6,174	81,326	87,500	4,225	46,144	50,369	2,855	42,488	45,343
Total Spawner Escapement	6,966	101,359	108,325	5,497	64,806	70,303	3,450	71,707	75,157

IN-RIVER HARVEST

	1996			1997			1998		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	100	3,110	3,210	49	2,182	2,231	124	1,603	1,727
Klamath River (Hwy 101 to Coon Cr Falls)	1,128	4,052	5,180	1,226	512	1,738	406	1,270	1,676
Trinity River basin (above Willow Creek)	331	1,214	1,545 r/	353	1,331	1,684 s/	275	3,262	3,537 u/
Balance of Klamath system	753	4,390	5,143	781	1,651	2,432 t/	303	1,575	1,878 v/
Subtotals	2,312	12,766	15,078	2,409	5,676	8,085	1,108	7,710 x/	8,818
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	163	49,113	49,276	21	5,574	5,595	16	3,454	3,470
Klamath River (Hwy 101 to Trinity mouth)	19	4,593	4,612	8	5,275	5,283	32	5,198	5,230
Trinity River (Hoopa Reservation)	8	2,770	2,778	6	1,238	1,244	5	1,535	1,540
Subtotals	190	56,476	56,666	35	12,087	12,122	53	10,187	10,240
Total In-river Harvest	2,502	69,242	71,744	2,444	17,763	20,207	1,161	17,897	19,058

IN-RIVER RUN

	1996			1997			1998		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	9,468	170,601	180,069	7,941	82,569	90,510	4,611	89,604	94,215
Angling Mortality (2% of harvest) f/	46	255	301	48	114	162	22	154	176
Net Mortality (8% of harvest) f/	15	4518	4533	3	967	970	4	815	819
Total In-river Run	9,529	175,374	184,903	7,992	83,650	91,642	4,637	90,573	95,210

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates
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SPAWNER ESCAPEMENT

	1999			2000			2001		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	4,830	9,290	14,120	839	71,635	72,474	1,364	37,204	38,568
Trinity River Hatchery (TRH)	2,027	5,037	7,064	1,070	25,976	27,046	267	17,908	18,175
Subtotals	6,857	14,327	21,184	1,909	97,611	99,520	1,631	55,112	56,743
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	4,154	6,753	10,907	3,376	23,468	26,844	1,336	35,991	37,327 cc/
Salmon River basin	110	670	780	228	1,544	1,772	743	2,607	3,350
Scott River basin	563	3,021	3,584	524	5,729	6,253	744	5,398	6,142
Shasta River basin	1,901	1,296	3,197	1,271	11,025	12,296	2,641	8,452	11,093
Bogus Creek basin	2,628	3,537	6,165	373	34,678	35,051	648	11,927	12,575
Main Stem Klamath River n/ (excluding IGH)	630	1,978	2,608	184	3,271	3,455	1,016	9,832	10,848
Misc. Klamath-Trinity tributaries o/ (above Hoopa and Yurok Reservations)	251	777	1,028	261	2,051	2,312	565	2,969	3,534
Hoopa and Yurok Reservation tribs. p/	210	425	635	177	962	1,139	54	657	711
Subtotals	10,447	18,457	28,904	6,394	82,728	89,122	7,747	77,833	85,580
Total Spawner Escapement	17,304	32,784	50,088	8,303	180,339	188,642	9,378	132,945	142,323

IN-RIVER HARVEST

	1999			2000			2001		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	37	177	214	108	1,190	1,298	298	4,620	4,918
Klamath River (Hwy 101 to Coon Cr Falls)	869 y/	1,112 y/	1,981 y/	972	1,006	1,978	825	1,960	2,785
Klamath River (Coon Cr Falls to IGH)	138 z/	571 z/	709 z/	117	1,549	1,666 bb/	242	3,041	3,283
Trinity River basin above Weitchpec aa/	572	422	994	385	1,905	2,290	135	2,513	2,648
Subtotals	1616	2282	3898	1582	5650	7232	1,500	12,134	13,634
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	126	4,387	4,513	35	17,278	17,313	261	28,967	29,228
Klamath River (Hwy 101 to Trinity mouth)	49	7,295	7,344	140	6,175	6,315	78	4,724	4,802
Trinity River (Hoopa Reservation)	96	2,978	3,074	128	5,962	6,090	60	4,954	5,014
Subtotals	271	14,660	14,931	303	29,415	29,718	399	38,645	39,044
Total In-river Harvest	1,887	16,942	18,829	1,885	35,065	36,950	1,899	50,779	52,678

IN-RIVER RUN

	1999			2000			2001		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	19,191	49,726	68,917	10,188	215,404	225,592	11,277	183,724	195,001
Angling Mortality (2% of harvest) f/	32	46	78	32	113	145	30	243	273
Net Mortality (8% of harvest) f/	22	1173	1195	24	2353	2377	32	3,092	3,124
Total In-river Run	19,245	50,945	70,190	10,244	217,870	228,114	11,339	187,059	198,398

(continued next page)

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates 1978-2002 a/

SPAWNER ESCAPEMENT

	2002			2003			2004		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	1,296	23,665	24,961						
Trinity River Hatchery (TRH)	1,034	3,515	4,549						
Hatchery Spawner Subtotals:	**2,330**	**27,180**	**29,510**						
Natural Spawners									
Main Stem Klamath River n/ (excluding IGH)	658	21,650	22,308						
Shasta River basin	386	6,432	6,818						
Scott River basin	47	4,261	4,308						
Salmon River basin	72	2,486	2,558						
Bogus Creek basin	305	17,529	17,834						
Misc. Klamath tributaries o/ (above Yurok Reservation)	44	1,344	1,388						
Yurok Reservation tribs. (Klamath River) p/	12	339	351						
Klamath Natural Spawner Subtotals:	**1,524**	**54,041**	**55,565**						
Main Stem Trinity River dd/ (excluding TRH)	2,257	11,075	13,332						
Misc. Trinity tributaries o/ (above Hoopa Reservation)	66	324	390						
Hoopa Reservation tribs. (Trinity River) p/	42	206	248						
Trinity Natural Spawner Subtotals:	**2,365**	**11,605**	**13,970**						
Natural Spawner Subtotals:	**3,889**	**65,646**	**69,535**						
Total Spawner Escapement	**6,219**	**92,826**	**99,045**						

IN-RIVER HARVEST

	2002			2003			2004		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	274	3,285	3,559						
Klamath River (Hwy 101 to Coon Cr Falls)	283	3,269	3,552						
Klamath River (Coon Cr Falls to IGH)	93	3,216	3,309						
Trinity River basin above Weitchpec aa/	221	640	861						
Angler Harvest Subtotals:	**871**	**10,410**	**11,281**						
Indian Net Harvest e/									
Klamath River (below Hwy 101 bridge)	17	19,701	19,718						
Klamath River (Hwy 101 to Trinity mouth)	41	3,257	3,298						
Trinity River (Hoopa Reservation)	68	1,168	1,236						
Indian Net Harvest Subtotals:	**126**	**24,126**	**24,252**						
Total In-river Harvest	**997**	**34,536**	**35,533**						

IN-RIVER RUN

	2002			2003			2004		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	7,216	127,362	134,578						
Angling Mortality (2% of harvest) f/	17	209	226						
Net Mortality (8% of harvest) f/	10	1,930	1,940						
Fish Die Off ee/	2,003	30,550	32,553						
Total In-river Run	**9,246**	**160,051**	**169,297**						

(continued next page)

Year	Grilse	Adults	Total					
1978	22,722	92,835	115,557					
1979	11,665	51,199	62,864					
1980	36,764	45,554	82,318					**Total**
1981	28,110	80,061	108,171					**82-'02**
1982	39,391	66,509	105,900					105900
1983	3,845	57,490	61,335					61335
1984	8,277	47,131	55,408					55408
1985	69,374	64,356	133,730					133730
1986	44,530	194,836	239,366					239366
1987	19,043	208,756	227,799					227799
1988	24,048	191,274	215,322					215322
1989	9,097	124,020	133,117					133117
1990	4,389	35,810	40,199					40199
1991	1,755	32,598	34,353					34353
1992	13,688	26,658	40,346					40346
1993	7,597	57,143	64,740					64740
1994	14,368	61,568	75,936					75936
1995	22,769	213,726	236,495					236495
1996	9,529	175,374	184,903					184903
1997	7,992	83,650	91,642	% of all previous years				91642
1998	4,637	90,573	95,210	0.250413	0.88472			95210
1999	19,245	50,945	70,190	1.039292	0.497632	0.5806		70190
2000	10,244	217,870	228,114	0.553209	2.128161	1.886921		228114
2001	11,339	187,059	198,398	0.612342	1.827198	1.641115		198398
2002	9,246	160,051	169,297					169297
Average:	18,517	102,375	120,892 *				**avg.**	128657.1

* In-River Runs from 1978 to Present Year-1

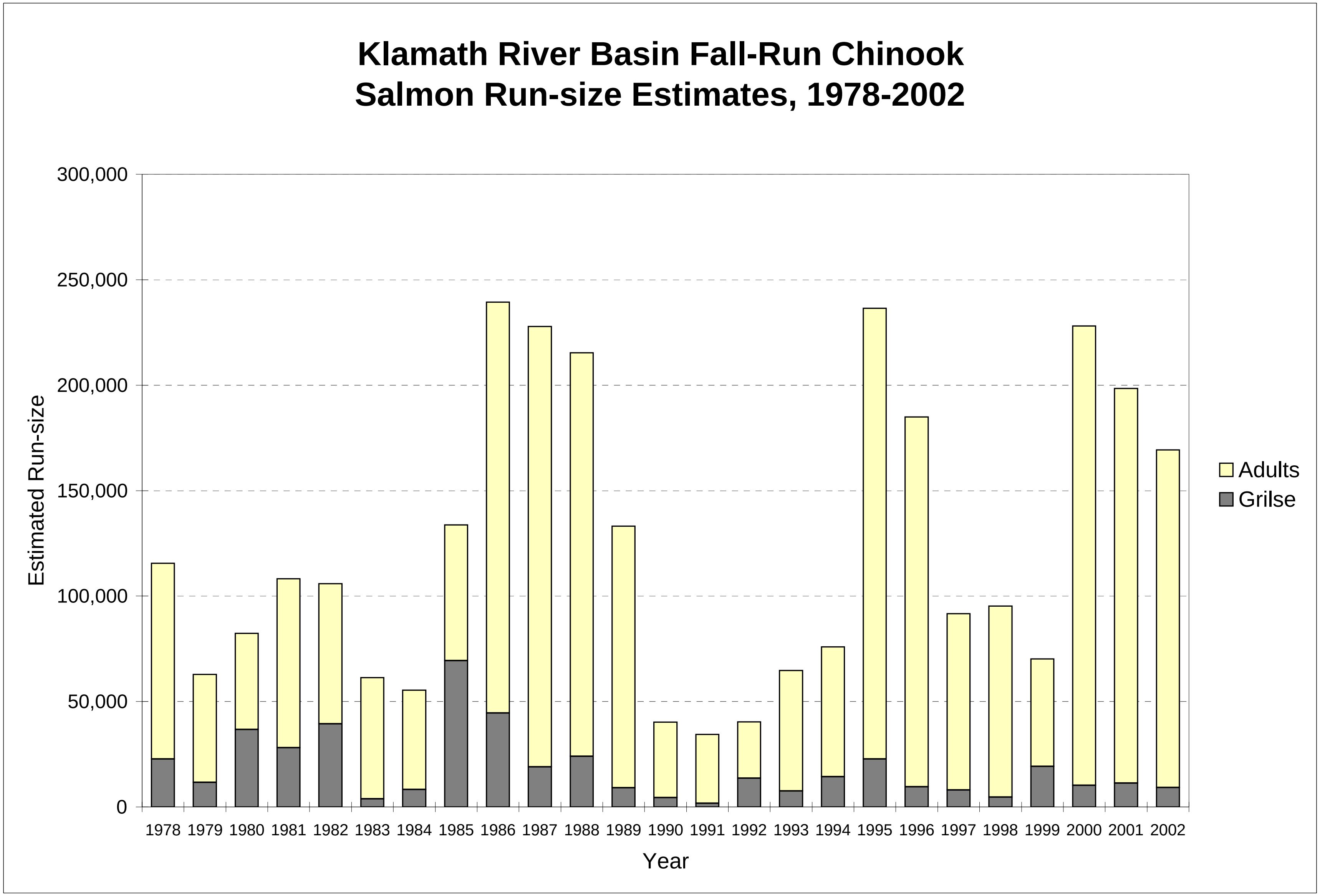

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Table B1-2
Estimated Trinity River Spring Chinook Run-size, Spawning Escapement, Angler Harvest, and Origin of Spawners Upstream of Junction City Weir (1977-2002) (W. Sinnen, CDFG, personal communication, 2003).

Year	Run Size Estimate	Total Basin Escapement	Inriver Spawner Escapement	Angler Harvest	TRSSH Escapement	TRFH Ad Clip Rate	JCW Ad Clip Rate	% Hatchery	Hatchery Produced Inriver Escapement	Natural Produced Inriver Escapement	Inriver % Natural
1977					1,509						
1978	19,006	18,246	14,413	760	3,833						
1979	8,077	6,779	5,008	1298	1,771						
1980	4,250	3,826	2,926	424	900						
1981	8,260	6,104	3,604	2156	2,500						
1982	6,387	5,631	4,255	756	1,376	0.753	0.489	64.9%	3,657	1,974	46%
1983					1,158						
1984	2,720	2,306	1,494	414	812	0.319	0.028	8.8%	202	2,104	141%
1985	9,712	8,849	5,696	863	3,153	0.24	0.223	92.9%	8,222	627	11%
1986	30,421	26,250	17,706	4171	8,544	0.097	0.174	100.0%	26,250	0	0%
1987	50,874	41,513	31,660	9361	9,853	0.138	0.135	97.8%	40,611	902	3%
1988	62,692	53,852	39,570	8840	14,282	0.13	0.115	88.5%	47,638	6,214	16%
1989	26,306	23,676	18,676	2630	5,000	0.145	0.131	90.3%	21,390	2,286	12%
1990	6,388	5,543	3,006	845	2,537	0.149	0.125	83.9%	4,650	893	30%
1991	2,381	2,045	1,360	336	685	0.088	0.061	69.3%	1,418	627	46%
1992	4,030	3,732	1,886	298	1,846	0.118	0.069	58.5%	2,182	1,550	82%
1993	5,232	4,809	2,148	423	2,661	0.083	0.091	100.0%	4,809	0	0%
1994	6,788	6,334	3,447	454	2,887	0.22	0.17	77.3%	4,894	1,440	42%
1995 a/					8,722						
1996	23,416	21,903	16,653	1513	5,250	0.168	0.113	67.3%	14,750	7,153	43%
1997	20,039	18,709	13,592	1330	5,117	0.124	0.064	51.8%	9,688	9,021	66%
1998	16,167	14,487	9,624	1680	4,863	0.160	0.117	72.8%	10,550	3,937	41%
1999	11,293	10,626	6,408	667	4,218	0.198	0.145	73.1%	7,765	2,861	45%
2000	26,082	24,275	12,110	1807	12,165	0.236	0.195	82.7%	20,081	4,194	35%
2001	19,621	18,457	11,462	1164	6,995	0.259	0.189	73.1%	13,489	4,968	43%
2002 b/	38,565	36,690	25,633	1875	11,057	0.211	0.152	71.7%	26,320	10,370	40%
Years		**('78-'82, '84-'94, '96-'02)**			**('77-'02)**					**('82,'84-94, '96-'02)**	
Average	**17,770**	**15,854**	**10,971**	**1,916**	**4,757**				**14,135**	**3,217**	**39.1%**
Min	**2,381**	**2,045**	**1,360**	**298**	**685**				**202**	**0**	**0.0%**
Max	**62,692**	**53,852**	**39,570**	**9,361**	**14,282**				**47,638**	**10,370**	**100.0%**

a/ the Junction City weir was not operated in 1995
b/ all data from 2002 is preliminary

Table B1-3

Estimated Trinity River Fall Chinook Salmon Run-size, Spawning Escapement, Angler Harvest, and Origin of Spawners Upstream of Junction City Weir (1977-2002) (W. Sinnen, DFG, personal communication, 2003)

Year	Run Size Estimate	Total Basin Escapement	Inriver Spawner Escapement	TRSSH Escapement	Angler Harvest	WCW Ad Clip Rate	TRFH Ad Clip Rate	Basin % Hatchery	Hatchery Produced Inriver Escapement	Natural Produced Inriver Escapement	Total Inriver spawners	Inriver % Natural
1977	32,914	27,450	23,238	4,212	5,464							35.6%
1978	43,123	43,123	35,764	7,359	0							17.8%
1979	16,185	14,263	11,964	2,299	1,922							49.2%
1980	34,346	30,892	24,537	6,355	3,454							9.7%
1981	29,250	24,620	21,246	3,374	4,630							22.7%
1982	28,591	23,716	17,423	6,293	4,875	0.161	0.218	73.9%	17,515	6,201	17,423	35.6%
1983	26,378	23,902	18,137	5,765	2,476	0.128	0.148	86.5%	20,672	3,230	18,137	17.8%
1984	13,131	12,002	9,070	2,932	1,129	0.081	0.129	62.8%	7,536	4,466	9,070	49.2%
1985	65,016	59,420	38,671	20,749	5,596	0.192	0.205	93.7%	55,652	3,768	38,671	9.7%
1986	147,888	132,411	113,007	19,404	15,477	0.216	0.268	80.6%	106,719	25,692	113,007	22.7%
1987	104,612	94,256	77,869	16,387	10,356	0.197	0.221	89.1%	84,020	10,236	77,869	13.1%
1988	89,422	77,346	55,242	22,104	12,076	0.111	0.134	82.8%	64,070	13,276	55,242	24.0%
1989	46,622	43,359	31,988	11,371	3,263	0.068	0.103	66.0%	28,625	14,734	31,988	46.1%
1990	9,992	9,642	7,923	1,719	350	0.060	0.128	46.9%	4,520	5,122	7,923	64.7%
1991	9,207	7,936	5,249	2,687	1,271	0.083	0.118	70.3%	5,582	2,354	5,249	44.8%
1992	14,164	13,692	9,702	3,990	472	0.039	0.118	33.1%	4,525	9,167	9,702	94.5%
1993	10,485	9,921	8,370	1,551	563	0.040	0.182	22.0%	2,180	7,741	8,370	92.5%
1994	21,924	21,117	13,411	7,706	807	0.084	0.128	65.6%	13,858	7,259	13,411	54.1%
1995	105,725	102,392	87,138	15,254	3,333	0.059	0.099	59.6%	61,021	41,371	87,138	47.5%
1996	55,646	53,784	47,124	6,660	1,862	0.048	0.115	41.5%	22,338	31,446	47,124	66.7%
1997	21,347	20,559	14,352	6,207	788	0.075	0.148	50.6%	10,396	10,163	14,352	70.8%
1998	43,189	40,922	26,434	14,488	2,267	0.070	0.106	65.8%	26,928	13,994	26,434	52.9%
1999	18,516	17,971	10,907	7,064	545	0.101	0.138	73.6%	13,234	4,737	10,907	43.4%
2000	55,473	53,890	26,844	27,046	1,583	0.176	0.228	77.4%	41,686	12,204	26,844	45.5%
2001	57,109	55,241	37,066	18,175	1,868	0.196	0.297	66.0%	36,477	18,764	37,066	50.6%
2002 a/	18,156	17,429	12,876	4,553	727	0.126	0.212	59.4%	10,359	7,070	12,876	54.9%
Years:			**(1977-2002)**							**(1982-2002)**		
Average	**43,016**	**39,664**	**30,214**	**9,450**	**3,352**			**65.1%**	**30,377**	**12,047**	**31,848**	**42.3%**
Min	**9,207**	**7,936**	**5,249**	**1,551**	**0**			**22.0%**	**2,180**	**2,354**	**5,249**	**9.7%**
Max	**147,888**	**132,411**	**113,007**	**27,046**	**15,477**			**93.7%**	**106,719**	**41,371**	**113,007**	**94.5%**

a/ all data from 2002 is preliminary

Table B1-4

Estimated Trinty River Coho Salmon Run-size, Spawning Escapement, Angler Harvest, and Origin of Spawners Upstream of Willow Creek Weir (1977-2002). (W.

Year	Run Size Estimate	Total Basin Escapement	Inriver Spawner Escapement	TRSSH Escapement	TRFH Ad Clip Rate	WCW Ad Clip Rate	Basin % Hatchery	Angler Harvest	Hatchery Produced Inriver Escapement	Natural Produced Inriver Escapement	% Natural
1977	3,858	3,709	1,781	1,928				149			
1978	9,132	9,132	5,477	3,655				0			
1979	11,624	10,797	7,262	3,535				827			
1980	6,094	6,094	2,771	3,323				0			
1981	10,970	10,004	5,481	4,523				966			
1982	11,529	11,053	6,255	4,798				476			
1983	1,971	1,789	1,083	706				182			
1984	19,694	18,020	9,159	8,861				1674			
1985	38,933	38,170	26,384	11,786				763			
1986	27,972	27,272	19,281	7,991				700			
1987	59,079	55,711	32,373	23,338				3368			
1988	38,904	36,943	24,127	12,816				1961			
1989	18,752	18,452	13,482	4,970				300			
1990	3,897	3,850	2,215	1,635				47			0%
1991	9,124	9,015	6,327	2,688	0.003	0.003	100.0%	109	9,015	0	0%
1992	10,339	10,315	6,733	3,582	0.100	0.091	91.0%	24	9,387	928	14%
1993	5,621	5,557	3,440	2,117	0.136	0.134	98.5%	64	5,475	82	2%
1994	852	852	558	294	0.061	0.070	100.0%	0	852	0	0%
1995	16,111	15,817	11,050	4,767	0.097	0.104	100.0%	294	15,817	0	0%
1996	36,660	36,412	26,457	9,955				248			
1997	7,935	7,893	6,135	1,758	0.981	0.918	93.6%	42	7,386	507	8%
1998	12,480	12,480	7,489	4,991	0.975	0.931	95.5%	0	11,923	557	7%
1999	5,535	5,437	1,930	3,507	0.968	0.904	93.4%	98	5,076	361	19%
2000	15,532	15,532	11,145	4,387	0.985	0.966	98.0%	0	15,225	307	3%
2001	32,140	32,140	21,359	10,781	0.988	0.895	90.6%	0	29,124	3,016	14%
2002 a/	16,016	16,016	8,818	7,198	0.986	0.946	96.0%	0	15,370	646	7%
Years:				('77-'02)					('91-'95, '97-'02)		
Average:	**16,567**	**16,095**	**10,330**	**5,765**				**473**	**11,332**	**582**	**7%**
Min:	**852**	**852**	**558**	**294**				**0**	**852**	**0**	**0%**
Max:	**59,079**	**55,711**	**32,373**	**23,338**				**3,368**	**29,124**	**3,016**	**19%**

a/ all data from 2002 is preliminary

Table B1-5

Estimated Trinty River Winter Steelhead Run-size, Spawning Escapement, Angler Harvest, and Origin of Spawners Upstream of the Willow Creek Weir (1977-2002). (W. Sinnen, CDFG, personal commumication, 2003)

Year	Run Size	Total Basin Escapement	Inriver Spawners	Angler Harvest	TRSSH Escapement	Hatchery Produced Inriver Escapement	Natural Produced Inriver Escapement	% Hatchery Origin	% Natural Origin
1977					285				
1978					683				
1979					382				
1980	25,094	21,568	19,563	3,526	2,005	5,101	14,462	26%	74%
1981					1,004				
1982	10,532	8,573	7,860	1,959	713	971	6,889	12%	88%
1983	8,605	7,260	6,661	1,345	599				
1984	7,833	6,572	6,430	1,261	142				
1985					461				
1986					3,780				
1987					3,007				
1988	12,743	12,743	11,926		817				
1989	37,276	33,698	28,933	3,578	4,765				
1990	5,348	4,118	3,188	1,230	930				
1991	11,417	9,077	8,631	2,340	446				
1992	3,046	2,754	2,299	292	455	759	1,540	33%	67%
1993	3,243	2,862	1,977	381	885	801	1,176	41%	59%
1994	4,244	3,699	3,288	545	411	878	2,410	27%	73%
1995	4,288	3,996	3,291	292	705	1,424	1,867	43%	57%
1996	10,435	9,842	5,830	593	4,012				
1997	5,212	4,696	4,267	516	429				
1998	2,972	2,904	2,463	68	441				
1999	5,470	5,388	3,817	82	1,571				
2000	8,042	7,865	7,097	177	768				
2001	12,638	12,271	9,938	367	2,333				
2002 a/	19,058	18,302	12,264	756	6,038	7,907	4,636	64%	38%
Years:		**('80,82-'84,'88-'02)**		**('80,'82-'84,'89-'02)**	**('77-'02)**		**('80,'82,'92-'95,'02)**		
Average:	**10,395**	**9,378**	**7,880**	**1,073**	**1,464**	**2,549**	**4,711**	**35%**	**65%**
Min:	**2,972**	**2,754**	**1,977**	**68**	**142**	**759**	**1,176**	**12%**	**38%**
Max:	**37,276**	**33,698**	**28,933**	**3,578**	**6,038**	**7,907**	**14,462**	**64%**	**88%**
Average('92-'95, '02)	**6,776**	**6,323**	**4,624**	**453**	**1,699**	**2,354**	**2,326**	**42%**	**59%**

a/ all data from 2002 is preliminary

Attachment B2
Memorandum from Daryl Peterson, Trinity Restoration Program: "Preliminary Results from Monitoring the Trinity River Fall Flows Action Plan"

Trinity River Restoration Program
P.O. Box 1300, 1313 South Main Street, Weaverville, California 96093
Telephone: 530-623-1800, Fax: 530-623-5944

NC-156

MEMORANDUM

TO:	Mike Ryan, Northern California Area Manager Russell Smith, Environmental Resources Division Chief
FROM:	Daryl Peterson, Trinity River Restoration Program, Technical Modeling Branch Chief
SUBJECT:	Preliminary Results From Monitoring the Trinity River Fall Flows Action Plan
CC:	Doug Schleusner, Executive Director, Trinity River Restoration Program

Introduction

In a March 5, 2003 court hearing, Judge Oliver Wanger directed the Department of the Interior to determine what actions would be necessary to "assure against the risk of fish losses that occurred late in the season last year." Judge Wanger subsequently issued a ruling on April 4, 2003 allowing Reclamation to use an additional 50,000 af from the Trinity River Division of the Central Valley Project "at its reasonable discretion" to prevent a recurrence of the September 2002 fish die-off.

In fall of 2003 an Action Plan was developed that recommended increased Trinity River flows to reduce the likelihood, and potentially reduce the severity, of a fish die-off occurring during the fall run Chinook salmon migration. The Action Plan provided flows known to be adequate for unimpaired salmon migration through the lower Klamath River. It was expected that increasing flows would reduce or eliminate adverse in-river conditions that contributed to the adult fish die-off of 2002.

An initial presentation of increased late-summer Trinity River dam release options and request for written comments was given at the TMC meeting on June 26, 2003. Written comments were received through July 18, 2003. A technical workgroup of state, federal, and tribal biologists was convened on July 23 and 24, 2003, to consider comments received and evaluate alternatives. That group developed a revised alternative, the Action Plan Flows option, that addresses these concerns. Additional updates were provided to a broadly representative group of stakeholders on July 29, 2003, at a TAMWG meeting in Weaverville, California, and a TMC conference call on July 30, 2003. A letter of support for the proposed action was forwarded directly to the Secretary of the Interior from the TMC and TAMWG in a letter dated August 8, 2003.

The need for implementing the Action Plan was both biological and legal in nature. In 2002, low flow conditions in the lower Klamath River, warm water temperatures, and an above average fall run Chinook salmon escapement combined to create conditions favorable to an epizootic outbreak resulting in a fish die-off. Biological consequences of a die-off in two consecutive years would substantially impact present efforts to restore the native Trinity River anadromous fish community and fishery. Reductions in the Trinity River fish population would also affect Tribal fishery harvest opportunities, ocean harvest levels, recreational fishing, as well as public perception and recovery mandates. Last year's loss of 3 year-old and a potential loss of 4 year-old fish from the 1999 brood year affect the population structure, and may impede recovery goals authorized by the Trinity River Division Central Valley Project Act of 1955 (P.L. 84-386), the Trinity River Basin Fish and Wildlife Act of 1984 (P.L. 98-541), and the Central Valley Project Improvement Act of 1992 (P.L. 102-575), for naturally produced fall run Chinook salmon.

Projected flow conditions and a large fall run Chinook salmon escapement on the lower Klamath River in 2003 were similar to conditions that existed during the die-off in 2002. The two triggers established for initiating the preventive flow release (low flow and a large return of fall run Chinook salmon) were met as of August 20, 2003. Therefore, Reclamation implemented the release schedule proposed in the Action Plan as a preventative means to reduce the likelihood of another fish die-off in 2003.

Methods

The Action Plan used a conservative risk management approach to avert another fish die-off in 2003. The Action Plan had two flow components. The first component was a preventative flow release, using 33,000 acre-ft (af) of water. The preventative flow was intended to reduce the likelihood of a large scale fish die-off by ensuring adequate conditions for adult upstream migration though the lower Klamath River. The second component was an emergency response flow release, using an additional 17,000 af of water. This flow would be implemented to decrease the severity of a fish die-off if real-time monitoring indicated a rapid spread of the incidence and severity of the disease Ich.

Implementing components of the Action Plan were dependant on separate triggers for initiating preventive and emergency response flow releases. Triggers for initiating the preventive flow release were: (1) a fall run Chinook salmon population size estimate of greater than 110,000 for the Klamath Basin, and (2) a flow of less than 3,000 cfs in the lower Klamath River. Triggers for initiating the emergency response flow release would have been an estimated doubling in less than 7 days of either the incidence (proportion of fish infected) or severity (number of parasites per gill) of Ich. Evaluation of emergency action triggers were based on real-time monitoring of disease incidence conducted by the U.S. Fish & Wildlife Service, Fish Health Center, the Yurok Tribe, the Karuk Tribe and California Department of Fish & Game.

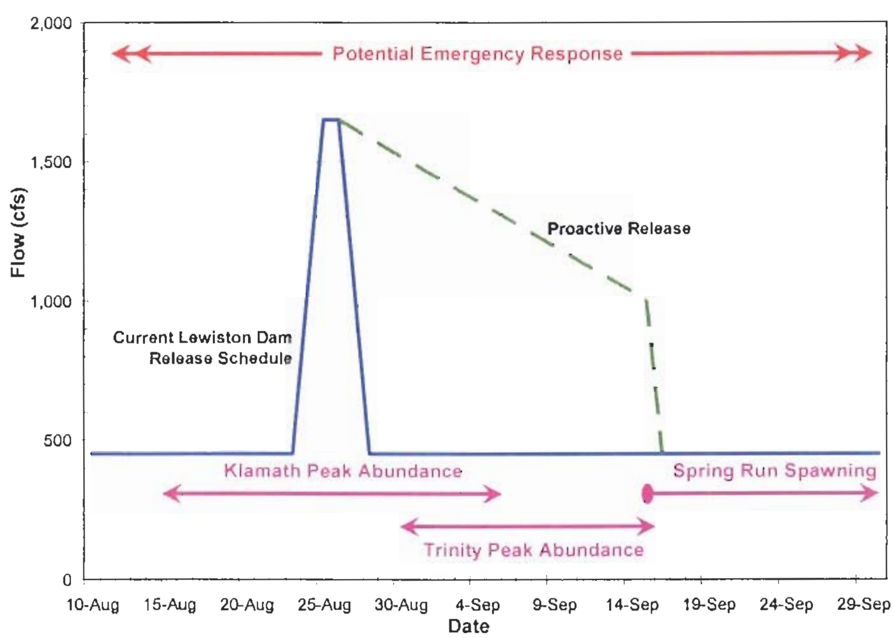


Figure 1. Daily Flow Schedule for Preventative Component of Action Plan.

Existing monitoring programs managed by the U.S. Fish & Wildlife Service, California Department of Fish & Game, the Hoopa Valley Tribe, the Yurok Tribe and the Karuk Tribe assessed the physical and biological effects associated with the Action Plan. Monitoring activities included weir counts, carcass and redd surveys, water temperature, water quality, angler and tribal harvest rates and adult salmon radio tracking, as well as disease incidence and severity from the real-time monitoring used as the trigger for the emergency action component of the Action Plan. Refugia dives and float surveys upstream of the Trinity River confluence were also conducted to evaluate the possibility of unintended effects on Klamath mainstem migrating adults.

Results

Results reported in this memo are preliminary and have not been peer reviewed for consistency with other findings and are subject to revision.

Figures 2, and 3 summarize results of key monitoring to assess effectiveness of the Action Plan release schedule. Additional information on run timing and migration patterns from weir operation, angler and tribal harvest and radio tracking studies is currently being prepared and will be reported in subsequent revisions of this memo.

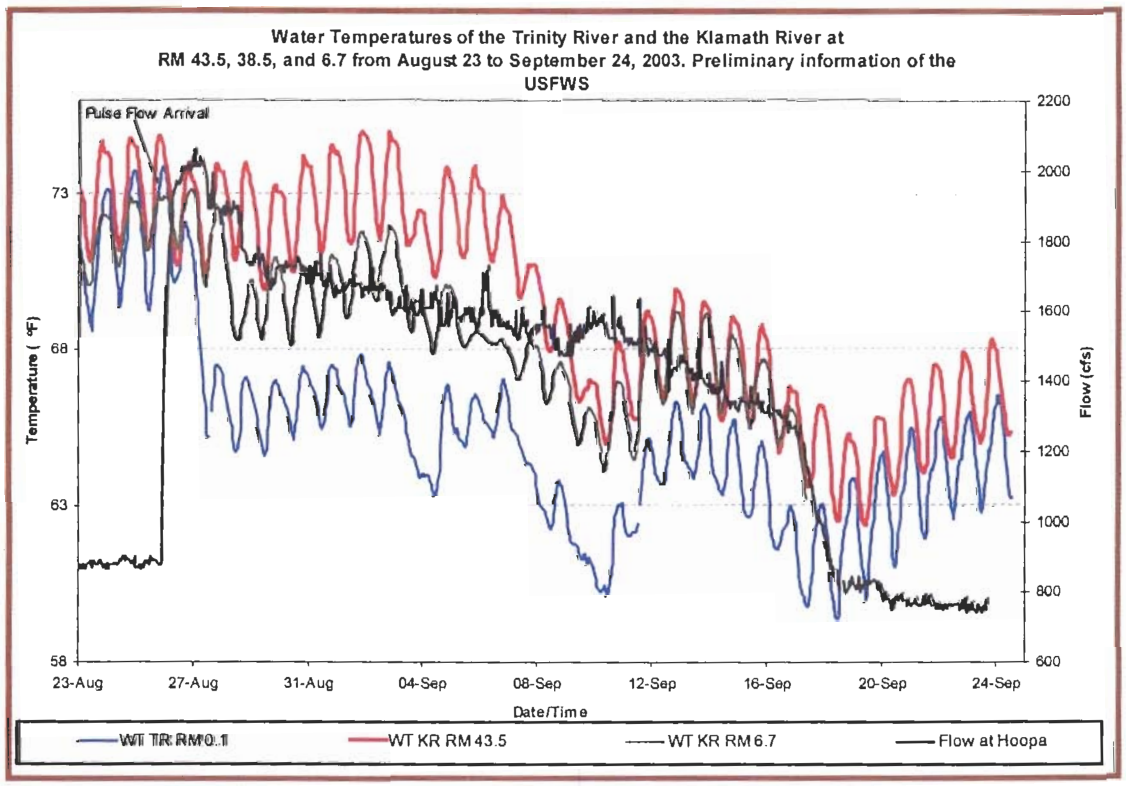


Figure 2. Trinity River flows reduce lower Klamath River water temperatures during the preventative action release schedule. River flow at Hoopa (black) during the fall of 2003, water temperature for the lower Trinity River near Hoopa (blue), Klamath River above Weitchpec (red) and lower Klamath River below the Trinity River confluence (green). Water temperatures above 71.6F inhibit adult Klamath Basin Chinook salmon migration. Preliminary data from Paul Zedonis, Fish & Wildlife Service, Arcata Field Office.

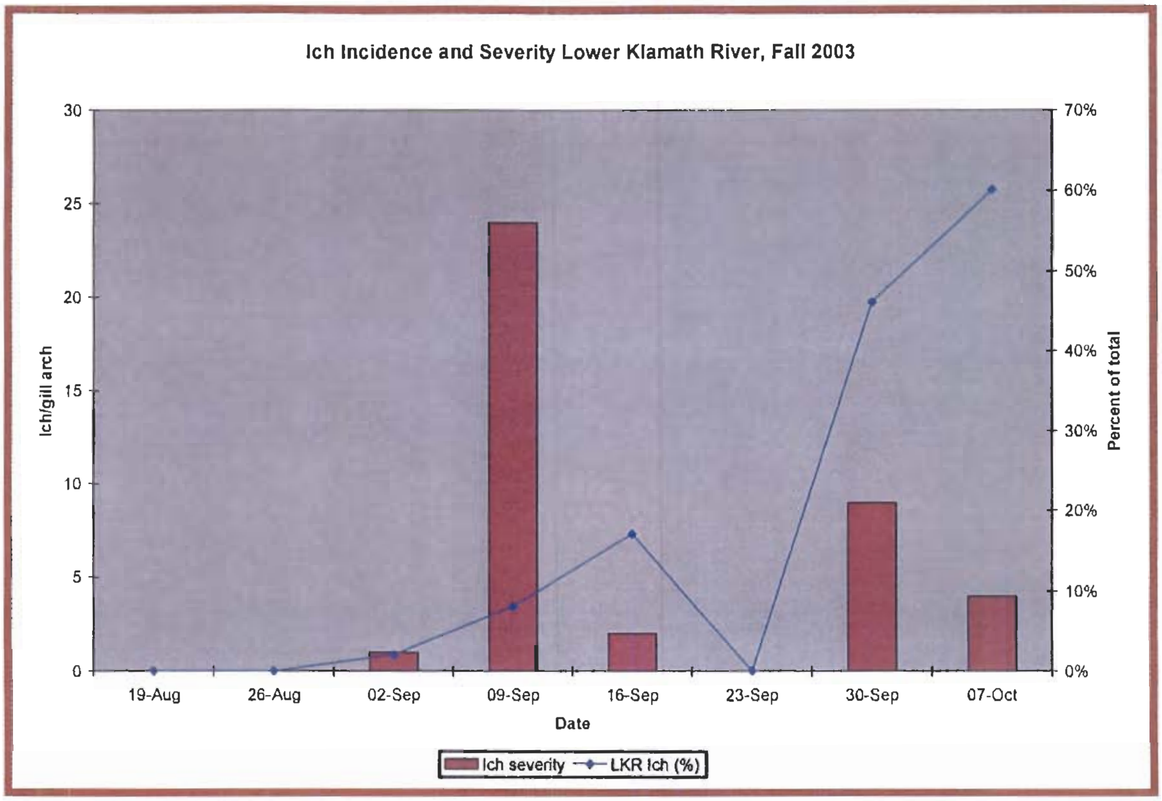


Figure 3. Incidence and severity of Ich (*Ichthyophthirius multifiliis*) on fall run Chinook salmon in the lower Klamath River during the fall of 2003. Disease incidence is reported as proportion of sampled fish with parasites (blue line). Severity is reported as the number of parasites per gill arch (red bars). Standard deviations not reported. Low value for incidence on 23 September is due to low sample size (n=10). Severity values greater than 30 parasites /gill arch is considered to a lower threshold for notable physiological stress. Preliminary data from Scott Foott, Fish & Wildlife Service, Fish Health Center, Red Bluff, Ca.

In addition, two preliminary conclusions from radio tracking studies to understand use of thermal refugia by adult Chinook salmon are relevant to the Trinity River fall flows (Josh Strange, University of Washington pers. com.).

- temperatures above 22C (71.6F) inhibit adult Chinook salmon migration and
- Fish die-off prevention flows from Trinity Dam substantially lowered temperatures in the lower Trinity and Klamath Rivers. During these higher flows thermal refugia use and migration delays were minimal among tagged Chinook salmon.

Conclusions

Monitoring results indicate that implementing the 2003 Trinity River Fall Flows Action Plan was successful in reducing the risk of a major die-off event. No observations of significant adult mortality were noted and the preventative flow schedule maintained water temperatures and flow magnitudes known to provide adequate fish migration in the lower Klamath River, specifically water temperatures were kept below 22C and flows near Klamath, Ca. (Terwar gage) greater than 3000 cfs.

Fall run Chinook salmon migration was unimpeded. Radio tracking of tagged fish demonstrated that migration delays were minimal. Congregations of large numbers of fish at known thermal refugia areas and below critical riffles and rapids were not noted by divers. Observations of fish above the confluence of the Trinity River did not note any negative migration, or health effects to Klamath mainstem Chinook salmon due to these artificially increased flows.

Emergency response flows were not called for although monitoring revealed disease incidence increased throughout the sample period and a doubling did occur. Incidence of Ich did not exceed 20% (10% was assumed to be an acceptable background value) until late September by this time the majority of the fish had migrated out of the lower Klamath and monitoring indicated that disease severity was kept at a low level and therefore did not pose a threat to the physiological health of infected fish.

Spring run Chinook salmon spawning was not affected in the upper Trinity River by the preventative flow schedule. Weekly redd counts in the Trinity River immediately below Lewiston Dam indicate that minimal spawning occurred before September 15, 2003. Lewiston Dam releases returned to the normal (450 cfs) on September 16, 2003. Those redds noted were not threatened by de-watering following flow reductions. Anecdotal reports indicate that fish condition was excellent throughout the run (Loren Everest, Forest Service, Trinity River Management Unit pers. com.).

Attachment B3
Trinity River Basin Water Year Type Classifications

TRINITY RIVER MAINSTEM FISHERY RESTORATION SEIS/R
TRINITY RIVER BASIN WATER YEAR TYPE DESIGNATIONS

YEAR TYPE	CATEGORY	NO. YEARS	PROBABILITY
EXTREMELY WET	1	12	0.12
WET	2	26	0.28
NORMAL	3	17	0.2
DRY	4	23	0.28
CRITICALLY DRY	5	9	0.12
		87	

YEAR	CATEGORY	YEAR TYPE
1912	3	Normal
1913	3	Normal
1914	1	Extremely Wet
1915	1	Extremely Wet
1916	2	Wet
1917	4	Dry
1918	5	Critically Dry
1919	3	Normal
1920	5	Critically Dry
1921	2	Wet
1922	4	Dry
1923	4	Dry
1924	5	Critically Dry
1925	2	Wet
1926	4	Dry
1927	2	Wet
1928	3	Normal
1929	5	Critically Dry
1930	4	Dry
1931	5	Critically Dry
1932	4	Dry
1933	4	Dry
1934	4	Dry
1935	4	Dry
1936	3	Normal
1937	4	Dry
1938	1	Extremely Wet
1939	5	Critically Dry
1940	2	Wet
1941	1	Extremely Wet
1942	2	Wet
1943	3	Normal
1944	4	Dry
1945	3	Normal
1946	2	Wet
1947	4	Dry
1948	3	Normal
1949	3	Normal
1950	4	Dry
1951	2	Wet
1952	2	Wet
1953	2	Wet
1954	2	Wet
1955	4	Dry
1956	1	Extremely Wet
1957	3	Normal
1958	1	Extremely Wet
1959	3	Normal
1960	3	Normal
1965	2	Wet
1966	3	Normal
1967	2	Wet
1968	3	Normal
1969	2	Wet
1970	2	Wet
1971	2	Wet
1972	3	Normal

TRINITY RIVER MAINSTEM FISHERY RESTORATION SEIS/R

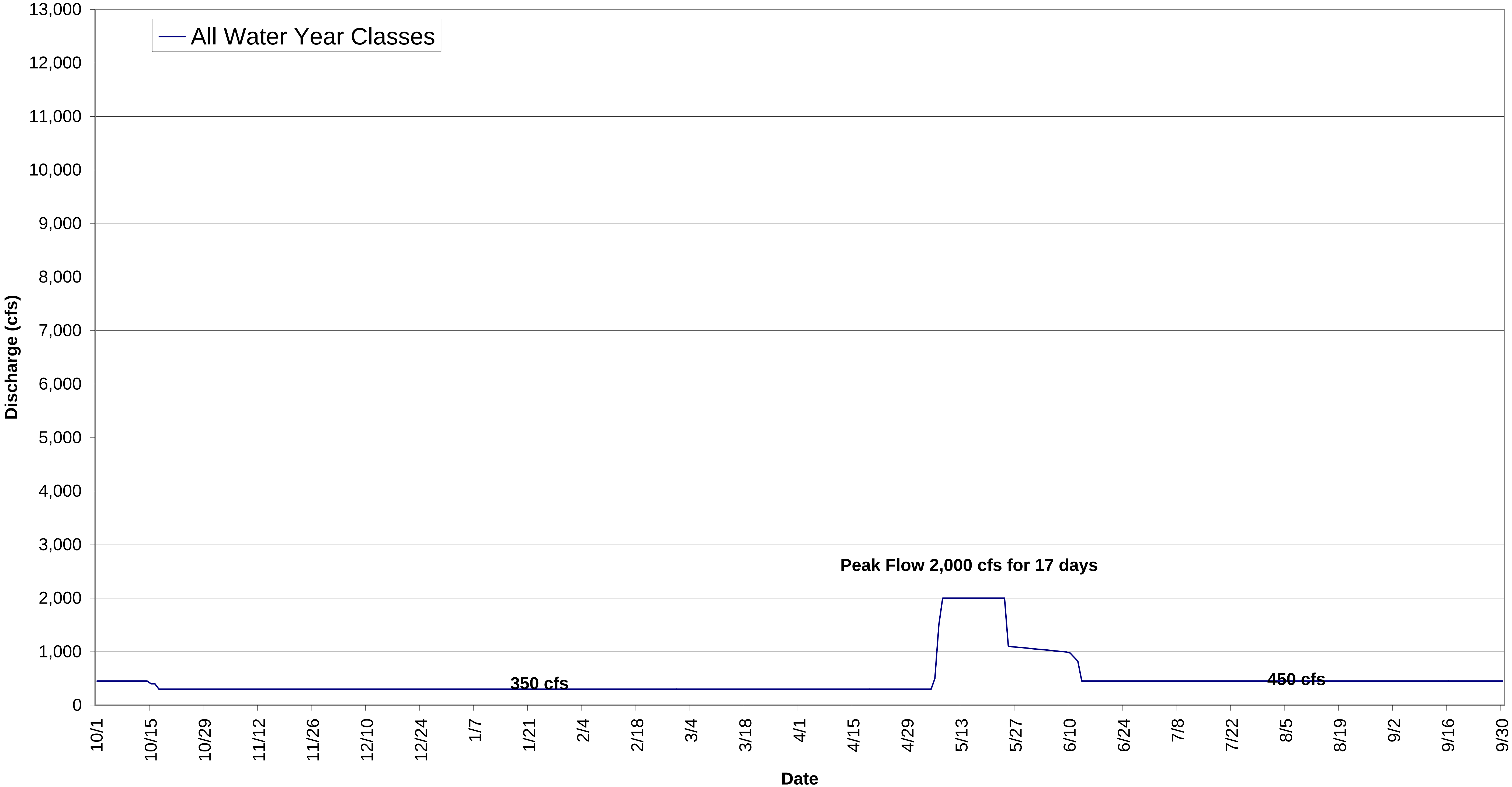
TRINITY RIVER BASIN WATER YEAR TYPE DESIGNATIONS

YEAR	CATEGORY	YEAR TYPE
1973	2	Wet
1974	1	Extremely Wet
1975	2	Wet
1976	4	Dry
1977	5	Critically Dry
1978	1	Extremely Wet
1979	4	Dry
1980	2	Wet
1981	4	Dry
1982	1	Extremely Wet
1983	1	Extremely Wet
1984	2	Wet
1985	4	Dry
1986	2	Wet
1987	4	Dry
1988	4	Dry
1989	3	Normal
1990	4	Dry
1991	5	Critically Dry
1992	4	Dry
1993	2	Wet
1994	5	Critically Dry
1995	1	Extremely Wet
1996	2	Wet
1997	2	Wet
1998	1	Extremely Wet
1999	2	Wet
2000	2	Wet
2001	4	Dry
2002	3	Normal

Attachment B4
Weekly Flows Schedules and Hydrographs for Proposed Alternatives

No Action Alternative		
		Flows (cfs)
Week Beginning	Week	All Water Year Classes
01-Oct	1	450
08-Oct	2	450
15-Oct	3	400
22-Oct	4	300
29-Oct	5	300
05-Nov	6	300
12-Nov	7	300
19-Nov	8	300
26-Nov	9	300
03-Dec	10	300
10-Dec	11	300
17-Dec	12	300
24-Dec	13	300
31-Dec	14	300
07-Jan	15	300
14-Jan	16	300
21-Jan	17	300
28-Jan	18	300
04-Feb	19	300
11-Feb	20	300
18-Feb	21	300
25-Feb	22	300
04-Mar	23	300
11-Mar	24	300
18-Mar	25	300
25-Mar	26	300
01-Apr	27	300
08-Apr	28	300
15-Apr	29	300
22-Apr	30	300
29-Apr	31	300
06-May	32	1714
13-May	33	2000
20-May	34	1741
27-May	35	1065
03-Jun	36	1016
10-Jun	37	643
17-Jun	38	450
24-Jun	39	450
01-Jul	40	450
08-Jul	41	450
15-Jul	42	450
22-Jul	43	450
29-Jul	44	450
05-Aug	45	450
12-Aug	46	450
19-Aug	47	450
26-Aug	48	450
02-Sep	49	450
09-Sep	50	450
16-Sep	51	450
23-Sep	52	450
	Acre Feet	341,871

No Action Alternative Hydrograph



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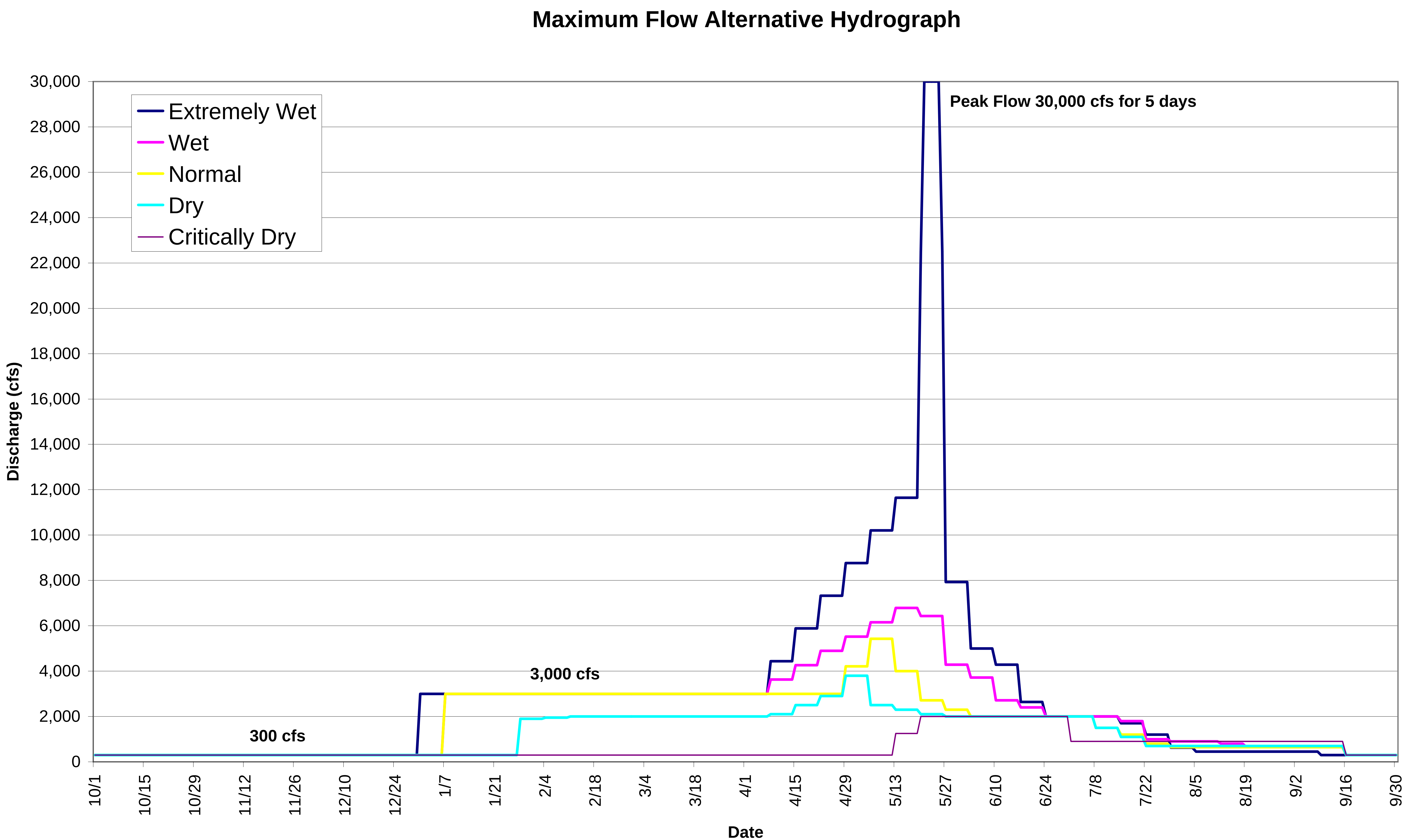
Maximum Flow Alternative						
	Flows (cfs)	Water Year Types				
Week Beginning	Week	Extremely Wet	Wet	Normal	Dry	Critically Dry
01-Oct	1	300	300	300	300	300
08-Oct	2	300	300	300	300	300
15-Oct	3	300	300	300	300	300
22-Oct	4	300	300	300	300	300
29-Oct	5	300	300	300	300	300
05-Nov	6	300	300	300	300	300
12-Nov	7	300	300	300	300	300
19-Nov	8	300	300	300	300	300
26-Nov	9	300	300	300	300	300
03-Dec	10	300	300	300	300	300
10-Dec	11	300	300	300	300	300
17-Dec	12	300	300	300	300	300
24-Dec	13	300	300	300	300	300
31-Dec	14	3000	300	300	300	300
07-Jan	15	3000	3000	3000	300	300
14-Jan	16	3000	3000	3000	300	300
21-Jan	17	3000	3000	3000	300	300
28-Jan	18	3000	3000	3000	1900	300
04-Feb	19	3000	3000	3000	1950	300
11-Feb	20	3000	3000	3000	2000	300
18-Feb	21	3000	3000	3000	2000	300
25-Feb	22	3000	3000	3000	2000	300
04-Mar	23	3000	3000	3000	2000	300
11-Mar	24	3000	3000	3000	2000	300
18-Mar	25	3000	3000	3000	2000	300
25-Mar	26	3000	3000	3000	2000	300
01-Apr	27	3000	3000	3000	2000	300
08-Apr	28	4441	3631	3000	2100	300
15-Apr	29	5882	4262	3000	2500	300
22-Apr	30	7323	4893	3000	2900	300
29-Apr	31	8764	5524	4215	3800	300
06-May	32	10,205	6155	5429	2500	300
13-May	33	11,643	6786	4000	2300	1250
20-May	34	22500	6429	2714	2100	2000
27-May	35	7929	4286	2300	2000	2000
03-Jun	36	5000	3714	2000	2000	2000
10-Jun	37	4286	2714	2000	2000	2000
17-Jun	38	2643	2400	2000	2000	2000
24-Jun	39	2000	2000	2000	2000	2000
01-Jul	40	2000	2000	2000	2000	900
08-Jul	41	2000	2000	1500	1500	900
15-Jul	42	1700	1800	1200	1100	900
22-Jul	43	1200	1000	800	700	900
29-Jul	44	629	900	650	700	900
05-Aug	45	450	900	650	700	900
12-Aug	46	450	800	650	700	900
19-Aug	47	450	670	650	700	900
26-Aug	48	450	650	650	700	900
02-Sep	49	450	650	650	700	900
09-Sep	50	300	650	650	700	900
16-Sep	51	300	300	300	300	300
23-Sep	52	300	300	300	300	300
	Acre Feet	2,146,443	1,508,624	1,243,351	888,496	463,636



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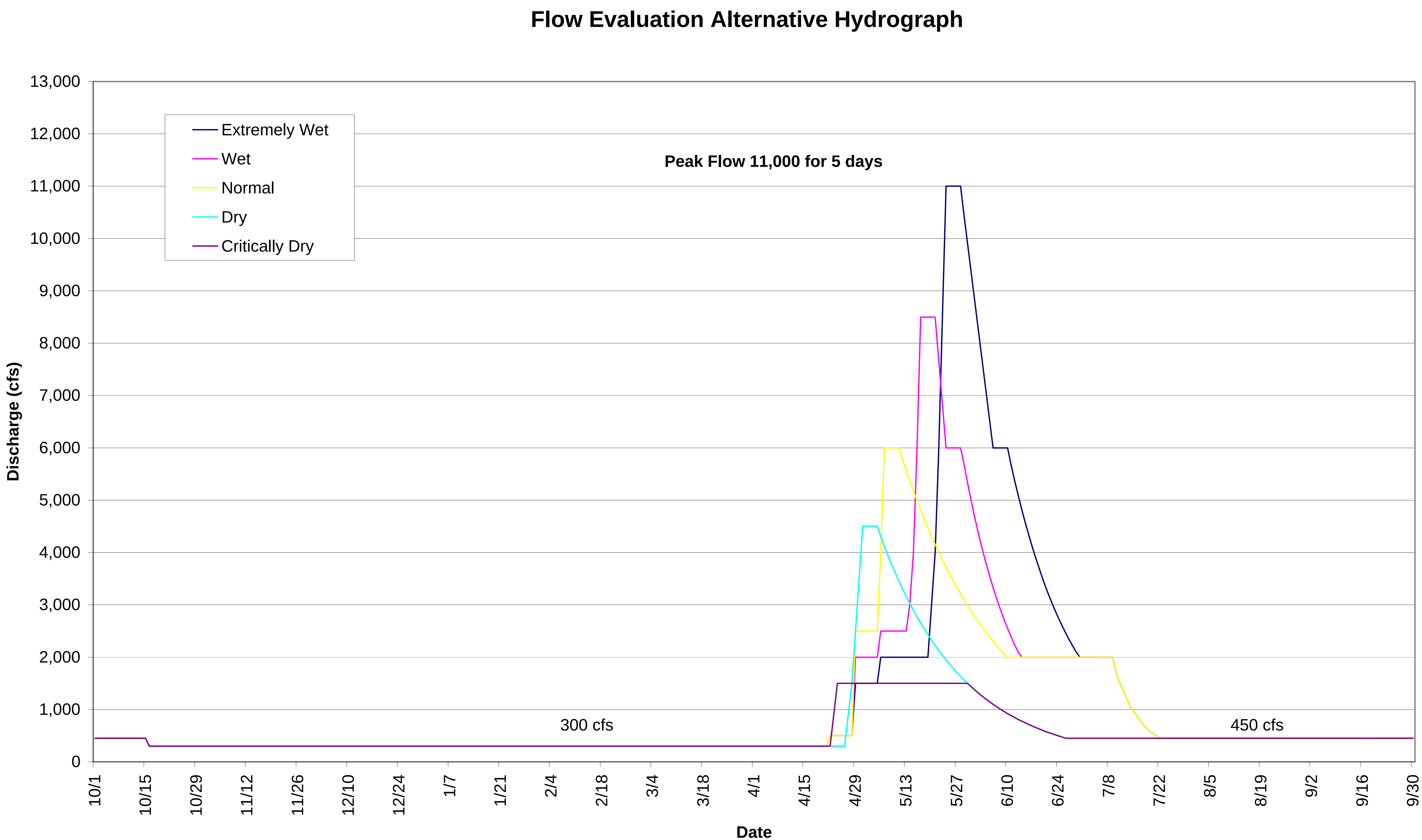
Flow Evaluation Alternative						
	Flows (cfs)	Water Year Types				
Week Beginning	Week	xtremely W	Wet	Normal	Dry	Critically Dry
01-Oct	1	450	450	450	450	450
08-Oct	2	450	450	450	450	450
15-Oct	3	450	450	450	450	450
22-Oct	4	300	300	300	300	300
29-Oct	5	300	300	300	300	300
05-Nov	6	300	300	300	300	300
12-Nov	7	300	300	300	300	300
19-Nov	8	300	300	300	300	300
26-Nov	9	300	300	300	300	300
03-Dec	10	300	300	300	300	300
10-Dec	11	300	300	300	300	300
17-Dec	12	300	300	300	300	300
24-Dec	13	300	300	300	300	300
31-Dec	14	300	300	300	300	300
07-Jan	15	300	300	300	300	300
14-Jan	16	300	300	300	300	300
21-Jan	17	300	300	300	300	300
28-Jan	18	300	300	300	300	300
04-Feb	19	300	300	300	300	300
11-Feb	20	300	300	300	300	300
18-Feb	21	300	300	300	300	300
25-Feb	22	300	300	300	300	300
04-Mar	23	300	300	300	300	300
11-Mar	24	300	300	300	300	300
18-Mar	25	300	300	300	300	300
25-Mar	26	300	300	300	300	300
01-Apr	27	300	300	300	300	300
08-Apr	28	300	300	300	300	300
15-Apr	29	300	300	300	300	300
22-Apr	30	500	500	500	300	300
29-Apr	31	1,500	2,000	2,500	2,500	1,500
06-May	32	2,000	2,500	4,000	4,500	1,500
13-May	33	2,000	2,500	5,574	3,164	1,500
20-May	34	3,000	8,500	4,307	2,325	1,500
27-May	35	11,000	6,000	3,328	1,708	1,500
03-Jun	36	7,667	4,072	2,572	1,255	1,255
10-Jun	37	6,000	2,550	2,000	922	922
17-Jun	38	4,064	2,000	2,000	678	678
24-Jun	39	2,759	2,000	2,000	498	498
01-Jul	40	2,000	2,000	2,000	450	450
08-Jul	41	2,000	2,000	2,000	450	450
15-Jul	42	950	950	950	450	450
22-Jul	43	450	450	450	450	450
29-Jul	44	450	450	450	450	450
05-Aug	45	450	450	450	450	450
12-Aug	46	450	450	450	450	450
19-Aug	47	450	450	450	450	450
26-Aug	48	450	450	450	450	450
02-Sep	49	450	450	450	450	450
09-Sep	50	450	450	450	450	450
16-Sep	51	450	450	450	450	450
23-Sep	52	450	450	450	450	450
	Acre Feet	816,653	702,258	648,079	453,416	369,269



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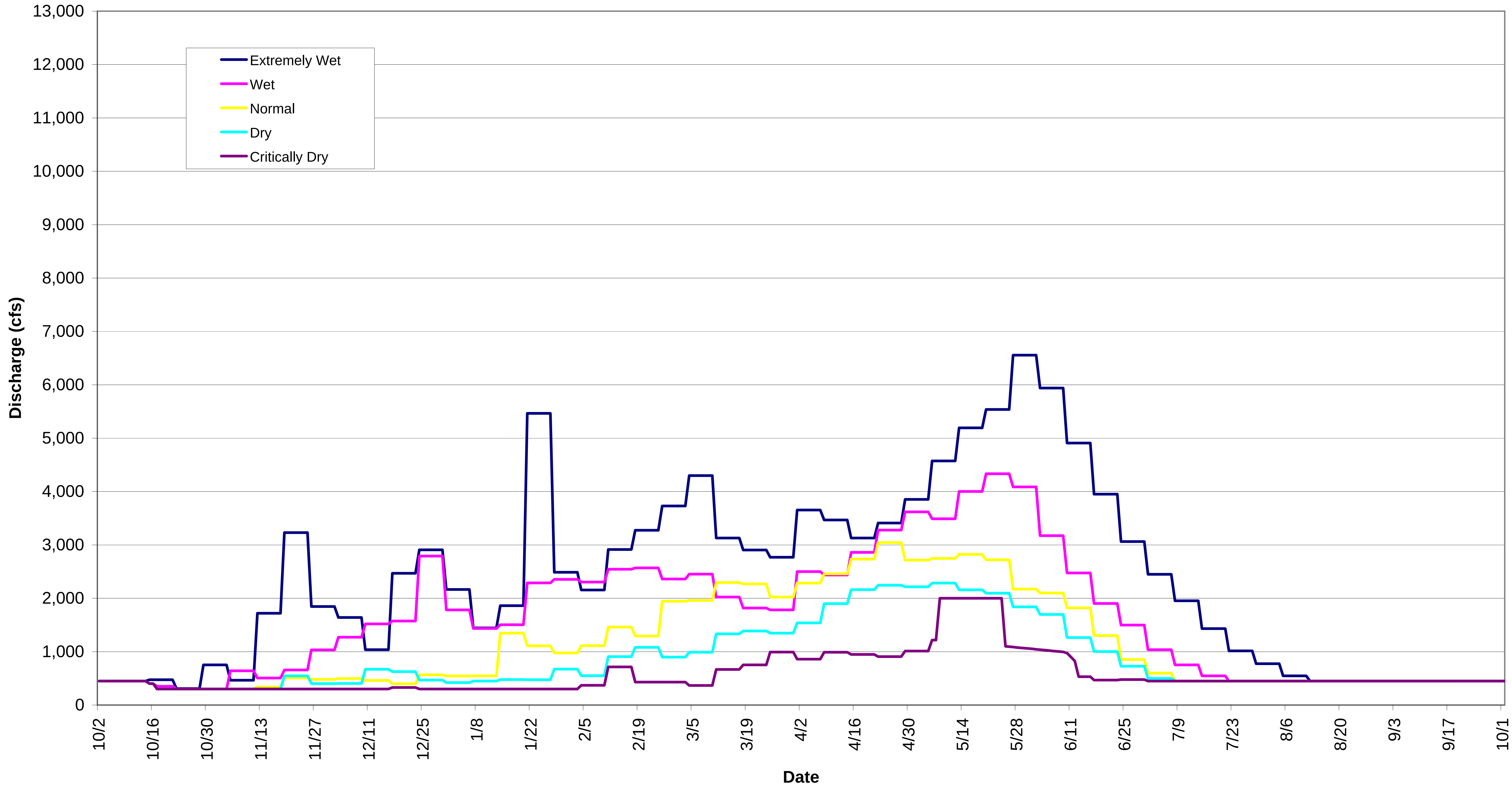
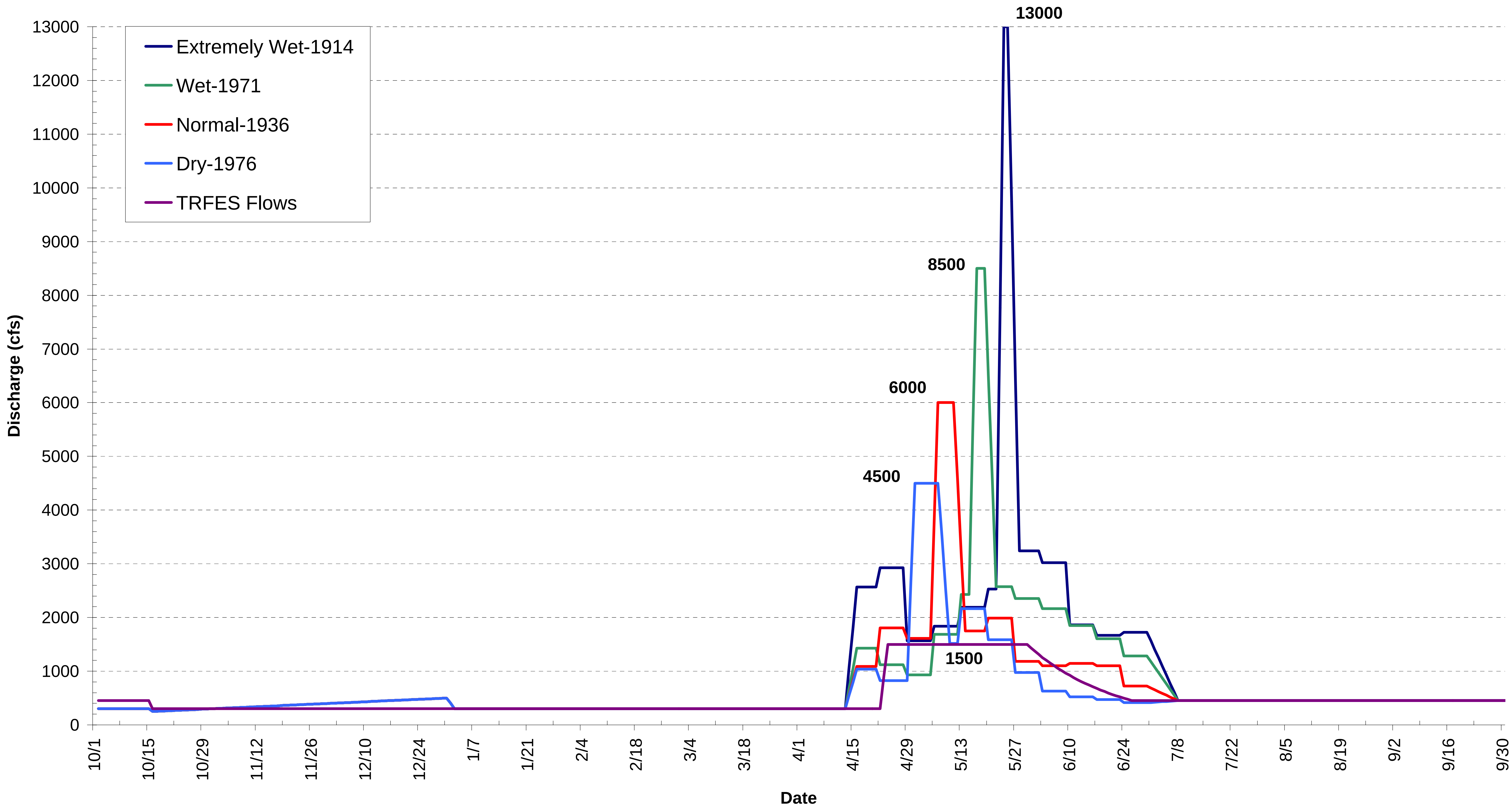
70 Percent Inflow Alternative						
	Flows	Representative Median Water Year Types:				
Week Beginning	Week	Extremely Wet	Wet	Normal	Dry	Critically Dry
1-Oct	1	450	450	450	450	450
8-Oct	2	450	450	450	450	450
15-Oct	3	474	400	400	400	400
22-Oct	4	310	300	300	300	300
29-Oct	5	751	300	300	300	300
5-Nov	6	466	641	300	300	300
12-Nov	7	1719	506	340	300	300
19-Nov	8	3229	656	509	546	300
26-Nov	9	1846	1033	481	403	300
3-Dec	10	1640	1271	497	406	300
10-Dec	11	1038	1519	460	670	300
17-Dec	12	2468	1575	397	627	327
24-Dec	13	2907	2791	567	469	300
31-Dec	14	2167	1783	544	422	300
7-Jan	15	1446	1435	548	448	300
14-Jan	16	1862	1503	1348	478	300
21-Jan	17	5465	2287	1110	474	300
28-Jan	18	2487	2354	977	672	300
4-Feb	19	2154	2303	1111	550	371
11-Feb	20	2916	2545	1461	908	714
18-Feb	21	3276	2571	1292	1080	431
25-Feb	22	3731	2361	1943	898	429
4-Mar	23	4298	2452	1960	989	368
11-Mar	24	3129	2023	2294	1335	667
18-Mar	25	2905	1817	2268	1386	751
25-Mar	26	2769	1782	2023	1348	992
1-Apr	27	3652	2501	2286	1540	859
8-Apr	28	3469	2438	2461	1899	989
15-Apr	29	3129	2861	2735	2161	949
22-Apr	30	3411	3278	3045	2244	907
29-Apr	31	3854	3619	2714	2216	1012
6-May	32	4573	3490	2746	2286	1218
13-May	33	5194	4002	2823	2160	2000
20-May	34	5537	4333	2721	2097	2000
27-May	35	6554	4086	2172	1839	1086
3-Jun	36	5940	3173	2100	1696	1037
10-Jun	37	4909	2475	1822	1265	975
17-Jun	38	3950	1904	1304	1003	467
24-Jun	39	3064	1500	854	728	478
1-Jul	40	2450	1038	599	499	450
8-Jul	41	1953	753	450	450	450
15-Jul	42	1432	548	450	450	450
22-Jul	43	1013	450	450	450	450
29-Jul	44	775	450	450	450	450
5-Aug	45	546	450	450	450	450
12-Aug	46	450	450	450	450	450
19-Aug	47	450	450	450	450	450
26-Aug	48	450	450	450	450	450
2-Sep	49	450	450	450	450	450
9-Sep	50	450	450	450	450	450
16-Sep	51	450	450	450	450	450
23-Sep	52	450	450	450	450	450
Representative	Acre Feet	1,735,062	1,188,913	834,469	633,539	421,239

Hydrograph for 70 Percent Inflow Alternative (representative water years)

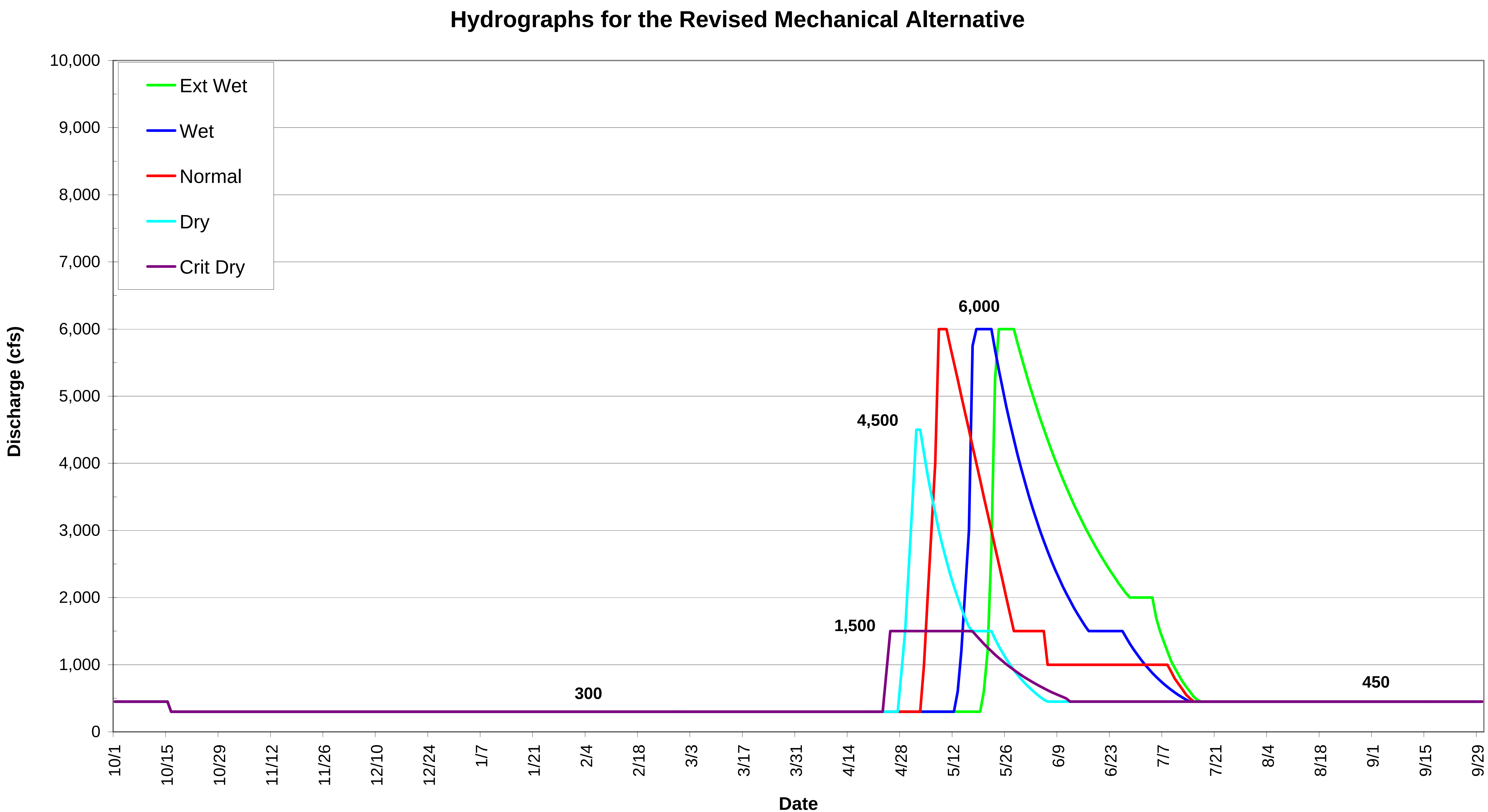


Modified Percent Inflow (Representative Years)						
		Extremely Wet	Wet	Normal	Dry	Critically Dry
Week Beginning:	Week	1914	1971	1936	1976	(TRFES)
1-Oct	1	300	300	300	300	450
8-Oct	2	300	300	300	300	450
15-Oct	3	300	300	300	300	450
22-Oct	4	270	270	270	270	300
29-Oct	5	293	293	293	293	300
5-Nov	6	316	316	316	316	300
12-Nov	7	339	339	339	339	300
19-Nov	8	362	362	362	362	300
26-Nov	9	385	385	385	385	300
3-Dec	10	408	408	408	408	300
10-Dec	11	431	431	431	431	300
17-Dec	12	454	454	454	454	300
24-Dec	13	477	477	477	477	300
31-Dec	14	500	500	500	500	300
7-Jan	15	300	300	300	300	300
14-Jan	16	300	300	300	300	300
21-Jan	17	300	300	300	300	300
28-Jan	18	300	300	300	300	300
4-Feb	19	300	300	300	300	300
11-Feb	20	300	300	300	300	300
18-Feb	21	300	300	300	300	300
25-Feb	22	300	300	300	300	300
4-Mar	23	300	300	300	300	300
11-Mar	24	300	300	300	300	300
18-Mar	25	300	300	300	300	300
25-Mar	26	300	300	300	300	300
1-Apr	27	300	300	300	300	300
8-Apr	28	300	300	300	300	300
15-Apr	29	1,813	1,052	825	790	300
22-Apr	30	2,927	1,121	1,806	821	300
29-Apr	31	1,568	931	1,613	2,661	1,500
6-May	32	1,836	1,684	3,807	4,500	1,500
13-May	33	2,192	2,426	6,000	2,167	1,500
20-May	34	2,530	8,500	1,986	1,587	1,500
27-May	35	13,000	2,355	1,181	973	1,500
3-Jun	36	3,019	2,166	1,102	632	1,255
10-Jun	37	1,864	1,851	1,145	522	922
17-Jun	38	1,666	1,602	1,099	472	678
24-Jun	39	1,724	1,281	721	413	498
1-Jul	40	1,564	1,177	688	450	450
8-Jul	41	450	450	450	450	450
15-Jul	42	450	450	450	450	450
22-Jul	43	450	450	450	450	450
29-Jul	44	450	450	450	450	450
5-Aug	45	450	450	450	450	450
12-Aug	46	450	450	450	450	450
19-Aug	47	450	450	450	450	450
26-Aug	48	450	450	450	450	450
2-Sep	49	450	450	450	450	450
9-Sep	50	450	450	450	450	450
16-Sep	51	450	450	450	450	450
23-Sep	52	450	450	450	450	450
Representative	Acre Feet	640,905	539,688	478,559	420,182	369,269

Hydrograph for Modified Percent Inflow Alternative (five repesentative water years)



Revised Mechanical Alternative						
Week Beginning:	Week	Extremely Wet	Wet	Normal	Dry	Critically Dry
1-Oct	1	450	450	450	450	450
8-Oct	2	450	450	450	450	450
15-Oct	3	450	450	450	450	450
22-Oct	4	300	300	300	300	300
29-Oct	5	300	300	300	300	300
5-Nov	6	300	300	300	300	300
12-Nov	7	300	300	300	300	300
19-Nov	8	300	300	300	300	300
26-Nov	9	300	300	300	300	300
3-Dec	10	300	300	300	300	300
10-Dec	11	300	300	300	300	300
17-Dec	12	300	300	300	300	300
24-Dec	13	300	300	300	300	300
31-Dec	14	300	300	300	300	300
7-Jan	15	300	300	300	300	300
14-Jan	16	300	300	300	300	300
21-Jan	17	300	300	300	300	300
28-Jan	18	300	300	300	300	300
4-Feb	19	300	300	300	300	300
11-Feb	20	300	300	300	300	300
18-Feb	21	300	300	300	300	300
25-Feb	22	300	300	300	300	300
4-Mar	23	300	300	300	300	300
11-Mar	24	300	300	300	300	300
18-Mar	25	300	300	300	300	300
25-Mar	26	300	300	300	300	300
1-Apr	27	300	300	300	300	300
8-Apr	28	300	300	300	300	300
15-Apr	29	300	300	300	300	300
22-Apr	30	300	300	300	300	300
29-Apr	31	300	300	300	1500	1500
6-May	32	300	300	3000	3527	1500
13-May	33	300	600	5250	1998	1500
20-May	34	600	6000	3500	1500	1312
27-May	35	6000	4594	1750	999	964
3-Jun	36	4845	3161	1500	566	708
10-Jun	37	3776	2175	1000	450	521
17-Jun	38	2942	1500	1000	450	450
24-Jun	39	2293	1500	1000	450	450
1-Jul	40	2000	1072	1000	450	450
8-Jul	41	1,200	670	1,000	450	450
15-Jul	42	525	450	450	450	450
22-Jul	43	450	450	450	450	450
29-Jul	44	450	450	450	450	450
5-Aug	45	450	450	450	450	450
12-Aug	46	450	450	450	450	450
19-Aug	47	450	450	450	450	450
26-Aug	48	450	450	450	450	450
2-Sep	49	450	450	450	450	450
9-Sep	50	450	450	450	450	450
16-Sep	51	450	450	450	450	450
23-Sep	52	450	450	450	450	450
	Acre feet	554,961	511,622	484,324	378,301	339,761


Hydrographs for the Revised Mechanical Alternative
Ext Wet
Wet
Normal
Dry
Crit Dry
Discharge (cfs)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
6,000
4,500
1,500
300
450
10/1
10/15
10/29
11/12
11/26
12/10
12/24
1/7
1/21
2/4
2/18
3/3
3/17
3/31
4/14
4/28
5/12
5/26
6/9
6/23
7/7
7/21
8/4
8/18
9/1
9/15
9/29
Date

Attachment B5
Smolt Survival and Harvest Assessment

PUBLIC DRAFT – March 1, 2004

Assessment of Temperature Influences on Potential Salmonid Smolt Production and Harvest of Chinook Salmon of the Trinity River

Introduction

The 1999 EIS/EIR included a model referred to as the Trinity River System Attribute Analysis Methodology (TRSAAM) for comparison of the relative restoration potential of the Trinity River fishery resources between alternatives (Trinity River DEIS/R, Appendix B, 1999). The Supplemental EIS/EIR (SEIS/EIR) that is currently being developed includes several alternatives that were in the 1999 EIS/EIR in addition to several other new alternatives that were developed following a Court Ruling that found the 1999 EIS/EIR did not evaluate a sufficient range of alternatives. The SEIS/EIR includes the addition of one new alternative (the 70 Percent Inflow Alternative) and changes to two previous alternatives (Mechanical Restoration and Percent Inflow alternatives) that respond to specific findings of the court with regard to the practicality of the alternatives. To reflect these changes the alternatives have been re-named the Revised Mechanical Restoration Alternative and the Modified Percent Inflow Alternative.

As part of the preparation of the SEIS/EIR, all of the alternatives were re-evaluated with TRSAAM to determine the relative restoration potential of the alternatives. Results from the updated TRSAAM analysis narrowed the relative differences between several alternatives, notably the new alternatives developed in response to the court's findings. The narrowing in relative difference was most evident in the comparisons between Modified Percent Inflow, Flow Evaluation and the 70 Percent Inflow alternatives. TRSAAM results are presented below in Table 1.

Table 1
Initial TRSAAM Results for SEIS/EIR for each Alternative

Alternative	TRSAAM Result	Percent of Possible
No Action	6	8%
Revised Mechanical	39	53%
Modified Percent Inflow	53	72%
Flow Evaluation	52	70%
70 Percent Inflow	53	72%
Maximum Flow	60	81%

As previously noted, in the 1999 EIS/EIR the TRSAAM results indicated a greater spread between alternatives. The 1999 EIS/EIR interpreted the TRSAAM scores to be representative of likely levels of spawning escapement that would be expected under the alternatives.

Originally, the SEIS/EIR intended to replicate that analysis. However, in reviewing preliminary results for the SEIS/EIR, it was determined that the close grouping of several of the alternatives had exceeded the ability of TRSAAM to differentiate alternatives – particularly between the Modified Percent Inflow, Flow Evaluation and 70 Percent Inflow alternatives. Detailed scrutiny of the alternatives indicated that, generally, the differences between alternatives was in the ability to mobilize fine and coarse sediment, vegetation maintenance on river terraces, and provision of suitable temperatures for smolt outmigration. Discussion of the differences in the alternatives' ability to mobilize and transport coarse and fine sediment materials and to achieve riparian recruitment on the river floodplain is provided in the Fishery Technical Appendix.

If water temperatures are suitable, salmonid smolts are likely to be more successful in reaching the ocean – ultimately increasing the numbers of subsequent spawners returning as adults. In order to assess temperature effects on smolt outmigration as a potentially limiting factor, water temperature was removed from TRSAAM analysis and evaluated independently. Ultimately, water temperature was determined to be a potential limiting factor such that even if the physical habitat was very abundant and of great quality that fish (salmonid smolts) still had to depart the Trinity River during the window of suitable temperatures, or be subject to increased mortality.

The purpose of this document is two-fold. First, it compares temperature-dependent survival indexes of steelhead, coho, and Chinook salmon smolts by alternative. The smolt temperature indices were developed to evaluate the impacts of changing water flows and subsequent water temperatures on successful smolt outmigration. While the index is called a smolt survival index, the term refers to an index of indirect smolt survival as opposed to an index of direct acute lethality. It is recognized that not all smolts of a given cohort would be expected to perish at the upper marginal temperature thresholds provided in Table 3. However, it would be expected that at the temperature thresholds shown in Table 3, smolts would likely revert to a non-migratory lifestage (parr) and attempt to rear in the river. Given that scenario, these parr may be considered potentially lost to that years' recruitment and would likely be subject to very low survival rates prior to the following year's outmigration period.

Secondarily, the analyses in this evaluation uses a suite of models to provide a relative index of harvestable Chinook salmon to further compare and contrast alternatives.

Methods

Instream Flow Release

Lewiston Dam release volumes varied by alternative (Table 2). Average annual volumes dedicated for fishery restoration range from 340 thousand acre-feet (TAF) in the No Action Alternative to 1,225 TAF for the Maximum Flow Alternative. Each alternative is comprised of five water year classes that are based on probability of recurrence and different annual allocations, except the No Action Alternative that uses the same release schedule across year types. Hydrographs for these alternatives during the active period of salmonid smolt emigration are shown in Figures 1 through 6 (found at the end of this assessment).

Table 2
Instream Release Volumes (thousands of acre-feet) by Water Year Type for Each Alternative.

Water Year Class	Probability	No Action	Revised Mechanical	Mod. Percent Flow	Flow Evaluation	70% Inflow	Maximum Flow
Critically Dry	0.12	340	340	369	369	421	463
Dry	0.28	340	380	438	453	632	889
Normal	0.20	340	485	483	647	833	1,206
Wet	0.28	340	513	540	701	1,187	1,508
Extremely Wet	0.12	340	556	720	815	1,732	2,146
Weighted Mean		340	455	501	595	934	1,225
Difference from No Action			115	161	255	594	885
% Change from No Action			34%	47%	75%	175%	260%
% of Total Yield		28%	37%	41%	49%	76%[1]	100%

[1]This alternative has a floor of 340 ac ft/year and has minimum flow releases during certain times of year that increases the total yield beyond the 70% of total on average.

Water Temperature

Estimates of the average weekly water temperatures of the Trinity River at Weitchpec, CA, were used in determining the survival of salmonid smolts departing the Trinity River. Temperature-flow relationships for a median atmospheric year were used to estimate weekly water temperatures at Weitchpec (USFWS and HVT 1999; Trinity River EIS/EIR 2000). A series of annual release schedules for each alternative was developed based on historical hydrology to determine water year classifications for water years 1912 through 2002 (excluding WY 1961 to WY1964 while the TRD was being constructed).

Smolt Outmigration Timing

Timing of smolt outmigration for steelhead, coho salmon, and Chinook salmon was estimated based on empirical juvenile trapping data collected at the USFWS Willow Creek trapping site for the period of 1992 to 2001, excluding 2000. This data set represented the most comprehensive and contemporary information on salmonid emigration in the Trinity River, and supersedes the information used in the original Flow Evaluation Study (USFWS and HVT, 1999). Emigration data for each species was necessary to identify weekly proportions of the emigrants exiting the Trinity River during times of variable thermal regimes. The weekly proportions of total catch were normalized for Julian weeks 15 to 35 (April 9 to August 27), corresponding to the smolt temperature evaluation period. The temporal distribution of smolt outmigration for Chinook salmon, coho salmon, and steelhead is shown as Figure 7.

Smolt Survival

This evaluation concentrates on the alternatives effects on the smolt life stage of salmonids in the Trinity River. This life-stage, in particular, is reported to be very temperature-sensitive and in the absence of appropriately cold water smolts may not survive entry to seawater and thus not return to the river as an adult spawner (USFWS and HVT, 1999).

The literature-derived temperature thresholds identified in the Flow Evaluation (USFWS and HVT 1999) were used to calculate survival indexes for alternatives and are shown in Table 3. The TRFE recommended these temperature thresholds for each species because they supported relatively good growth while extending the physiological readiness of juveniles (i.e. the smoltification process) to successfully survive in seawater (USFWS and HVT 1999). Temperatures that support good growth further enhances a juvenile's ability grow to a larger size which enhances its chances of survival in seawater. (Clarke and Shelbourn, 1985). In the absence of appropriate thermal regimes, salmonid smolts may revert to the non-migratory parr lifestage and be forced to rear in freshwater during the summer (Folmar and Dickhoff, 1980, Wedemeyer et al., 1980). Survival of parr, however, may be jeopardized if they are subjected to poor water quality, competition or predators (Cada et al., 1997). Diseases in particular are of major concern for fish departing the Trinity River and entering the lower Klamath River, which harbors debilitating and lethal diseases (i.e. *Ceratomyxa shasta* and *Columnaris sp*.) for juvenile and adult salmonids (Guillen 2003).

Smolt survival was based on the estimated average weekly water temperatures of the Trinity River at Weitchpec. It was assumed that if a smolt reached Weitchpec and the temperature was below the upper bound of the optimal smolt temperature range (Table 3) that there was 100% survival (i.e.: for steelhead, this would be 55.4 degrees F). When temperatures exceeded the upper bound of the optimal range, it was assumed that survival declined linearly until reaching 0% at the upper bound of the marginal range (for steelhead, this would be 59 degrees F). The linear temperature-survival relationship was developed as a tool to compare alternatives that include a range of flows (and thus a range of temperatures).

Table 3
Optimal and Marginal Salmonid Smolt Temperature Criteria (USFWS and HVT, 1999, Table 5.11)

Species	**Optimal Temperature (F)**	**Marginal Temperature (F)**
Steelhead	42.8-55.4	55.4-59.0
Coho Salmon	50.0-59.0	59.0-62.6
Chinook Salmon	50.0-62.6	62.6-68.0

Survival Index

A weekly survival index (SI) was calculated for each species by multiplying the weekly proportions (P) of the populations outmigrating past Weitchpec by the species specific survival (S) for that week (Equations 1a, b, c).

$SI(sth)_i$ =	steelhead survival index during week i = $S(sth)_i * P(sth)_i$	Equation 1a
$SI(coho)_i$ =	coho survival index during week i = $S(coho)_i * P(coho)_i$	Equation 1b
$SI(chin)_i$ =	Chinook survival index during week i = $S(chin)_i * P(chin)_i$	Equation 1c

$S(sth)_i$ = steelhead survival during week i
$S(coho)_i$ = coho survival during week i
$S(chin)_i$ = Chinook survival during week i

$P(sth)_i$ = proportion of steelhead outmigrating during week i
$P(coho)_i$ = proportion of coho outmigrating during week i
$P(chin)_i$ = proportion of Chinook outmigrating during week i

The annual smolt survival index was estimated by summing the weekly survival indexes (Equation 2).

$$\text{Smolt Survival Index} = \sum (SI(species)i) \qquad \text{Equation 2}$$

Chinook Salmon Production Analysis

As part of this evaluation, Chinook salmon production was further evaluated by using a harvest/escapement model (HEM). Parameters used in this model were consistent with harvest assessment parameters used in models utilized for management of Klamath Basin Chinook salmon ocean and inriver fisheries. The HEM used in this analysis is specific to the Chinook salmon life cycle that uses life history parameters (age specific survival, maturity rates, harvest rates, etc.) as developed for Trinity (or Klamath Basin) Chinook salmon. Use of the HEM generated an index of harvestable salmon (HI) specific to each alternative and water year type and allowed for comparison between alternatives. Because no similar model exists for the steelhead and coho, Chinook is the only species that underwent this evaluation.

To isolate the influence of smolt survival on Chinook salmon production, ocean and inriver harvest rates were adjusted to produce a constant number of adult spawners across alternatives. This allowed for the assumption that a fixed number of smolts for a given number of spawners would be produced from the upper Trinity River to outmigrate to the ocean. Varying juvenile Chinook salmon production is expected for a given number of spawners due to different levels of instream restoration for the alternatives. A juvenile Chinook salmon production model, SALMOD (Williamson et al., 1993), was developed for the Trinity River and used to evaluate the influence of varying flow schedules and habitat restoration actions on juvenile Chinook salmon production. Information generated from SALMOD for the TRFE was used to seed the Chinook harvest/ escapement model (USFWS and HVT, 1999, Table 5.23).

The HEM was used to test the sensitivity of two parameters. and these included: 1) varying the number of spawners that seed the available habitat of the Trinity River from Lewiston to Dutch Creek (i.e. either 33,000 or 68,000 salmon), and 2) adjusting the amount of rearing habitat that an alternative is likely to create (Table 4). *(Note: the level of habitat created or restored for the Revised Mechanical Restoration is problematic in that if it is assumed that full restoration would occur, then a habitat value similar to the other alternatives [e.g. Flow Evaluation] which scored a TRAASM score of greater than 70% of possible could be given; if on the other hand this alternative could only obtain habitat restoration of 50% of possible, then a much lower habitat value would be assumed. Therefore, two levels of habitat restoration were evaluated for this alternative. It is likely that the habitat benefit from this alternative lies somewhere between the two levels selected for this analysis).*

Table 4
Parameters Used in the Sensitivity Analysis

Alternative Scenario	Rearing Habitat Improvement	Predicted Pre-Smolt Production in the Trinity River prior to outmigration (Millions)	
		33,000 Spawners	68,000 Spawners
No Action	0	2.959	2.976
Revised Mechanical A [1]	50%	3.748	4.462
Revised Mechanical B [1]	100%	4.537	5.948
Modified Percent Inflow	100%	4.537	5.948
Flow Evaluation	100%	4.537	5.948
70% Inflow	100%	4.537	5.948
Max Flow	100%	4.537	5.948

[1] Habitat and resultant production of smolts was varied under the Revised Mechanical Alternative to assess the sensitivity of the analysis to habitat assumptions for this alternative

Two levels of spawning escapement and resulting smolt production were used for this analysis. For the first evaluation, it was assumed that 2.959 million smolts would be produced by a spawning escapement of 33,000 adults for the No Action alternative (Table 4). For all alternatives with significant levels of channel rehabilitation and/or high flows to achieve fluvial processes, it was assumed that a two-fold increase in habitat (i.e. 100% increase) would result in 4.537 million smolts being produced by 33,000 spawners. The Revised Mechanical Restoration alternative was evaluated with two levels of smolt production. For the first evaluation (Revised Mechanical-A), it was assumed that the channel rehabilitation activities would increase smolt production to a level 1/2 way between the No Action and other alternatives that contained channel rehabilitation and/or fluvial process flows. Under this alternative 33,000 spawners would produce 3.748 million smolts. For the second evaluation (Revised Mechanical-B) it was assumed that smolt production would equal 4.537 million, similar to the Flow Evaluation, MPI, 70% Inflow, and Maximum Flow alternatives.

A second parallel analysis, using smolt production produced by 68,000 spawners was also conducted (Table 4). For these analyses, it was assumed that smolt production would equal 2.077 million for the No Action alternative, 4.462 million for the Revised Mechanical-A, and 5.948 for Revised Mechanical-B, MPI, Flow Evaluation, 70%, and Maximum Flow alternatives

For WY 1961-1964, the construction years for which smolt survival indexes were not calculated, mean survival index values for corresponding water year types were used. Mean annual harvest (ocean and inriver) indexes were calculated for each alternative. Harvest values generated by this exercise are only an index of Trinity River naturally produced fish and do not account for harvest of hatchery produced Chinook salmon or harvest in the mixed stock fisheries (river and ocean).

Results

Smolt Survival Indexes

Steelhead

The mean steelhead smolt SI (all WYs) ranged from 0.600 for the No Action alternative to 0.810 for the Maximum Flow alternative, a 35% increase compared to the No Action alternative (Table 5, Figure 8). The survival index for the Flow Evaluation alternative (0.800) was similar to that of the Maximum Flow, a 33% increase compared to the No Action alternative. The index values shown in Table 5, in some cases, seem counter intuitive. For example the Smolt Index for the Flow Evaluation Alternative is slightly lower than that for the No Action during critically dry years.

On inspection of the hydrographs in Figure 3 (Flow Evaluation) and Figure 1 (No Action) it is apparent why this occurs. For all water year types for the No Action alternative release flows ramp up to and hold at 2,000 cfs during Julian week 19 (May 6th) and remains at that level until Julian week 21 (approximately May 25th). On the other hand the releases during critical dry years for the Flow Evaluation alternative for example, ramp up to only1,500 cfs during week 17 and are held at that level through Julian week 22 (approximately May 31st). Julian week 20 corresponds to the peak of steelhead outmigration (Figure 7). As a result, a slightly lower index was calculated for Flow Evaluation compared to the No Action alternative, but only for this water year type (Table 5). A similar circumstance occurs for the Maximum Flow alternative during week 20 when flows are ramped up to 1,250 cfs during that week (Figure 2) as opposed to 2,000 cfs for the No Action alternative (Figure 1). The slightly smaller release during the peak of steelhead outmigration results in a slightly lower smolt SI during critically dry water years. In summary, the timing AND the magnitude of the flow releases and their overlap with the timing of out migrating smolts greatly affects the resulting index of survival for these species. This is true for all salmonid species and alternatives assessed.

Table 5
Steelhead Smolt Survival Indexes by Water Year Type for each Alternative

Water Year Class	No Action	Revised Mechanical	Flow Evaluation	MPI	70% Inflow	Maximum Flow
Critically Dry	0.600	0.547	0.558	0.439	0.525	0.535
Dry	0.600	0.590	0.652	0.475	0.657	0.685
Normal	0.600	0.695	0.835	0.535	0.731	0.763
Wet	0.600	0.762	0.929	0.624	0.816	0.956
Extremely Wet	0.600	0.714	0.918	0.820	0.945	0.981
Mean (all WYs)	0.600	0.670	0.800	0.580	0.740	0.810
Difference from No Action		0.070	0.200	-0.020	0.140	0.210
% Change from No Action		12%	33%	-3%	23%	35%

Coho Salmon

Mean coho salmon smolt SI (all WYs) ranged from 0.840 for the No Action alternative to 0.990 for the Maximum Flow alternative, an 18% increase compared to the No Action alternative (Table 6, Figure 9). All other alternatives has coho salmon smolt survival indexes greater than 0.910 including Flow Evaluation alternative which has an index of 0.950, an increase of 13% over the No Action alternative.

Table 6
Coho Salmon Smolt Survival Indexes by Water Year Type for Each Alternative

Water Year Class	No Action	Revised Mechanical	Flow Evaluation	MPI	70% Inflow	Maximum Flow
Critically Dry	0.840	0.822	0.867	0.867	0.813	0.981
Dry	0.840	0.815	0.871	0.863	0.904	0.981
Normal	0.840	0.898	0.989	0.903	0.949	0.981
Wet	0.840	0.979	0.991	0.947	0.973	0.993
Extremely Wet	0.840	0.990	0.995	0.989	0.996	0.993
Mean (all Wys)	0.840	0.910	0.950	0.910	0.940	0.990
Difference from No Action		0.070	0.110	0.070	0.100	0.150
% Change from No Action		8%	13%	8%	12%	18%

Chinook Salmon

Mean Chinook salmon smolt SI (all WYs) ranged from 0.410 for the No Action alternative to 0.764 for the Maximum Flow alternative (Table 7, Figure 10). Compared to the No Action alternative, the percentage increase of the other alternatives ranged from 20.5 % increase for the MPI alternative to 86.3 % increase for the Maximum Flow alternative. The Flow Evaluation alternative index increased 46.8% compared to the No Action alternative.

Table 7
Chinook Salmon Smolt Survival Indexes by Water Year Type for each Alternative

Water Year Class	**No Action**	**Revised Mechanical**	**Flow Evaluation**	**MPI**	**70% Inflow**	**Maximum Flow**
Critically Dry	0.410	0.387	0.443	0.443	0.394	0.677
Dry	0.410	0.385	0.443	0.438	0.474	0.729
Normal	0.410	0.540	0.694	0.476	0.516	0.734
Wet	0.410	0.568	0.694	0.526	0.586	0.827
Extremely Wet	0.410	0.643	0.694	0.594	0.745	0.805
Mean (all Wys)	0.410	0.506	0.602	0.494	0.545	0.764
SI Difference from No Action		0.096	0.192	0.084	0.135	0.354
% Change from No Action		23%	47%	21%	33%	86%

Chinook Salmon Harvest

Mean HI (Brood Years 1912-2002) of naturally produced Trinity River Chinook salmon ranged from 4,400 fish for the No Action alternative to 66,600 fish for the Maximum Flow alternative under the 33,000 spawner scenario (Table 8). Compared to the No Action alternative, all alternatives had increased harvest indexes (> 370% increase). The Flow Evaluation alternative resulted in the second largest harvest index increase with greater than a 10-fold increase (919%).

Table 8
Chinook Salmon Harvest Index for each Alternative using the Assumption of 33,000 Spawners for Seeding the System as well as 33, 000 adult Spawners

	Alternative						
	No Action	**Revised Mechanical A**	**Revised Mechanical B**	**Flow Evaluation**	**MPI**	**70% Inflow**	**Maximum Flow**
	33,000 scenario	**33,000 scenario**	**33,000 scenario**	**33,000 scenario**	**33,000 scenario**	**33,000 scenario**	**33,000 scenario**
Harvest Index	4,364	20,506	32,013	44,486	30,794	37,311	66,646
Harvest Difference from No Action	--	16,142	27,649	40,122	26,430	32,947	62,282
% Change from No Action	--	370%	634%	919%	606%	755%	1427%

Under the 68,000 spawner scenario, mean harvest indexes (Brood Years 1912-2002) of naturally produced Trinity River Chinook salmon ranged from zero fish for the No Action alternative to 61,600 fish for the Maximum Flow alternative (Table 9). The No Action and Revised Mechanical A alternatives were not able to produce enough pre-smolts and suitable temperatures during emigration to even achieve 68,000 adult spawners and so the harvest index was zero. This inability to even maintain a self-sustaining spawning population is the result of density dependent factors influencing the number of smolts produced per adult spawner. Under this scenario, freshwater habitat is over-seeded which results in higher levels of freshwater mortality due to habitat bottlenecks than under the 33,000 spawning escapement scenario.

Table 9
Chinook Salmon Harvest Index for each Alternative Using the Assumption of 68,000 Spawners for Seeding the System as well as 68, 000 Adult Spawners

	Alternative						
	No Action	**Revised Mechanical A**	**Revised Mechanical B**	**Flow Evaluation**	**MPI**	**70% Inflow**	**Maximum Flow**
	68,000 scenario	**68,000 scenario**	**68,000 scenario**	**68,000 scenario**	**68,000 scenario**	**68,000 scenario**	**68,000 scenario**
Harvest Index	0	0	16,426	32,705	14,847	23,339	61,661
Harvest Difference from No Action	--	0	NA	NA	NA	NA	NA
% Change from No Action	--	0	NA	NA	NA	NA	NA

Summary

Survival Indexes

Temperature regimes resulting from different flows during the salmonid smolt out-migration period had varying affects on the smolt survival index depending on species and alternative. Proportional increases in mean survival index (all water years combined) between the No Action and action alternatives were the smallest for coho salmon smolts, ranging from an 8% increase for the Revised Mechanical alternative to an 18% increase for the Maximum Flow alternative (Table 11). Changes in steelhead smolt survival index, compared to the No Action alternative, ranged from a 3% reduction (Modified Percent Inflow) to a 35% increase (Maximum Flow). Changes in smolt survival indexes were greatest for Chinook salmon, ranging from 21% (MPI) to 86% (Maximum Flow). Chinook salmon harvest indices increased substantially for all alternatives and were greatest for the Maximum Flow alternative (1427%) and the Flow Evaluation alternative (919%) (Figure 11).

Table 11
Percentage Change from No Action Alternative for Instream Release Volumes, Steelhead, Coho, and Chinook Survival Index, and Chinook Harvest Index for Each Alternative

	Revised Mechanical A	**Revised Mechanical B**	**Flow Evaluation**	**MPI**	**70% Inflow**	**Maximum Flow**
Instream Volumes	34%	34%	75%	47%	175%	260%
Steelhead Survival Index	12%	12%	33%	-3%	23%	35%
Coho Survival Index	8%	8%	13%	8%	12%	18%
Chinook Survival Index	23%	23%	45%	21%	32%	86%
Increase to Chinook Harvest Index (33 K)	370%	634%	919%	606%	755%	1427%
Increase in Numbers of Harvestable Chinook (68K)	NA	NA	NA	NA	NA	NA

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Figure 1. Hydrograph of Flow Releases for the No Action Alternative during the active Period of Steelhead, Coho and Chinook Salmon Smolt Emigration.

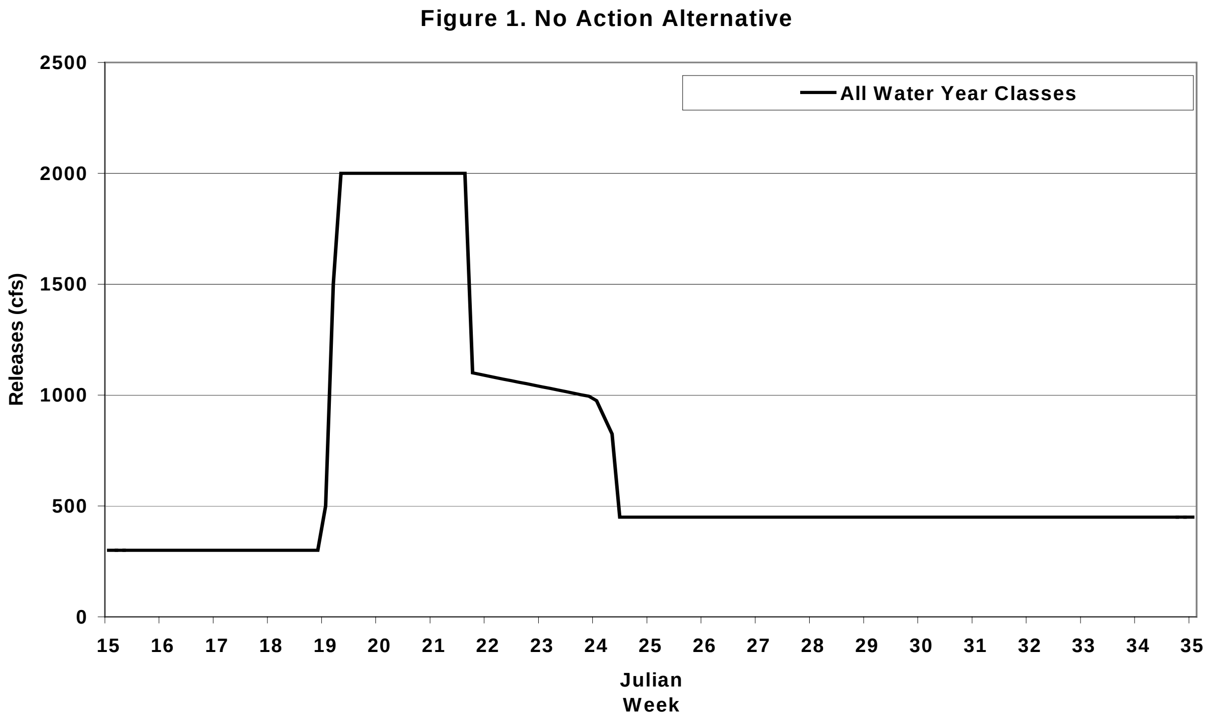


Figure 2. Hydrograph of Flow Releases for the Maximum Flow Alternative during the active Period of Steelhead, Coho and Chinook Salmon Smolt Emigration.

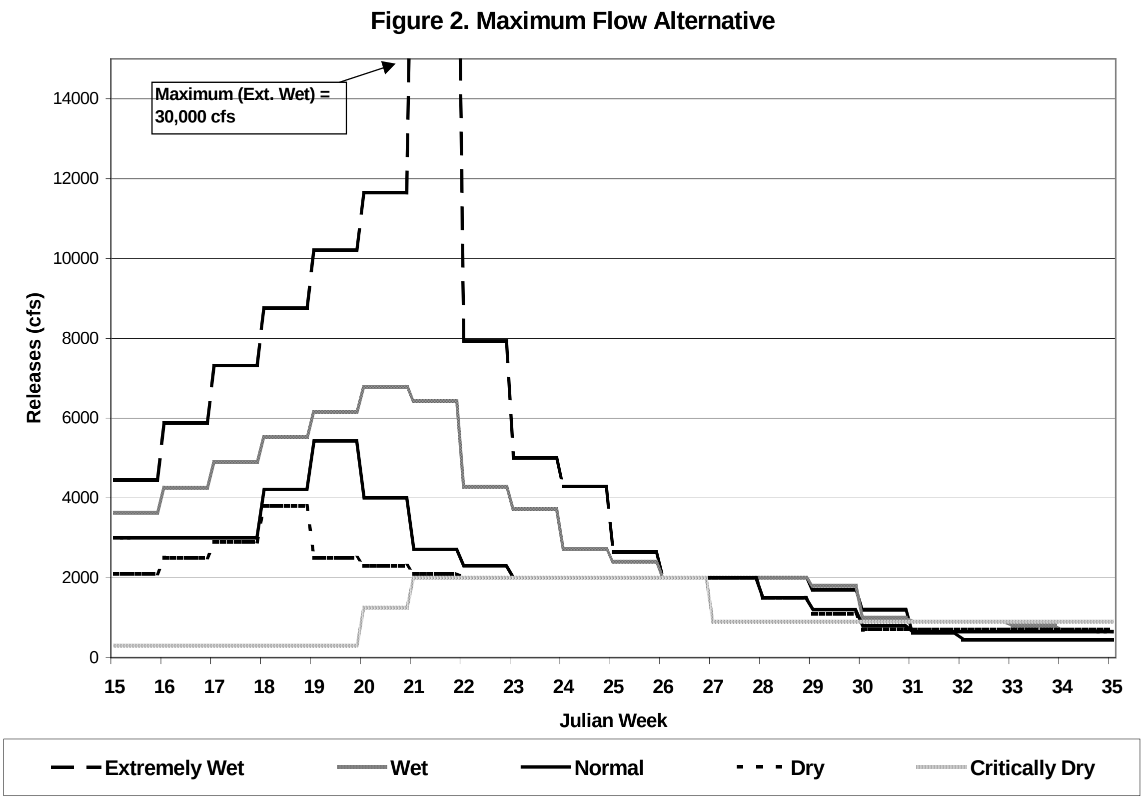


Figure 3. Hydrograph of Flow Releases for the Flow Evaluation Alternative during the active Period of Steelhead, Coho and Chinook Salmon Smolt Emigration.

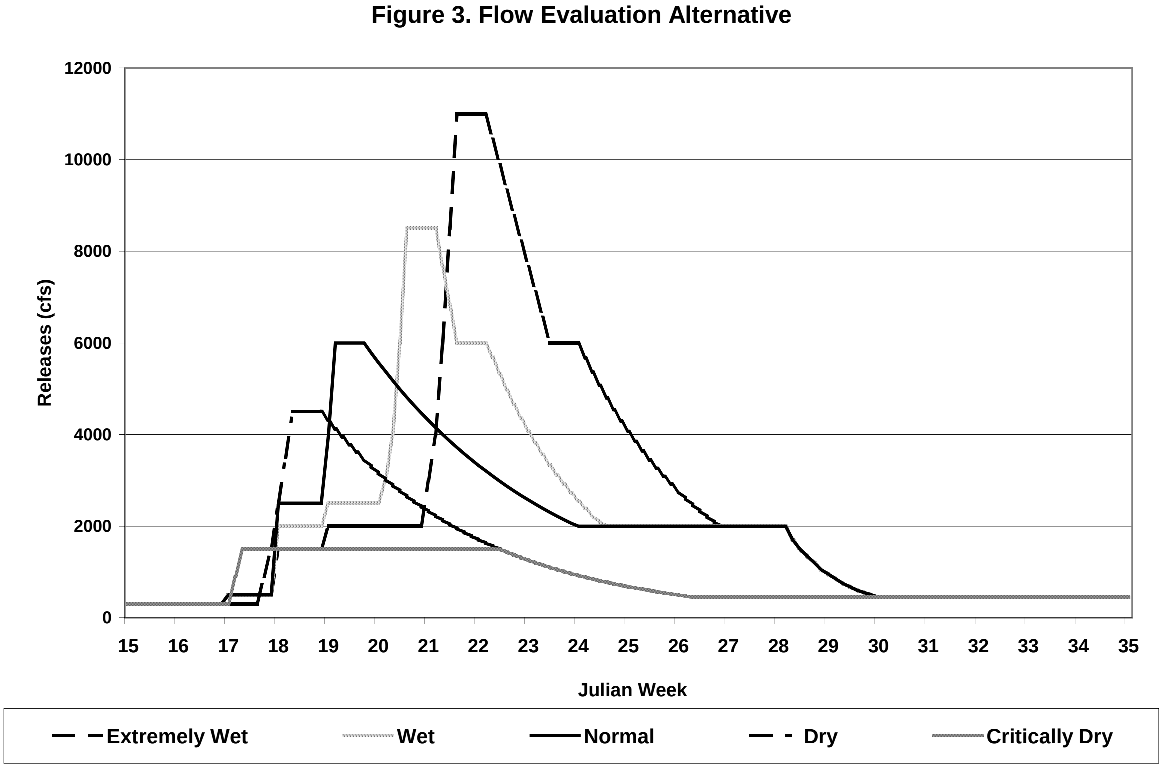


Figure 4. Hydrograph of Flow Releases for the 70 Percent Inflow Alternative during the active Period of Steelhead, Coho and Chinook Salmon Smolt Emigration.

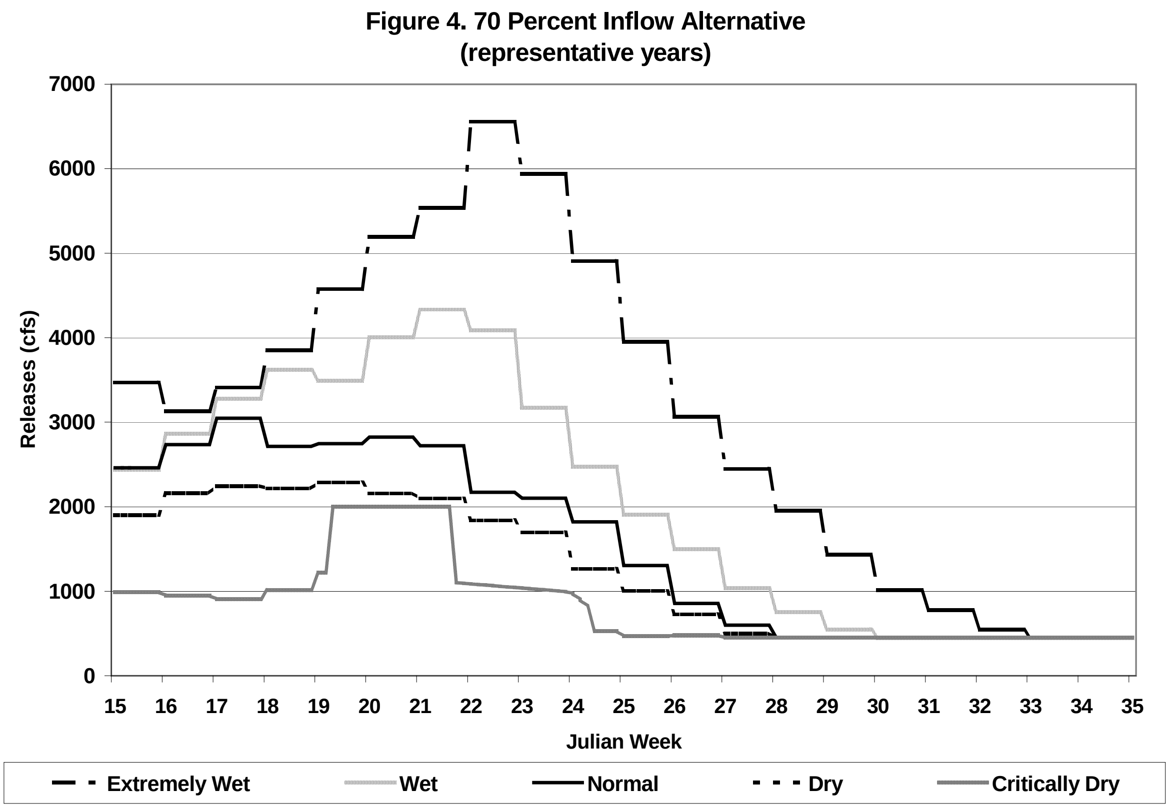


Figure 5. Hydrograph of Flow Releases for the Revised Mechanical Restoration Alternative during the active Period of Steelhead, Coho and Chinook Salmon Smolt Emigration.

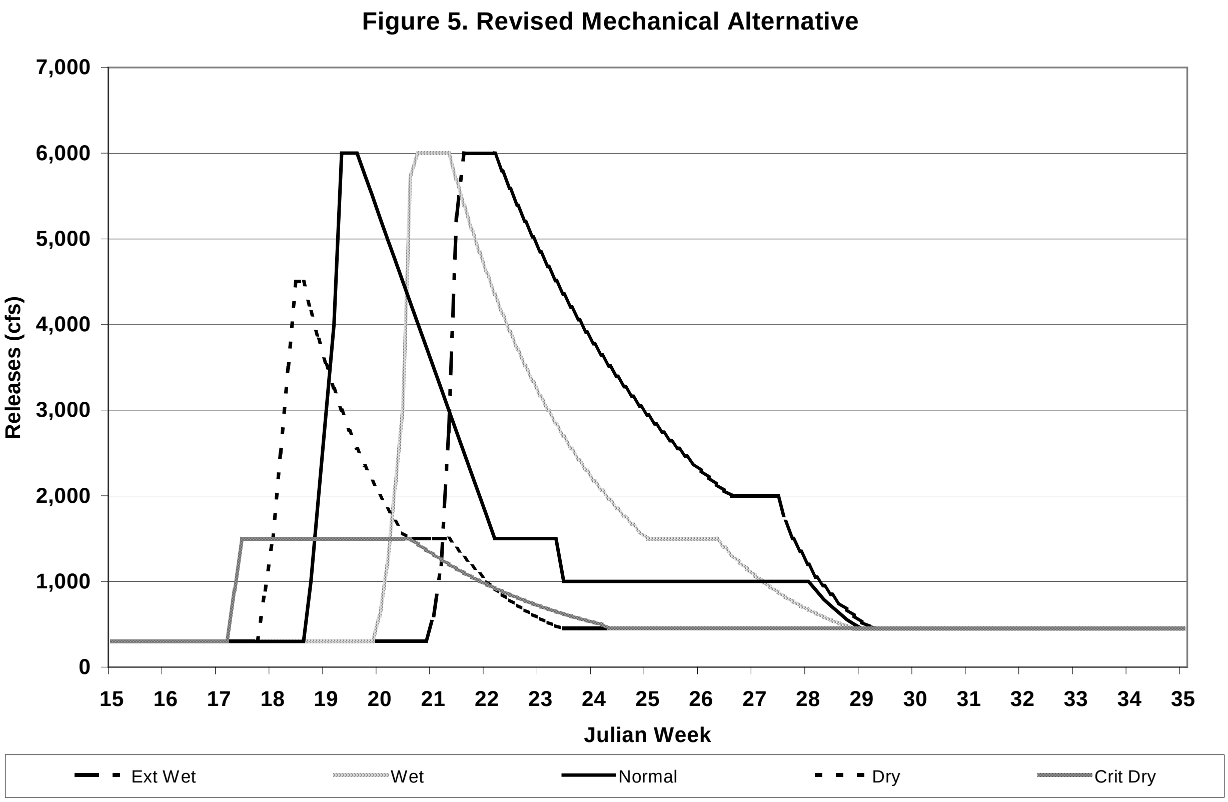


Figure 6. Hydrograph of Flow Releases for the Modified Percent Inflow Alternative during the active Period of Steelhead, Coho and Chinook Salmon Smolt Emigration.

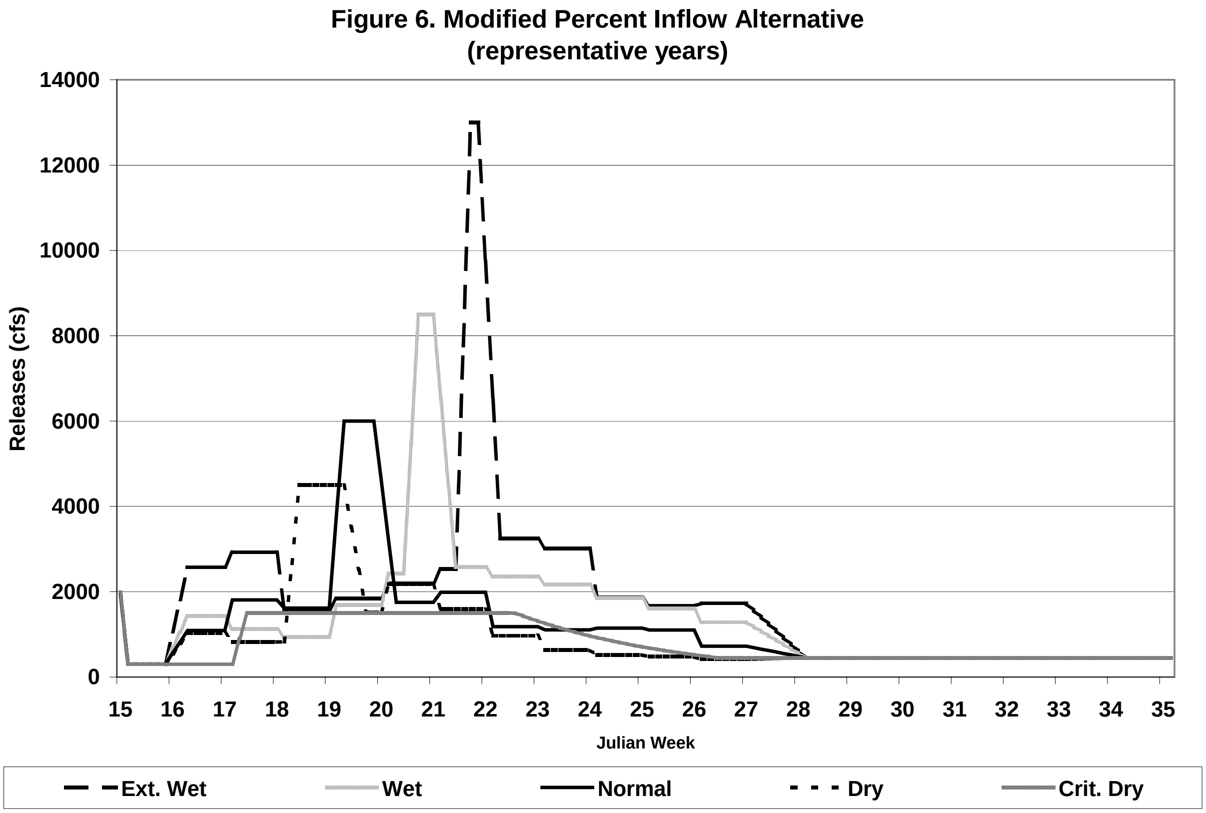


Figure 7. Mean weekly proportions of juvenile salmonid smolts outmigrating from the Trinity River, 1992-1999, 2001, at Willow Creek, CA.

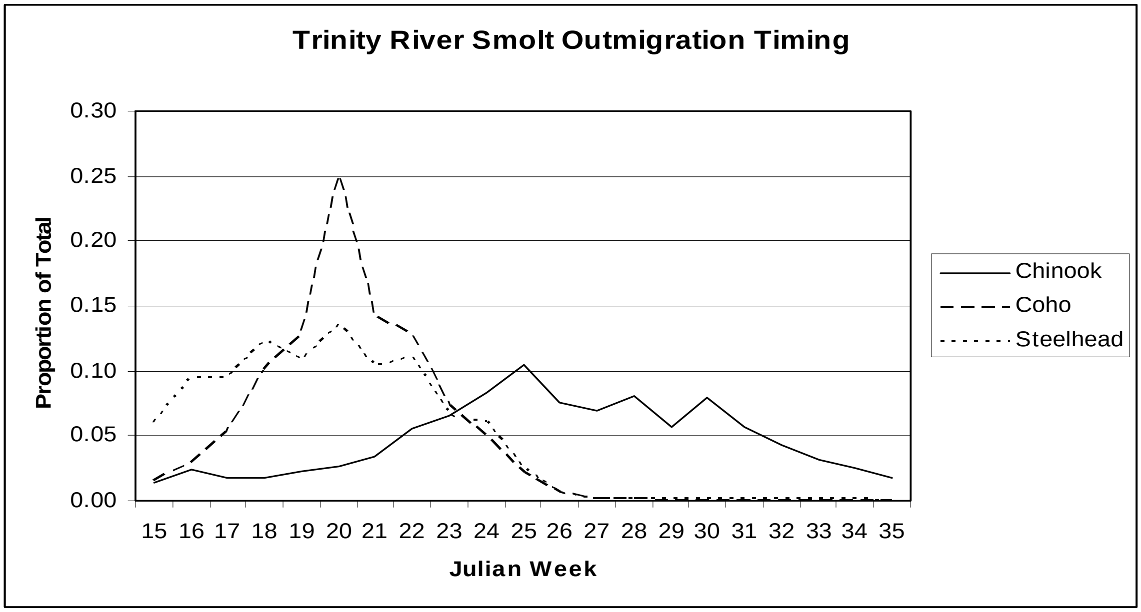


Figure 8. Steelhead Smolt Survival Suitability Indices by alternative

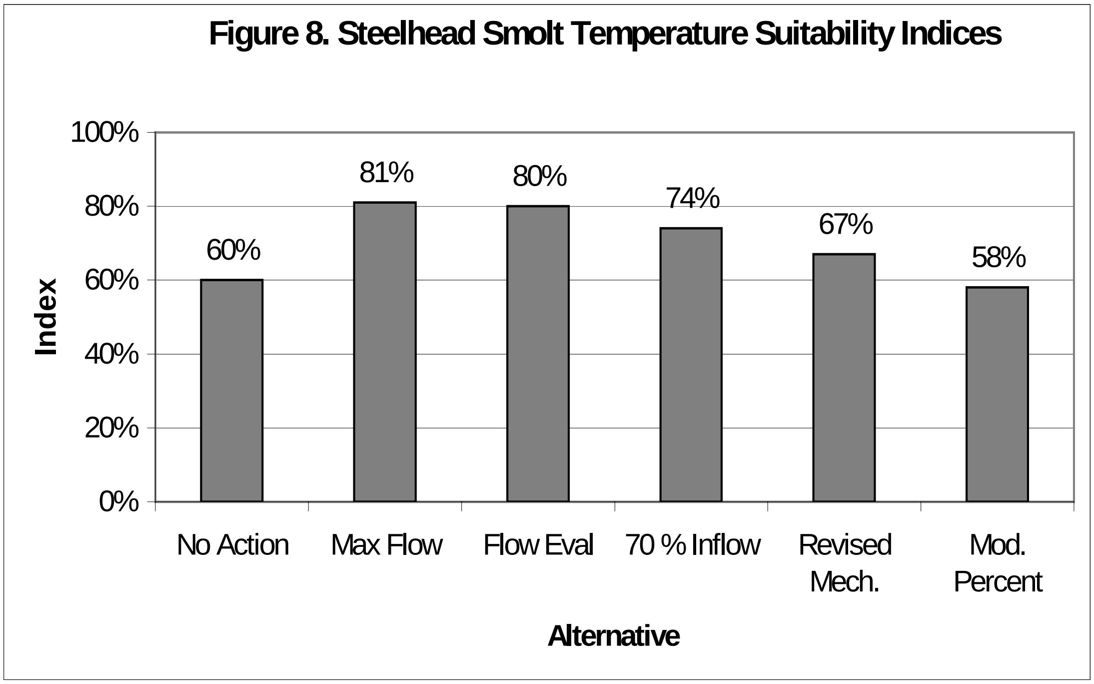


Figure 9. Mean Coho Salmon Smolt Survival Indices By Alternative.

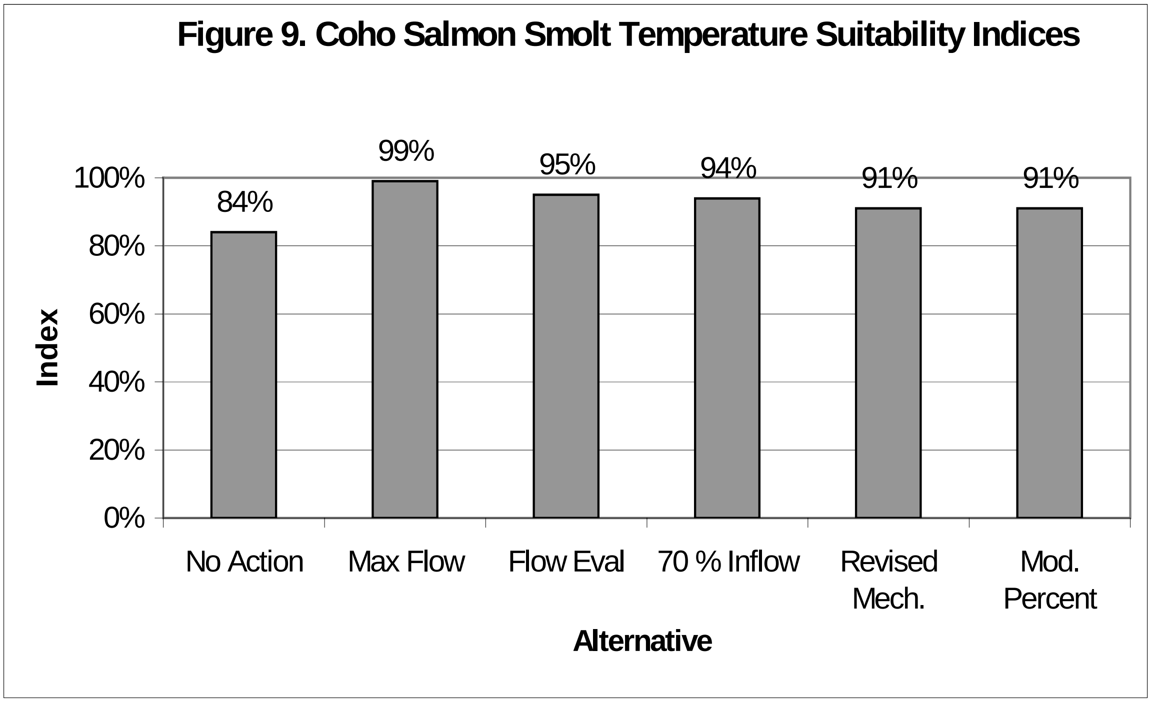


Figure 10. Percentage Change of the Chinook Salmon Smolt Survival Index Compared to the No Action Alternative.

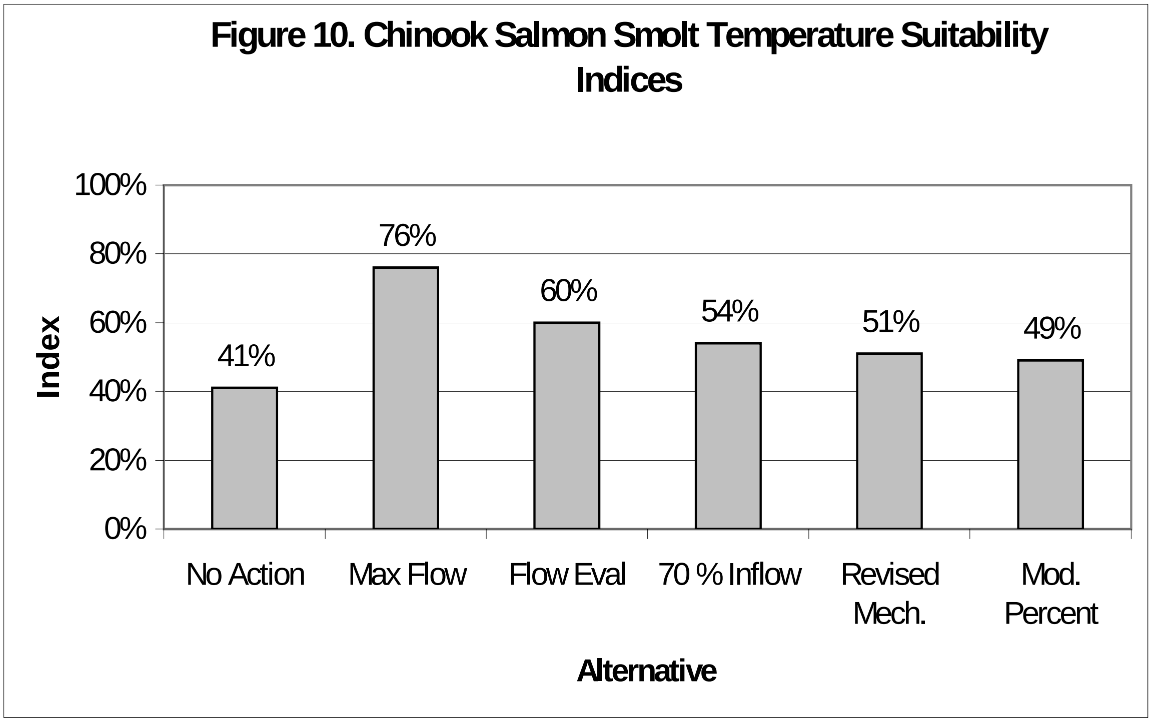
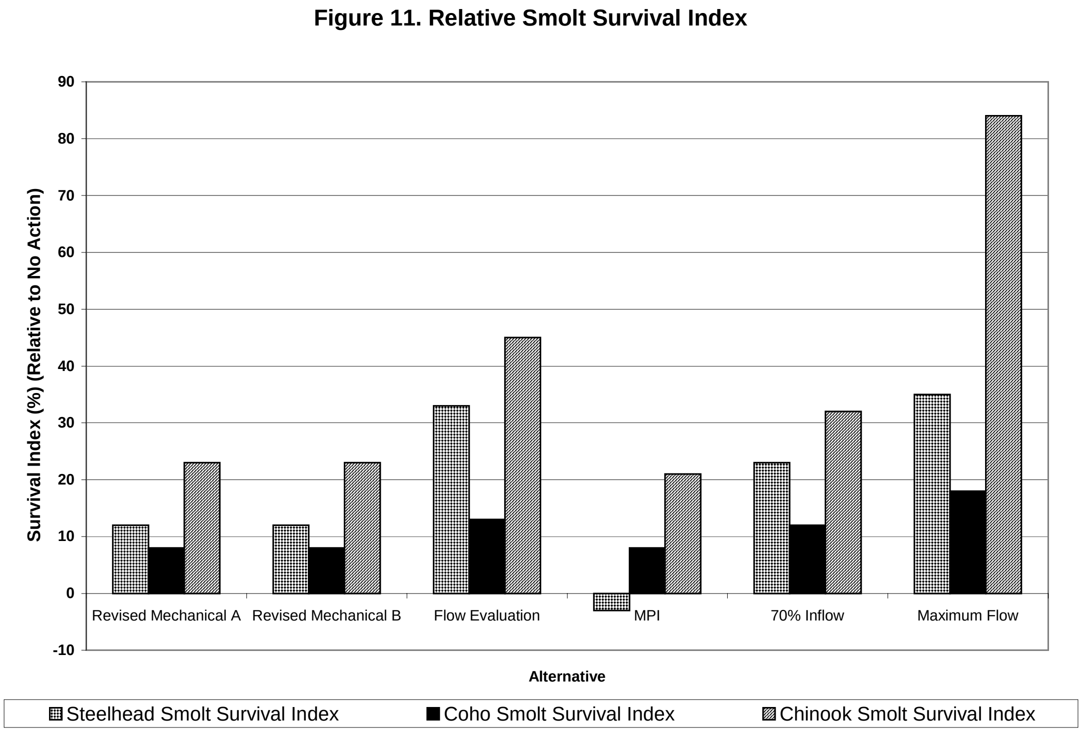


Figure 11.
Relative Changes in Smolt Survival Indices.



Attachment B6
TRAASM Scoring Worksheets

	ATTRIBUTE #1 Spatially complex channel geomorphology							
	OBJECTIVE	**No Action**	**Maxflow**	**FlowEval**	**Mech Rest**	**70% Inflow**	**Revised Mech**	**Mod. % Inflow**
1	Restore alluvial channel (able to form its own bed, particle, and bank dimensions)	NS	NS	NS	NS	NS	NS	NS
2	Create and/or maintain structural complexity of alternate bar sequences	NS	NS	NS	NS	NS	NS	NS
3	Create and maintain functional floodplains	NS	NS	NS	NS	NS	NS	NS
4	Increase diversity of channelbed particle size	NS	NS	NS	NS	NS	NS	NS
5	Greater topographic complexity in side channels	NS	NS	NS	NS	NS	NS	NS
	Sum of the Alternative	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Thresholds:								
1,2, 3	Dependent on an integration of all attributes							
Scorir	These objectives are dependent on the integration of all other attributes and therefore the Fish Tech Team did not attempt to assess these objectives to eliminate "double counting"							

		No Action	Maxflow	FlowEval	Mech Rest	70% Inflow	Revised Mech	Mod. % Inflow
	ATTRIBUTE #2 Flows and water quality are predictably unpredictable							
	OBJECTIVE							
1	Provide inter- and intra-annual flow variation for summer baseflows (July 1-October 1)	0	0	0	0	2	0	0
2	Provide inter- and intra-annual flow variation for winter baseflows (January 1-April 1)	0	0	0	0	2	0	0
3	Provide inter- and intra-annual flow variation for winter flood (October 1-April 30)	0	0	0	0	1	0	0
4	Provide inter- and intra-annual flow variation for snowmelt peak floods (April1-June 30)	1	2	2	1	2	2	2
5	Provide inter- and intra-annual flow variation for snowmelt recession (May 1-July 31)	1	2	2	1	2	2	2
	Sum of the Alternative	**2**	**4**	**4**	**2**	**9**	**4**	**4**
Thresholds:								
1-5	Based on flow schedule's emulation of pre-dam hydrograph components							
Scoring:								
	"2" presence of natural AND variable hydrograph components*							
	"1" presence of natural OR variable hydrograph components							
	"0" natural and variable hydrograph components absent							
	* natural components follow the same relative magnitude, trends and timing of pre-dam hydrograph components of the hydrograph are variable when magnitudes vary throughout the season and year							

		No Action	Maxflow	FlowEval	Mech Rest	70% Inflow	Revised Mech	Mod. % Inflow
	ATTRIBUTE #3 Frequently mobilized channelbed surface							
	OBJECTIVE							
1	Exceed incipient motion for mobile active channel alluvial features (median bars, pool tails, spawning gravel deposits) every 2 of 3 years	0	2	2	0	2	2	2
2	Achieve incipient motion for most channelbed surfaces (riffles, face of point bars) every 2 of 3 years	0	2	2	0	2	2	2
3	Exceed threshold for transporting sand through most pools every 2 of 3 years	0	2	2	1	2	2	2
	Sum of the Alternative	**0**	**6**	**6**	**1**	**6**	**6**	**6**
Thresholds:								
1	Bed surface mobilization of the mobile active channel alluvial features occurs >3,000 cfs							
2	Bed surface mobilization of most of the channel bed surface occurs >6,000 cfs							
3	Transport of substantial volumes of sand through pools requires flows >3,000 cfs							
Scoring:								
	"2" Always or nearly always exceeds threshold							
	"1" sometimes exceeds threshold							
	"0" never or nearly never exceeds thresholds							

	ATTRIBUTE #4 Periodic channelbed scour and fill							
	OBJECTIVE	**No Action**	**Maxflow**	**FlowEval**	**Mech Rest**	**70% Inflow**	**Revised Mech**	**Mod. % Inflow**
1	Scour/redeposit spawning gravel deposits (at least 2 D84 thicknesses) every 2-3 years	0	2	2	0	2	2	2
2	Scour/redeposit faces of alternate bars (at least 2 D84 thicknesses) every 3-5 years	0	1	2	0	1	0	2
3	Deposit fine sediment onto upper alternate bar and floodplain surfaces every 2-3 years	0	2	2	0	2	1	2
4	Maintain scour channels on alternate bar surfaces every 3-5 years	0	1	2	0	1	0	2
	Sum of the Alternative	**0**	**6**	**8**	**0**	**6**	**3**	**8**
Thresholds:								
1	Bed scour (>2 D84 particle thickness) in mobile active channel features occurs >6,000 cfs							
2, 4	Bed Scour (>2 D84 thickness) on face of alternate bar surfaces begins to occur at 8,500 cfs							
3	Bed scour (>2 D84 particle thickness) in mobile active channel features occurs >6,000 cfs and with depths of 1 foot and greater on floodplain surfaces							
Scoring:								
	"2" always or nearly always exceeds threshold							
	"1" sometimes exceeds threshold							
	"0" never or nearly never exceeds threshold							

		No Action	Maxflow	FlowEval	Mech Rest	70% Inflow	Revised Mech	Mod. % Inflow
	ATTRIBUTE #5 Balanced fine and coarse sediment budgets							
	OBJECTIVE							
1	Reduce fine sediment storage in mainstem	0	2	2	1	2	2	2
2	Maintain coarse sediment budget in the mainstem	0	2	2	0	1	1	2
3	Route mobilized D84 gravel through alternate bar sequences every 2 of 3 years	0	2	2	0	2	2	2
4	Prevent excessive aggradation of tributary-derived material in the mainstem	0	2	2	0	2	2	2
	Sum of the Alternative	**0**	**8**	**8**	**1**	**7**	**7**	**8**
Thresholds:								
1	Ability of combined flow magnitude and duration to transpost fine sediments through the system							
2	Ability of combined flow magnitude and duration to achive ZERO net coarse sediment budget							
3	Exceeded by flows greater than 6,000 cfs							
4	Mechanically excavated and distributed downstream and/or maintained by flows; distribution of delta begins at > 6,000 cfs but coarser particles require flows >14,000 cfs							
Scoring:								
1	Alternatives were scored relative to each other, "2" moved the most fine sediment, "0" the least							
2	Alternative closest to ZERO net supply scored "2", other over/under supplies were scored relative to this alternative, where "1" was the next best range, and "0" was the most over/under supply							
3, 4	"2" always or nearly always exceeds threshold							
	"1" sometimes exceeds threshold							
	"0" never or nearly never exceeds threshold							

		No Action	Maxflow	FlowEval	Mech Rest	70% Inflow	Revised Mech	Mod. % Inflow
	ATTRIBUTE #6							
	Periodic channel migration							
	OBJECTIVE							
1	Channel migrates in alluvial reaches	0	1	1	0	1	1	1
2	Maintain channel geometry as channel migrates	0	2	2	0	2	1	2
3	Create channel avulsions every 10 years	0	2	0	0	0	0	0
	Sum of the Alternative	**0**	**5**	**3**	**0**	**3**	**2**	**3**
Thresholds:								
1	Requires partial removal of riparian berm and estimate >6,000 cfs flow							
2	Requires adequate coarse sediment supply and estimated >6,000 cfs flow							
3	Flows must be greater than 30,000 cfs for channel avulsions							
Scoring:								
	"2" always or nearly always exceeds threshold							
	"1" sometimes exceeds threshold							
	"0" never or nearly never exceeds threshold							

		No Action	Maxflow	FlowEval	Mech Rest	70% Inflow	Revised Mech	Mod. % Inflow
	ATTRIBUTE #7 Functional floodplain							
	OBJECTIVE							
1	Inundate the floodplain on average every 2 to 3 years	0	2	2	0	2	1	2
2	Encourage local floodplain surface scour and deposition by infrequent (every 3-5 years) but larger floods	0	1	2	0	1	0	2
3	Floodplain construction keeps pace with floodplain loss on opposite bank	0	2	2	0	2	0	2
	Sum of the Alternative	**0**	**5**	**6**	**0**	**5**	**1**	**6**
Thresholds:								
1	Flows greater than 6,000 cfs							
2	Flows greater than 8,500 cfs							
3	Requires fine sediment supply and flows greater than 6,000 cfs and depths > 1' on floodplain							
Scoring:								
	"2" always or nearly always exceeds threshold							
	"1" sometimes exceeds threshold							
	"0" never or nearly never exceeds threshold							

	ATTRIBUTE #8 Infrequent channel resetting floods							
	OBJECTIVE	**No Action**	**Maxflow**	**FlowEval**	**Mech Rest**	**70% Inflow**	**Revised Mech**	**Mod. % Inflow**
1	Major reorganization of alternate bar sequences every 10-20 years	0	2	0	0	0	0	0
2	Remove upstream bedload impedance by distributing tributary delta materials	0	2	2	2	2	2	2
3	Infrequent (once in 5-10 years) deep scour on floodplain surfaces	0	2	0	0	0	0	0
4	Construct and maintain/rejuvenate side channels	0	2	1	2	1	2	2
5	Deposit fine sediment on lower terrace surfaces	0	2	0	0	1	0	0
	Sum of the Alternative	**0**	**10**	**3**	**4**	**4**	**4**	**4**
Thresholds:								
1	Flows estimated to be greater than 30,000 cfs							
2	Flows estimated to be greater than 14,000 cfs and balance coarse sediment budget							
3	Flows greater than 24,000 cfs							
4	Flows estimated to be > 11,000 cfs OR mechanically maitained side channels							
5	Flows greater than 11,000-14,000 cfs causing innundation of pre-dam flood plains (now functioning as terraces)							
Scoring:								
	"2" always or nearly always exceeds threshold							
	"1" sometimes exceeds threshold							
	"0" never or nearly never exceeds threshold							

	ATTRIBUTE #9 Self-sustaining diverse riparian plant communities							
	OBJECTIVE	**No Action**	**Maxflow**	**FlowEval**	**Mech Rest**	**70% Inflow**	**Revised Mech**	**Mod. % Inflow**
1	Prevent seedling germination on lower bar surfaces	0	1	1	0	1	1	1
2	Scour or remove most initiating seedlings (0- to 1-year old plants)	0	2	2	1	2	1	2
3	Scour of most established seedling (2- to 3-year old plants)	0	2	1	1	1	1	1
4	Periodic removal of individual mature riparian trees at least every 10 years	0	2	0	1	0	1	1
5	Seed deposition on floodplains every 2-3 years	0	2	2	0	2	2	2
	Sum of the Alternative	**0**	**9**	**6**	**3**	**6**	**6**	**7**
Thresholds:								
1	Bar innundation of seed dispersal period (1,500 cfs-2,000 cfs) in June and July							
2	Surficial bed scour on lower bar surfaces require flows greater than 6,000 cfs OR hand and/or mechanical removal							
3	Deep bed scour or bar surfaces requires flows greater than 8,500 to 14,000 cfs							
4	Individual exposed alder trees require at least 14,000 cfs, widespread removal of alder trees requires over 30,000 cfs OR mature riparian alders are mechanically removed							
5	Floodplain access begins at 5,000-6,000 cfs; flows needed May 5th to June 5th							
Scoring:								
	"2" always or nearly always exceeds threshold							
	"1" sometimes exceeds threshold							
	"0" never or nearly never exceeds threshold							

		No Action	Maxflow	FlowEval	Mech Rest	70% Inflow	Revised Mech	Mod. % Inflow
	ATTRIBUTE #10							
	Naturally fluctuating groundwater table							
	OBJECTIVE							
1	Groundwater recharge of gravel bars	2	2	2	2	2	2	2
2	Groundwater recharge of floodplains and off-channel wetland habitats	0	2	2	0	1	2	2
3	Groundwater recharge of terraces and associated wetland habitats	0	1	1	0	1	0	1
	Sum of the Alternative	**2**	**5**	**5**	**2**	**4**	**4**	**5**
Thresholds:								
	Exceeded by flows greater than 1,500-2,000 cfs							
	Exceeded by flows greater than 6,000 cfs							
	Flows greater than 10,000 to 14,000 cfs							
Scoring:								
	"2" always or nearly always exceeds threshold							
	"1" sometimes exceeds threshold							
	"0" never or nearly never exceeds threshold							

Attachment B7
Assumptions and Rationale for TRAASM Scores

TRINITY RIVER SEIS FISH AND CHANNEL RESTORATION TEAM-TRAASM SCORING RATIONALE

ASSUMPTIONS:

- If actions are made to improve habitat conditions that move closer to meeting or that meet the objectives of the "Healthy River" Attributes, fish production will increase,
- All Attributes were weighted equally important in the analysis of the Attributes,
- These Attributes provide and maintain habitat for all freshwater lifestages of anadromous salmonids,
- Changes in fish numbers are not linearly correlated with flow,
- Only scheduled flows were considered in scoring the attributes, no "safety of dam release" flows were assessed,
- Sediment related Attributes were only considered for the mainstem Trinity River upriver from Indian Creek confluence,
- The 70 percent Inflow and the Modified Inflow alternatives were based on historic inflows to the reservoir and not average flow schedules by water year type used for other impact assessment
- The impacts of water temperature on anadromous salmonids were evaluated outside the TRAASM methodology (see Attachment 6)

Attribute # 1, all Objectives

As the objectives under Attribute #1 depend on the integration of all the remaining 10 attributes, none of the Alternatives were scored (to eliminate potential double counting).

Attribute # 2

Objective 1

"0" was scored for all alternatives except the 70 Percent of inflow alternative. All the remaining alternatives have summer flows maintained to meet State Regional water quality standards and therefore there is no inter- and intra-annual variation.

"2" was scored for the 70 Percent Inflow alternative as this alternative allows for inter and intra-annual variation of flow releases during summer (above a "floor of 300 cfs) based on the in-flow to Trinity Reservoir.

Objective 2

"0" was scored for all alternatives except the 70 Percent of inflow alternative. All the remaining alternatives have winter flows maintained at minimum flow releases and therefore there is no inter- and intra-annual variation.

None of the alternative scored a "1" for this Objective.

"2" was scored for the 70 Percent Inflow alternative as this alternative allows for inter and intra-annual variation of flow releases during winter base flow period based on the in-flow to Trinity Reservoir.

Objective 3

"0" was scored for all alternatives except the 70 Percent of inflow alternative. All the remaining alternatives eliminate winter flood flows, maintaining minimum flow releases and therefore there is no inter- and intra-annual variation.

"1" was scored for the 70 Percent Inflow alternative as this alternative allows for inter and intra-annual variation of flow releases during winter flood flow period based on the in-flow to Trinity Reservoir but at a much smaller magnitude that historic hydrograph (a "cap" of 70% of in-flow to the Trinity Reservoir).

Objective 4

None of the alternatives scored a "0" as all provide at least some annual variation of snow-melt peak flows.

"1" was scored for No Action and Mechanical Restoration alternatives as these alternatives allow for a snowmelt peak flow each year (not variable between years however).

"2" was scored for the remaining alternatives as all have peaks of flows during the winter within a year and peaks that vary between years depending on water year type.

Objective 5

None of the alternatives scored a "0" as all provide at least some inter and intra-annual variation of snow-melt recession flows.

"1" was scored for No Action and Mechanical Restoration alternatives as these alternatives allow for a variable snow-melt (descending limb) hydrograph within each year (not variable between years however).

"2" was scored for the remaining alternatives as all have descending limb hydrographs within each year and are variable depending on water year type.

Attribute 2

Objective 1

"0" was scored for No Action and Mechanical Restoration alternatives as the threshold of flows greater that 3,000 cfs is never met.

"2" was scored for the remaining alternative as all had flows greater than the threshold of 3,000 cfs for at least 2 out of 3 years.

Objective 2

"0" was scored for No Action and Mechanical Restoration alternatives as the threshold of flows greater that 6,000 cfs is never met.

"2" was scored for the remaining alternative as all had flows greater than the threshold of 6,000 cfs for at least 2 out of 3 years.

Objective 3

"0" was scored for No Action as the threshold of flows greater that 3,000 cfs is never met.

"1" was scored for Mechanical Restoration as the objective may partially be met through additional mechanical dredging and fine sediment reduction input measures beyond that for the No Action alternative.

"2" was scored for the remaining alternative as all had flows greater than the threshold of 6,000 cfs for at least 2 out of 3 years.

Attribute 4

Objective 1

"0" was scored for No Action and Mechanical as flows greater than 6,000 cfs are never met.

"2" was scored for the remaining alternatives as all meet and exceed the 6,000 cfs threshold in at least 2 out of 3 years.

Objective 2

"0" was scored for No Action and Mechanical as flows greater than 8,500 cfs are never met.

"1" was scored for Maximum Flow and 70 Percent Inflow alternatives as these alternatives meet the threshold of 8,500 cfs only in extremely wet water years.

"2" was scored for the Flow Evaluation and Modified Percent Inflow alternatives as they meet the 8,500 cfs threshold in extremely wet and wet water year types.

Objective 3

"0" was scored for No Action and Mechanical as flows greater than 6,000 cfs are never met.

"1" was scored for Revised Mechanical alternative as this alternatives meets but doesn't exceed the minimum threshold of 6,000 cfs in 3 of 5 years and depths on the floodplain are minimal and much less than 1 foot.

"2" was scored for the remaining alternatives as all meet and greatly exceed the 6,000 cfs threshold in at least 2 out of 3 years.

Objective 4

“0” was scored for No Action and Mechanical as flows greater than 8,500 cfs are never met.

“1” was scored for Maximum Flow and 70 Percent Inflow alternatives as these alternatives meet the threshold of 8,500 cfs only in extremely wet water years.

“2” was scored for the Flow Evaluation and Modified Percent Inflow alternatives as they meet the 8,500 cfs threshold in extremely wet and wet water year types.

Attribute 5

Objective 1

“0” was scored for No Action as this alternative would be expected to move the least volume of fine sediment.

“1” was scored for Mechanical Restoration as this alternative were reduce fine sediment storage in the mainstem by additional mechanical dredging and fine sediment reduction input measures beyond that for the No Action alternative.

“2” was scored for the remaining alternatives all demonstrate the ability to reduce the accumulation and transport fine sediments through the system.

Objective 2

“0” was scored for the No Action and Mechanical Restoration alternatives as these have flow releases insufficient to route coarse sediment through the system resulting in large surpluses of coarse sediments over time.

“1” was scored for the 70 Percent and Revised Mechanical alternatives as these alternatives were “intermediate” in achieving a zero net supply of coarse sediment relative to the alternatives that resulted in either a large over or under supply of coarse sediments.

“2” was scored for the Maximum Flow, Flow Evaluation, and the Modified Percent Inflow alternatives as these were the best in meeting a zero net balance of coarse sediments relative to the other alternatives considering both flows and gravel augmentation.

Objective 3

“0” was scored for No Action and Mechanical Restoration alternative as these alternatives never reach the threshold of 6,000 cfs flow releases to route coarse sediment through alternate bar sequences.

“2” was scored for the remaining alternatives as all always or nearly always reach and/or exceed the threshold of 6,000 cfs flow releases in 3 out of 5 years to route coarse sediments through alternate bar sequences.

Objective 4

“0” was scored for No Action and Mechanical Restoration alternative as these alternatives never reach the threshold of 6,000 cfs flow releases to prevent coarse sediment aggradation of tributary-derived sediment in the mainstem.

“2” was scored for the remaining alternatives as all always or nearly always reach the threshold of 6,000 cfs to 14,000 cfs flow releases in 3 out of 5 years and/or would use additional mechanical excavation measures to prevent coarse sediment aggradation of tributary-derived sediment in the mainstem.

Attribute 6

Objective 1

“0” was scored for No Action and Mechanical Restoration alternatives as flows greater than 6,000 cfs are never met.

“1” was scored for the remaining alternatives as all meet the 6,000 cfs threshold to initiate channel migration but insufficient flow duration to maintain rate of channel migration.

None of the alternatives was scored a “2” as none met the duration of flows sufficient to maintain rate of channel migration.

Objective 2

“0” was scores for No Action and Mechanical Restoration alternatives as flows greater than 6,000 cfs are never met.

“1” was scored for the Revised Mechanical Restoration alternative as it meets the 6,000 cfs threshold to maintain channel geometry but insufficient to route coarse sediment through system.

“2” was scored for the remaining alternatives as flows are equal to or greater than 6,000 cfs are met to maintain channel geometry and also sufficiently routes course sediment through the system.

Objective 3

“0” was scored for all but the Maximum Flow alternative since none have scheduled releases of 30,000 cfs or greater.

“2” was scored for the Maximum Flow alternative as 30,000 cfs is scheduled for the first 3 extremely wet water years.

Attribute 7

Objective 1

“0” was scored for No Action and Mechanical Restoration as either of these alternatives ever exceed the threshold of 6,000 cfs.

“1” was scored for Revised Mechanical Restoration since this alternative meets the minimum of 6,000 cfs scheduled releases meet, but are no greater than, 6,000 cfs for widespread floodplain inundation.

“2” was scored for the remaining alternatives since the releases are greater than 6,000 cfs in greater than 2 out of 3 years.

Objective 2

“0” was scored for No Action, Mechanical Restoration, and Revised Mechanical Restoration alternative as these alternatives never reach 8,500 cfs required to encourage floodplain scour.

“1” was scored for Maximum Flow and 70 Percent Inflow alternatives as neither of these alternative provide scheduled releases of 8,500 cfs with sufficient frequency to meet the objective of 3 out of 5 years.

“2” was scored for the Flow Evaluation and Modified Percent Inflow alternatives as these alternatives exceed releases of greater than 8,500 cfs with sufficient frequency (>3 out of 5 years).

Objective 3

“0” was scored for No Action, Mechanical Restoration, and Revised Mechanical Restoration alternative as these alternatives never reach 6,000 cfs or exceed 6,000 cfs with sufficient depths greater than 1 foot on the floodplain required to encourage floodplain construction.

“2” was scored for the remaining alternatives as the threshold of 6,000 cfs and greater, with greater than 1 foot depth on the are met with sufficient frequency to provide fine sediment supply for floodplain construction.

Attribute 8

Objective 1

“0” was scored for all alternatives because none have scheduled releases of 30,000 cfs.

Objective 2

“0” was scored for No Action alternative as no schedules flows reach or exceed 14,000 cfs nor mechanical means would be used to accomplish objective.

“2” was scored for all action alternatives; Maximum flow because releases greater than 14,000 cfs would be provided; the remaining alternatives would use mechanical means to accomplish the objective.

Objective 3

“0” was scored for all but the Maximum flow alternative because schedule flow releases for those alternatives would never meet or exceed 14,000 cfs required to accomplish the objective.

"2" was scored for the Maximum Flow alternative because flow releases in excess of 14,000 cfs would occur at least once per 10 years.

Objective 4

"0" was scored by the No action alternative because the scheduled releases would not meet or exceed the 11,000 cfs threshold to meet the objective.

"1" was scored for the Flow Evaluation alternative because the scheduled flows up to 11,000 cfs in extremely wet water years (12% of years) may be sufficiently frequent to maintain the constructed side channels; the 70 Percent Flow alternative may provide adequate flows (>11,000 cfs) in sufficient number of years to maintain side channels and would use additional mechanical means for maintenance.

"2" was scored for the Maximum Flow alternative because scheduled releases up to 30,000 cfs in extremely wet water years are expected to construct and maintain side channels; the remaining alternatives would use mechanical means to construct and maintain side channels in order to meet this objective.

Objective 5

"0" was scored for No Action, Flow Evaluation, Mechanical Restoration, Revised Mechanical Restoration, and Modified Percent Inflow alternatives because scheduled flow releases never exceed 11,000 cfs.

"1" was scored for the 70 Percent of Inflow alternative as this alternative may provide adequate flows (>11,000 cfs) in sufficient number of years to deposit some fine sediments on the floodplain.

"2" was scored for the Maximum Flow Alternative because scheduled releases up to 30,000 cfs in extremely wet water years are expected to deposit fine sediments onto the floodplain.

Attribute 9

Objective 1

"0" was scored for the No Action and Mechanical Restoration Alternatives as neither of these alternatives provided flows >1,500-2,000 cfs in June and July thereby leaving bar surfaces exposed and allow seedling germination.

"1" was scored for all of the remaining alternatives as thee all had at least some period for at least some years where the scheduled flow releases were >1,500-2,000 cfs providing at least partial bar surface inundation and prevention of germination .

No Alternative always provided flows at >1,500-2000 cfs throughout June and July.

Objective 2

"0" was scored for No Action as no flows are scheduled for 6,000 cfs or greater nor are there mechanical methods used to remove initiating seedling plants.

“1” was scored for Mechanical Restoration, and Revised Mechanical Restoration alternatives because these alternatives rely only on mechanical means to remove initiating seedling on channel restoration sites only.

“2” was scored for the Flow Evaluation, the 70 Percent Inflow and Maximum Flow alternatives as these alternatives provide scheduled releases of greater that 6,000 cfs with sufficient frequency to scour initiating seedlings off of lower bar surfaces; the Modified Percent Inflow alternative would provide sufficiently frequent flows at or greater than 6,000 cfs and would provide mechanical seedling removal in spots.

Objective 3

“0” was scored for No Action as no flows are scheduled for 8,500 cfs or greater to 14,000 nor are there mechanical methods used to remove 2-3 year old plants.

“1” was scored for Flow Evaluation, 70 Percent Inflow, and Modified Percent Inflow alternatives provide flows that meet or exceed the 8,500 cfs threshold but not with sufficient frequency to scour most of the 2-3 year old plants along the channel. The Mechanical and Revised Mechanical Restoration alternatives do not provide adequate flows but rely on mechanical means to remove plants at specific locations, but not along the entire reach of channel.

“2” was scored for the Maximum Flow alternative because the scheduled flows of up to 30,000 cfs would be highly efficient at removing most established 2-3 plants along large segments of the channel.

Objective 4

“0 “ was scored for the No Action, Flow Evaluation, and the 70 Percent alternatives as these alternatives don’t have scheduled flow releases greater than 14,000 cfs.

“1” was scored for the Mechanical and the Revised Mechanical Restoration Alternatives because they would mechanically remove mature riparian trees at lease in some locations along the channel.

“2” was scored for the Maximum Flow alternative because flows greater than 14,000 and up to 30,000 cfs would be scheduled for extremely wet water years and would be highly effective in removing mature riparian trees along large segments of the channel.

Objective 5

“0” was scored for the No Action and the Mechanical Restoration Alternatives because those alternatives do not have scheduled releases greater than 5,000 to 6,000 cfs every 2-3 years during May to June to disperse seeds onto the floodplains.

“2” was scored for the Maximum Flow, Flow Evaluation, 70 Percent Inflow, Revised Mechanical Restoration, and the Modified Percent Inflow Alternatives as they all had scheduled flows greater than 5,000 to 6,000 cfs at least 1 of every 3 years (33%).

Attribute 10

Objective 1

"2" was scored by all alternatives as they all have scheduled flow releases greater than 1,500 to 2,000 cfs in all years.

Objective 2

"0" was scored for No Action and the Mechanical Restoration alternatives because these alternatives never have scheduled released greater than 6,000 cfs.

"1" was scored for the 70 Percent Inflow alternative because the frequency of years where scheduled flows equal or exceed 6,000 cfs is inadequate for completely recharging floodplains and off-channel wetlands habitats.

"2" was scored for the Maximum Flow, Flow Evaluation, Revised Mechanical Restoration, 70 Percent Inflow, and Modified Percent Inflow alternatives as the frequency years in which flows exceeding 6,000 cfs are sufficient to completely recharge floodplains and off-channel wetlands habitats.

Objective 3

"0" was scored for the No Action, Mechanical Restoration and the Revised Mechanical Restoration alternatives because scheduled flow releases for these alternative never exceed the threshold of 10,000 cfs needed to recharge the groundwater of terraces and associated wetland habitats.

"1" was scored for the Maximum Flow, Flow Evaluation, 70 Percent Inflow, and Modified Percent Inflow alternatives because many years scheduled flow releases exceed the 10,000 cfs threshold needed to recharge the groundwater of terraces and associated wetland habitats.

No alternatives were score a "2" as none always or nearly always had scheduled release flows of greater than 10,000 cfs.

Attachment B8
Tables of Annual Estimates of Chinook Salmon Mortalities in the Sacramento River

No Action Alternative Salmon Mortality Estimates

Sacramento River Salmon (Fall, Late-fall, Winter,Spring) Loss (%)
No Action Alternative (version 1 revised)

Year	Sac Index	Fall	Late Fall	Winter	Spring
1927	1	12.5	0.8	0.1	4.4
1938	1	13.2	1.5	0.3	6.8
1941	1	11.1	1.3	0.2	2.9
1942	1	9.7	0.7	0.1	2.6
1943	1	11.4	0.5	0.1	5.1
1952	1	6.9	0.7	0.2	2.0
1953	1	9.1	0.3	0.1	2.5
1956	1	9.8	2.0	0.3	2.9
1958	1	21.8	4.5	0.2	13.0
1963	1	13.7	0.9	0.3	10.1
1965	1	13.6	0.8	0.3	6.2
1967	1	21.4	3.0	0.2	9.6
1969	1	8.0	1.8	0.2	2.9
1970	1	15.1	0.7	0.2	14.8
1971	1	10.3	0.8	0.2	5.2
1974	1	13.8	1.7	0.2	4.0
1975	1	14.0	0.7	0.2	7.1
1982	1	1.5	0.8	0.2	2.4
1983	1	16.0	0.6	0.1	5.5
1984	1	10.3	0.4	0.6	5.4
1986	1	8.5	0.4	0.4	4.1
1922	2	7.0	0.4	0.2	2.4
1928	2	10.8	0.5	0.3	7.0
1940	2	13.3	1.3	0.3	6.0
1951	2	6.5	0.3	0.1	2.4
1954	2	13.4	0.6	0.1	7.3
1957	2	12.2	0.5	0.2	9.1
1973	2	5.3	1.0	0.3	4.2
1978	2	13.7	0.8	1.1	4.8
1980	2	6.5	0.2	0.1	1.6
1993	2	12.1	0.5	0.2	3.4
1923	3	13.4	1.4	1.5	3.4
1935	3	31.0	2.4	3.2	92.7
1936	3	31.8	4.5	1.8	38.7
1937	3	6.5	0.6	0.2	3.2
1945	3	14.6	0.5	0.1	4.6
1946	3	4.2	0.3	0.1	1.1
1948	3	9.1	0.5	0.3	4.5
1950	3	3.0	0.6	0.2	2.2
1959	3	35.6	4.7	0.8	65.5
1962	3	22.3	2.4	0.2	19.3
1966	3	14.7	0.5	0.1	11.1
1968	3	15.4	0.7	0.3	15.4
1972	3	10.9	0.3	0.3	7.4
1979	3	9.9	0.5	0.2	5.4
1925	4	20.4	1.2	0.4	23.6
1926	4	30.4	2.8	4.8	77.6
1930	4	16.9	1.7	1.4	7.5
1932	4	40.0	4.3	46.2	99.9
1939	4	24.8	2.3	0.3	29.1
1944	4	17.7	0.5	0.3	11.3
1947	4	21.0	1.1	0.8	24.9
1949	4	2.4	0.7	0.1	0.4
1955	4	15.2	0.9	0.2	7.2
1960	4	18.4	0.7	0.4	15.1
1961	4	23.1	1.4	0.2	23.2
1964	4	19.3	0.5	0.1	14.5
1981	4	12.4	0.5	0.2	8.7
1985	4	10.6	0.4	0.1	2.8
1987	4	25.9	1.3	0.1	32.8
1989	4	15.5	0.9	0.1	7.5
1924	5	29.6	1.1	98.7	96.5
1929	5	35.9	5.8	0.6	33.2
1931	5	36.2	2.0	87.8	99.2
1933	5	42.3	4.1	58.9	100.0
1934	5	36.0	2.9	100.0	99.0
1976	5	20.0	3.2	0.4	19.4
1977	5	36.6	1.3	93.6	99.2
1988	5	32.9	1.4	0.8	88.1
1990	5	29.3	1.7	0.6	63.4
1991	5	36.1	2.4	1.8	95.9
1992	5	37.5	2.1	62.1	99.4
Average		17.5	1.4	8.03	23.9

Sacramento River Salmon Mortality (%)
(Version 1 with revised Spawning Distributions*)

2001 Exist Cond

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	11.7	1.2	0.2	5.3
	MED	11.1	0.8	0.2	4.8
	MAX	21.7	4.5	0.6	12.7
	MIN	1.6	0.3	0.1	1.9
Above Normal	AVG	9.6	0.6	0.3	4.7
	MED	10.5	0.6	0.2	4.5
	MAX	14.2	1.0	1.1	8.8
	MIN	4.8	0.2	0.1	1.8
Below Normal	AVG	16.0	1.5	0.6	19.2
	MED	13.8	0.6	0.2	6.1
	MAX	35.5	4.9	2.2	85.8
	MIN	2.9	0.3	0.1	1.1
Dry	AVG	19.0	1.4	2.9	22.4
	MED	18.7	1.0	0.2	15.5
	MAX	39.9	4.6	37.3	99.8
	MIN	2.2	0.4	0.1	0.4
Critical	AVG	34.9	2.5	45.6	86.1
	MED	37.0	2.1	23.4	99.3
	MAX	43.2	5.8	99.4	100.0
	MIN	19.7	1.1	0.4	20.5

2020 No Act

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.0	1.2	0.2	5.7
	MED	11.4	0.8	0.2	5.1
	MAX	21.8	4.5	0.6	14.8
	MIN	1.5	0.3	0.1	2.0
Above Normal	AVG	10.1	0.6	0.3	4.8
	MED	11.5	0.5	0.2	4.5
	MAX	13.7	1.3	1.1	9.1
	MIN	5.3	0.2	0.1	1.6
Below Normal	AVG	15.9	1.4	0.7	19.6
	MED	14.0	0.6	0.2	6.4
	MAX	35.6	4.7	3.2	92.7
	MIN	3.0	0.3	0.1	1.1
Dry	AVG	19.6	1.3	3.5	24.1
	MED	18.8	1.0	0.2	14.8
	MAX	40.0	4.3	46.2	99.9
	MIN	2.4	0.4	0.1	0.4
Critical	AVG	33.8	2.5	45.9	81.2
	MED	36.0	2.1	58.9	96.5
	MAX	42.3	5.8	100.0	100.0
	MIN	20.0	1.1	0.4	19.4

Difference = 2020 No Act - 2001 Exist Cond

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	0.3	0.0	0.0	0.4
	MED	0.2	0.0	0.0	0.3
	MAX	0.1	0.0	0.0	2.1
	MIN	-0.1	0.0	0.0	0.2
Above Normal	AVG	0.4	0.0	0.0	0.1
	MED	0.9	-0.1	0.0	0.0
	MAX	-0.5	0.3	0.0	0.3
	MIN	0.6	0.0	0.0	-0.2
Below Normal	AVG	-0.1	0.0	0.1	0.4
	MED	0.2	-0.1	0.0	0.3
	MAX	0.0	-0.2	1.0	6.9
	MIN	0.1	0.0	0.0	0.0
Dry	AVG	0.6	0.0	0.6	1.8
	MED	0.1	0.0	0.0	-0.7
	MAX	0.1	-0.3	8.9	0.0
	MIN	0.1	0.0	0.0	0.0
Critical	AVG	-1.1	0.0	0.3	-4.9
	MED	-1.0	0.0	35.5	-2.7
	MAX	-0.9	0.0	0.6	0.0
	MIN	0.3	0.0	0.0	-1.0

No Action: Sacramento River Salmon Mortality (%) for Critical Water Years

Year	Sac Index	Fall	Late Fall	**Winter**	Spring
1924	5	29.6	1.1	**98.7**	96.5
1929	5	35.9	5.8	**0.6**	33.2
1931	5	36.2	2.0	**87.8**	99.2
1933	5	42.3	4.1	**58.9**	100.0
1934	5	36.0	2.9	**100.0**	99.0
1976	5	20.0	3.2	**0.4**	19.4
1977	5	36.6	1.3	**93.6**	99.2
1988	5	32.9	1.4	**0.8**	88.1
1990	5	29.3	1.7	**0.6**	63.4
1991	5	36.1	2.4	**1.8**	95.9
1992	5	37.5	2.1	**62.1**	99.4
	Average	33.8	2.5	**45.9**	81.2

Sacramento River Salmon (Fall, Late-fall, Winter,Spring) Loss (%)

Maximum Flow Alternative (version 1 revised)

Year	Sac Index	Fall	Late Fall	Winter	Spring
1927	1	23.7	1.1	0.1	27.0
1938	1	19.0	1.8	0.4	16.3
1941	1	14.7	1.5	0.3	5.2
1942	1	17.0	1.0	0.2	6.2
1943	1	20.1	1.0	0.1	16.8
1952	1	11.0	0.8	0.2	3.0
1953	1	14.9	0.6	0.2	6.6
1956	1	14.0	2.1	0.4	3.8
1958	1	26.8	5.3	0.4	25.8
1963	1	24.1	1.2	0.3	38.1
1965	1	17.4	1.1	2.1	7.9
1967	1	25.6	3.2	0.3	16.3
1969	1	14.4	2.3	0.2	3.1
1970	1	29.5	1.5	2.2	79.0
1971	1	14.9	1.0	0.2	7.1
1974	1	17.3	1.8	0.4	7.3
1975	1	19.1	1.1	0.3	17.2
1982	1	4.3	0.7	0.2	2.4
1983	1	19.9	1.1	0.2	11.0
1984	1	20.9	0.6	1.1	27.7
1986	1	24.8	1.4	0.5	35.4
1922	2	25.6	1.2	0.5	51.9
1928	2	28.9	1.5	0.7	73.3
1940	2	32.0	2.1	3.1	95.2
1951	2	20.1	0.8	0.2	14.2
1954	2	27.5	1.1	0.6	62.1
1957	2	17.2	1.0	0.2	12.1
1973	2	17.2	1.2	0.3	9.4
1978	2	24.5	1.7	1.0	16.6
1980	2	15.5	0.6	0.1	3.8
1993	2	14.9	0.7	0.3	5.7
1923	3	36.0	2.3	24.5	99.0
1935	3	34.7	2.4	25.0	98.8
1936	3	47.6	6.3	5.1	100.0
1937	3	22.6	1.4	0.4	24.5
1945	3	30.6	1.2	0.8	79.3
1946	3	17.9	0.7	0.1	11.1
1948	3	14.0	0.6	0.3	7.6
1950	3	6.3	0.8	0.3	3.1
1959	3	43.0	5.1	26.9	100.0
1962	3	27.2	2.5	0.3	44.4
1966	3	37.5	2.3	4.7	99.7
1968	3	31.7	1.6	4.2	92.2
1972	3	21.3	0.7	2.5	23.3
1979	3	17.6	0.6	0.3	14.7
1925	4	32.7	1.7	4.9	97.2
1926	4	37.3	2.3	27.7	99.4
1930	4	34.4	2.6	5.6	98.1
1932	4	40.1	4.2	80.7	99.9
1939	4	37.8	4.3	3.9	99.4
1944	4	33.6	1.3	2.5	96.5
1947	4	32.2	1.7	17.9	97.2
1949	4	9.0	1.9	0.2	0.4
1955	4	31.5	1.5	1.4	84.0
1960	4	35.1	1.5	5.0	99.1
1961	4	29.7	1.8	0.5	66.1
1964	4	28.8	1.2	0.3	59.8
1981	4	26.0	0.7	4.0	81.5
1985	4	29.4	0.9	10.1	95.3
1987	4	38.6	2.1	27.7	99.8
1989	4	29.3	1.3	8.9	93.1
1924	5	29.6	2.4	100.0	96.7
1929	5	46.7	6.4	16.0	100.0
1931	5	34.2	1.8	100.0	98.6
1933	5	40.4	3.2	95.9	99.9
1934	5	35.1	2.7	100.0	98.7
1976	5	37.7	4.9	3.4	98.9
1977	5	34.7	1.1	100.0	98.4
1988	5	38.5	1.4	79.3	99.7
1990	5	36.6	2.0	80.0	99.2
1991	5	38.0	1.7	100.0	99.4
1992	5	34.8	1.5	100.0	98.4
Average		26.6	1.8	16.5	55.0

Sacramento River Salmon Mortality (%)

(Version 1 with revised Spawning Distributions*)

No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.0	1.2	0.2	5.7
	MED	11.4	0.8	0.2	5.1
	MAX	21.8	4.5	0.6	14.8
	MIN	1.5	0.3	0.1	2.0
Above Normal	AVG	10.1	0.6	0.3	4.8
	MED	11.5	0.5	0.2	4.5
	MAX	13.7	1.3	1.1	9.1
	MIN	5.3	0.2	0.1	1.6
Below Normal	AVG	15.9	1.4	0.7	19.6
	MED	14.0	0.6	0.2	6.4
	MAX	35.6	4.7	3.2	92.7
	MIN	3.0	0.3	0.1	1.1
Dry	AVG	19.6	1.3	3.5	24.1
	MED	18.8	1.0	0.2	14.8
	MAX	40.0	4.3	46.2	99.9
	MIN	2.4	0.4	0.1	0.4
Critical	AVG	33.8	2.5	45.9	81.2
	MED	36.0	2.1	58.9	96.5
	MAX	42.3	5.8	100.0	100.0
	MIN	20.0	1.1	0.4	19.4

Max Flow Alt

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	18.7	1.5	0.5	17.3
	MED	19.0	1.1	0.3	11.0
	MAX	29.5	5.3	2.2	79.0
	MIN	4.3	0.6	0.1	2.4
Above Normal	AVG	22.3	1.2	0.7	34.4
	MED	22.3	1.2	0.4	15.4
	MAX	32.0	2.1	3.1	95.2
	MIN	14.9	0.6	0.1	3.8
Below Normal	AVG	27.7	2.0	6.8	57.0
	MED	28.9	1.5	1.7	61.8
	MAX	47.6	6.3	26.9	100.0
	MIN	6.3	0.6	0.1	3.1
Dry	AVG	31.6	1.9	12.6	85.4
	MED	32.5	1.7	4.9	96.8
	MAX	40.1	4.3	80.7	99.9
	MIN	9.0	0.7	0.2	0.4
Critical	AVG	36.9	2.7	79.5	98.9
	MED	36.6	2.0	100.0	98.9
	MAX	46.7	6.4	100.0	100.0
	MIN	29.6	1.1	3.4	96.7

Difference = Max Flow Alt - No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	6.8	0.3	0.3	11.6
	MED	7.7	0.3	0.1	5.9
	MAX	7.7	0.8	1.6	64.2
	MIN	2.8	0.3	0.0	0.3
Above Normal	AVG	12.3	0.6	0.4	29.6
	MED	10.8	0.7	0.2	10.9
	MAX	18.3	0.9	2.0	86.1
	MIN	9.6	0.4	0.0	2.2
Below Normal	AVG	11.8	0.6	6.2	37.4
	MED	14.9	0.9	1.4	55.4
	MAX	12.0	1.6	23.7	7.3
	MIN	3.2	0.4	0.0	2.0
Dry	AVG	12.0	0.6	9.1	61.3
	MED	13.6	0.7	4.7	82.1
	MAX	0.1	0.0	34.5	0.1
	MIN	6.6	0.3	0.1	-0.1
Critical	AVG	3.1	0.1	33.6	17.7
	MED	0.7	0.0	41.1	2.4
	MAX	4.4	0.6	0.0	0.0
	MIN	9.6	0.0	3.0	77.3

Maximum Flow: Sacramento River Salmon Mortality (%) for Critical Water Years

Year	Sac Index	Fall	Late Fall	**Winter**	Spring
1924	5	29.6	2.4	**100.0**	96.7
1929	5	46.7	6.4	**16.0**	100.0
1931	5	34.2	1.8	**100.0**	98.6
1933	5	40.4	3.2	**95.9**	99.9
1934	5	35.1	2.7	**100.0**	98.7
1976	5	37.7	4.9	**3.4**	98.9
1977	5	34.7	1.1	**100.0**	98.4
1988	5	38.5	1.4	**79.3**	99.7
1990	5	36.6	2.0	**80.0**	99.2
1991	5	38.0	1.7	**100.0**	99.4
1992	5	34.8	1.5	**100.0**	98.4
	Average	36.9	2.7	**79.5**	98.9

Sacramento River Salmon (Fall, Late-fall, Winter,Spring) Loss (%)

Preferred Flow (version 1 revised)

Year	Sac Index	Fall	Late Fall	Winter	Spring
1927	1	15.5	0.9	0.1	6.5
1938	1	14.1	1.6	0.4	8.6
1941	1	11.1	1.4	0.2	3.3
1942	1	10.2	0.8	0.2	3.1
1943	1	13.5	0.6	0.1	6.3
1952	1	7.2	0.9	0.3	2.9
1953	1	9.8	0.3	0.1	3.4
1956	1	11.1	2.1	0.3	4.0
1958	1	22.0	4.7	0.3	13.8
1963	1	19.3	1.3	0.3	20.0
1965	1	17.7	1.0	0.3	9.6
1967	1	21.6	3.1	0.2	9.9
1969	1	10.0	1.9	0.2	3.9
1970	1	24.2	1.1	0.3	35.0
1971	1	12.1	1.0	0.2	6.6
1974	1	14.2	1.9	0.4	6.3
1975	1	14.2	0.9	0.3	8.0
1982	1	3.2	0.7	0.2	3.0
1983	1	16.1	0.6	0.1	5.6
1984	1	11.4	0.4	0.6	6.7
1986	1	12.7	0.7	0.5	5.5
1922	2	8.8	0.5	0.2	2.9
1928	2	18.2	1.1	0.3	13.9
1940	2	20.5	1.6	0.4	18.4
1951	2	11.7	0.6	0.1	2.6
1954	2	16.9	0.6	0.1	13.0
1957	2	17.9	1.0	0.2	14.3
1973	2	8.9	0.9	0.3	4.2
1978	2	19.5	1.2	1.1	9.2
1980	2	7.3	0.2	0.1	1.9
1993	2	12.6	0.5	0.2	3.7
1923	3	20.3	2.0	2.3	10.6
1935	3	33.9	2.5	9.0	98.4
1936	3	38.8	5.4	1.9	75.2
1937	3	8.2	0.9	0.3	4.5
1945	3	17.4	0.6	0.1	8.6
1946	3	9.8	0.4	0.1	2.2
1948	3	10.4	0.5	0.2	4.8
1950	3	5.2	0.7	0.3	3.4
1959	3	36.4	4.5	1.2	82.6
1962	3	26.2	2.5	0.2	38.5
1966	3	24.4	1.3	0.2	27.3
1968	3	23.8	1.2	0.3	30.6
1972	3	16.2	0.5	0.3	13.3
1979	3	15.3	0.6	0.2	9.9
1925	4	27.0	1.5	0.7	59.5
1926	4	33.8	2.3	2.6	96.2
1930	4	21.6	2.0	0.3	15.8
1932	4	40.1	4.6	35.7	99.9
1939	4	19.4	0.9	1.2	48.2
1944	4	19.9	0.6	0.5	15.9
1947	4	26.2	1.5	1.2	52.6
1949	4	5.1	1.4	0.1	0.4
1955	4	19.8	1.2	0.3	15.0
1960	4	27.7	1.1	0.7	59.3
1961	4	30.7	1.8	0.7	78.2
1964	4	24.1	0.7	0.2	30.7
1981	4	16.2	0.5	0.2	17.6
1985	4	14.2	0.6	0.1	5.5
1987	4	25.9	1.6	0.1	33.1
1989	4	22.1	1.2	0.2	26.5
1924	5	29.6	1.1	99.1	96.7
1929	5	38.0	5.8	0.2	53.4
1931	5	35.2	1.8	93.9	98.9
1933	5	42.6	4.2	59.8	100.0
1934	5	35.7	2.7	100.0	99.0
1976	5	21.3	3.5	0.4	22.2
1977	5	36.5	1.2	94.5	99.1
1988	5	35.7	1.4	2.8	99.0
1990	5	35.3	2.0	4.4	98.7
1991	5	39.3	2.7	17.0	99.8
1992	5	37.3	2.1	79.1	99.4
Average		20.6	1.6	8.63	31.8

Sacramento River Salmon Mortality (%)

(Version 1 with revised Spawning Distributions*)

No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.0	1.2	0.2	5.7
	MED	11.4	0.8	0.2	5.1
	MAX	21.8	4.5	0.6	14.8
	MIN	1.5	0.3	0.1	2.0
Above Normal	AVG	10.1	0.6	0.3	4.8
	MED	11.5	0.5	0.2	4.5
	MAX	13.7	1.3	1.1	9.1
	MIN	5.3	0.2	0.1	1.6
Below Normal	AVG	15.9	1.4	0.7	19.6
	MED	14.0	0.6	0.2	6.4
	MAX	35.6	4.7	3.2	92.7
	MIN	3.0	0.3	0.1	1.1
Dry	AVG	19.6	1.3	3.5	24.1
	MED	18.8	1.0	0.2	14.8
	MAX	40.0	4.3	46.2	99.9
	MIN	2.4	0.4	0.1	0.4
Critical	AVG	33.8	2.5	45.9	81.2
	MED	36.0	2.1	58.9	96.5
	MAX	42.3	5.8	100.0	100.0
	MIN	20.0	1.1	0.4	19.4

Pref Flow Alt

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	13.9	1.3	0.3	8.2
	MED	13.5	1.0	0.3	6.3
	MAX	24.2	4.7	0.6	35.0
	MIN	3.2	0.3	0.1	2.9
Above Normal	AVG	14.2	0.8	0.3	8.4
	MED	14.7	0.8	0.2	6.7
	MAX	20.5	1.6	1.1	18.4
	MIN	7.3	0.2	0.1	1.9
Below Normal	AVG	20.5	1.7	1.2	29.3
	MED	18.9	1.1	0.3	12.0
	MAX	38.8	5.4	9.0	98.4
	MIN	5.2	0.4	0.1	2.2
Dry	AVG	23.4	1.5	2.8	40.9
	MED	23.1	1.3	0.4	31.9
	MAX	40.1	4.6	35.7	99.9
	MIN	5.1	0.5	0.1	0.4
Critical	AVG	35.1	2.6	50.1	87.8
	MED	35.7	2.1	59.8	99.0
	MAX	42.6	5.8	100.0	100.0
	MIN	21.3	1.1	0.2	22.2

Difference = Pref Flow Alt - No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	1.9	0.1	0.0	2.5
	MED	2.1	0.2	0.1	1.2
	MAX	2.4	0.2	0.0	20.2
	MIN	1.7	0.0	0.0	0.9
Above Normal	AVG	4.1	0.2	0.0	3.6
	MED	3.2	0.3	0.0	2.2
	MAX	6.8	0.4	0.0	9.3
	MIN	2.0	0.0	0.0	0.3
Below Normal	AVG	4.6	0.3	0.5	9.7
	MED	4.8	0.5	0.1	5.6
	MAX	3.2	0.7	5.8	5.7
	MIN	2.1	0.2	0.0	1.1
Dry	AVG	3.8	0.1	-0.7	16.8
	MED	4.2	0.3	0.1	17.1
	MAX	0.1	0.3	-10.5	0.0
	MIN	2.7	0.1	0.0	0.0
Critical	AVG	1.3	0.1	4.2	6.6
	MED	-0.2	0.0	0.9	2.4
	MAX	0.4	0.0	0.0	0.0
	MIN	1.3	-0.1	-0.2	2.7

Preferred Flow: Sacramento River Salmon Mortality (%) for Critical Water Years

Year	Sac Index	Fall	Late Fall	**Winter**	Spring
1924	5	29.6	1.1	**99.1**	96.7
1929	5	38.0	5.8	**0.2**	53.4
1931	5	35.2	1.8	**93.9**	98.9
1933	5	42.6	4.2	**59.8**	100.0
1934	5	35.7	2.7	**100.0**	99.0
1976	5	21.3	3.5	**0.4**	22.2
1977	5	36.5	1.2	**94.5**	99.1
1988	5	35.7	1.4	**2.8**	99.0
1990	5	35.3	2.0	**4.4**	98.7
1991	5	39.3	2.7	**17.0**	99.8
1992	5	37.3	2.1	**79.1**	99.4
	Average	35.1	2.6	**50.1**	87.8

70 Percent Inflow Alternative Salmon Mortality Estimates

Sacramento River Salmon (Fall, Late-fall, Winter,Spring) Loss (%)
70 Percent Inflow Alternative (version 1 revised)

Year	Sac Index	Fall	Late Fall	Winter	Spring
1927	1	21.6	1.1	0.1	18.2
1938	1	16.7	1.7	0.4	13.4
1941	1	11.4	1.5	0.3	3.7
1942	1	12.1	0.8	0.2	3.4
1943	1	17.5	0.9	0.1	10.6
1952	1	7.7	0.9	0.2	2.7
1953	1	10.9	0.4	0.2	3.7
1956	1	11.8	2.2	0.4	3.7
1958	1	22.2	5.2	0.3	14.5
1963	1	22.4	1.3	0.3	28.2
1965	1	23.2	1.1	1.5	22.3
1967	1	21.3	3.1	0.3	9.8
1969	1	12.1	2.2	0.2	2.8
1970	1	31.6	1.7	2.7	92.0
1971	1	15.9	1.0	0.2	9.4
1974	1	15.1	1.9	0.3	5.8
1975	1	18.8	1.1	0.3	16.6
1982	1	4.1	0.7	0.2	2.4
1983	1	16.2	0.8	0.1	5.9
1984	1	18.5	0.6	1.1	18.0
1986	1	20.3	1.2	0.5	16.4
1922	2	17.1	0.9	0.2	9.5
1928	2	24.0	1.5	0.3	28.9
1940	2	28.8	2.1	0.8	69.4
1951	2	17.9	0.9	0.1	9.5
1954	2	13.4	0.3	0.1	21.0
1957	2	22.3	1.0	0.3	36.4
1973	2	12.5	1.0	0.3	4.7
1978	2	24.9	1.7	1.0	17.8
1980	2	13.2	0.6	0.1	1.8
1993	2	13.9	0.6	0.3	4.3
1923	3	28.4	2.2	2.8	55.7
1935	3	35.5	2.5	24.3	99.1
1936	3	47.4	6.3	4.7	100.0
1937	3	23.4	1.5	0.4	26.1
1945	3	27.4	0.9	0.3	49.2
1946	3	14.1	0.6	0.1	4.1
1948	3	14.8	0.8	0.2	7.4
1950	3	6.4	0.8	0.3	3.0
1959	3	41.5	4.6	12.5	99.9
1962	3	29.6	2.3	0.6	66.4
1966	3	27.7	1.7	0.6	56.4
1968	3	31.1	1.6	3.2	88.9
1972	3	23.9	0.9	2.5	37.9
1979	3	19.8	0.7	0.3	18.4
1925	4	29.1	1.6	1.5	82.9
1926	4	37.1	2.1	16.8	99.4
1930	4	31.1	2.5	1.0	83.7
1932	4	39.8	4.3	49.6	99.9
1939	4	36.0	4.1	1.3	94.7
1944	4	25.5	0.9	0.6	36.0
1947	4	28.8	1.7	2.6	78.6
1949	4	7.7	2.0	0.1	0.3
1955	4	27.8	1.5	0.4	51.7
1960	4	32.7	1.4	2.2	94.8
1961	4	35.0	1.8	2.3	99.1
1964	4	30.3	1.2	0.4	72.6
1981	4	26.7	0.7	4.2	83.7
1985	4	21.7	0.7	0.1	26.1
1987	4	35.8	1.9	2.2	99.2
1989	4	24.2	1.3	0.3	40.9
1924	5	29.7	1.0	100.0	96.9
1929	5	45.3	6.4	1.8	99.9
1931	5	34.4	1.7	100.0	98.6
1933	5	39.0	3.0	89.9	99.4
1934	5	35.2	2.7	100.0	98.8
1976	5	29.8	4.7	0.5	45.1
1977	5	34.7	1.0	100.0	98.4
1988	5	38.3	1.7	10.1	99.7
1990	5	37.3	2.1	14.3	99.4
1991	5	38.5	2.1	36.2	99.5
1992	5	35.5	1.9	98.4	98.7
Average		24.7	1.8	11.2	47.2

Sacramento River Salmon Mortality (%)
(Version 1 with revised Spawning Distributions*)

No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.0	1.2	0.2	5.7
	MED	11.4	0.8	0.2	5.1
	MAX	21.8	4.5	0.6	14.8
	MIN	1.5	0.3	0.1	2.0
Above Normal	AVG	10.1	0.6	0.3	4.8
	MED	11.5	0.5	0.2	4.5
	MAX	13.7	1.3	1.1	9.1
	MIN	5.3	0.2	0.1	1.6
Below Normal	AVG	15.9	1.4	0.7	19.6
	MED	14.0	0.6	0.2	6.4
	MAX	35.6	4.7	3.2	92.7
	MIN	3.0	0.3	0.1	1.1
Dry	AVG	19.6	1.3	3.5	24.1
	MED	18.8	1.0	0.2	14.8
	MAX	40.0	4.3	46.2	99.9
	MIN	2.4	0.4	0.1	0.4
Critical	AVG	33.8	2.5	45.9	81.2
	MED	36.0	2.1	58.9	96.5
	MAX	42.3	5.8	100.0	100.0
	MIN	20.0	1.1	0.4	19.4

70 Perc Alt

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	16.7	1.5	0.5	14.4
	MED	16.7	1.1	0.3	9.8
	MAX	31.6	5.2	2.7	92.0
	MIN	4.1	0.4	0.1	2.4
Above Normal	AVG	18.8	1.1	0.3	20.3
	MED	17.5	0.9	0.3	13.7
	MAX	28.8	2.1	1.0	69.4
	MIN	12.5	0.3	0.1	1.8
Below Normal	AVG	26.5	2.0	3.8	50.9
	MED	27.5	1.5	0.6	52.4
	MAX	47.4	6.3	24.3	100.0
	MIN	6.4	0.6	0.1	3.0
Dry	AVG	29.3	1.9	5.4	71.5
	MED	29.7	1.6	1.4	83.3
	MAX	39.8	4.3	49.6	99.9
	MIN	7.7	0.7	0.1	0.3
Critical	AVG	36.2	2.6	59.2	94.1
	MED	35.5	2.1	89.9	98.8
	MAX	45.3	6.4	100.0	99.9
	MIN	29.7	1.0	0.5	45.1

Difference = 70 Perc Alt - No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	4.7	0.3	0.2	8.8
	MED	5.4	0.3	0.1	4.7
	MAX	9.8	0.6	2.1	77.2
	MIN	2.6	0.1	0.0	0.4
Above Normal	AVG	8.7	0.5	0.1	15.5
	MED	6.0	0.4	0.1	9.2
	MAX	15.1	0.9	-0.1	60.3
	MIN	7.2	0.1	0.0	0.2
Below Normal	AVG	10.6	0.5	3.1	31.3
	MED	13.5	0.9	0.4	46.0
	MAX	11.9	1.6	21.1	7.3
	MIN	3.4	0.3	0.0	1.9
Dry	AVG	9.7	0.5	1.9	47.3
	MED	10.9	0.6	1.2	68.5
	MAX	-0.2	0.0	3.4	0.0
	MIN	5.4	0.3	0.0	-0.2
Critical	AVG	2.3	0.0	13.3	12.8
	MED	-0.4	0.0	31.0	2.2
	MAX	3.0	0.6	0.0	-0.1
	MIN	9.7	-0.2	0.0	25.6

70 Percent Inflow: Sacramento River Salmon Mortality (%) for Critical Water Years

Year	Sac Index	Fall	Late Fall	**Winter**	Spring
1924	5	29.7	1.0	**100.0**	96.9
1929	5	45.3	6.4	**1.8**	99.9
1931	5	34.4	1.7	**100.0**	98.6
1933	5	39.0	3.0	**89.9**	99.4
1934	5	35.2	2.7	**100.0**	98.8
1976	5	29.8	4.7	**0.5**	45.1
1977	5	34.7	1.0	**100.0**	98.4
1988	5	38.3	1.7	**10.1**	99.7
1990	5	37.3	2.1	**14.3**	99.4
1991	5	38.5	2.1	**36.2**	99.5
1992	5	35.5	1.9	**98.4**	98.7
	Average	36.2	2.6	**59.2**	94.1

Sacramento River Salmon (Fall, Late-fall, Winter,Spring) Loss (%)
Revised Mechanical Alternative (version 1 revised)

Year	Sac Index	Fall	Late Fall	Winter	Spring
1927	1	12.4	0.8	0.1	4.3
1938	1	13.6	1.6	0.4	7.9
1941	1	11.2	1.3	0.2	3.0
1942	1	9.9	0.8	0.2	2.7
1943	1	11.1	0.5	0.1	4.9
1952	1	6.9	0.8	0.2	2.4
1953	1	9.3	0.3	0.1	2.6
1956	1	10.1	2.0	0.3	3.5
1958	1	22.0	4.6	0.2	13.5
1963	1	17.1	0.9	0.3	17.1
1965	1	14.6	0.9	0.3	6.4
1967	1	21.4	3.0	0.2	9.8
1969	1	8.9	1.8	0.1	3.1
1970	1	19.0	0.9	0.2	17.5
1971	1	10.5	0.9	0.2	5.5
1974	1	14.0	1.8	0.3	4.7
1975	1	14.2	0.8	0.2	7.5
1982	1	2.2	0.7	0.2	3.2
1983	1	16.1	0.6	0.1	5.6
1984	1	10.6	0.4	0.6	5.7
1986	1	8.4	0.4	0.5	4.4
1922	2	7.0	0.4	0.2	2.4
1928	2	14.8	0.9	0.3	8.2
1940	2	13.5	1.2	0.3	6.1
1951	2	6.5	0.4	0.1	2.2
1954	2	13.1	0.6	0.1	7.7
1957	2	15.9	0.7	0.2	11.2
1973	2	7.1	0.9	0.3	4.2
1978	2	15.8	1.0	1.1	6.2
1980	2	5.8	0.2	0.1	1.8
1993	2	12.3	0.5	0.2	3.5
1923	3	14.1	1.4	1.5	4.4
1935	3	32.2	2.5	5.0	96.3
1936	3	33.0	4.7	1.8	44.1
1937	3	7.5	0.7	0.2	3.6
1945	3	15.5	0.6	0.1	5.6
1946	3	6.4	0.3	0.1	1.5
1948	3	9.4	0.5	0.2	4.2
1950	3	3.9	0.6	0.2	2.9
1959	3	35.1	4.6	0.9	62.9
1962	3	24.8	2.5	0.2	27.4
1966	3	17.3	0.6	0.2	13.0
1968	3	19.6	1.0	0.3	19.3
1972	3	10.8	0.3	0.3	7.3
1979	3	11.7	0.5	0.2	5.7
1925	4	23.9	1.4	0.5	35.4
1926	4	30.6	2.3	1.2	78.0
1930	4	18.9	1.9	0.6	10.1
1932	4	39.9	4.2	54.4	99.9
1939	4	24.5	2.2	0.3	28.1
1944	4	16.9	0.5	0.3	10.5
1947	4	21.2	1.2	1.3	26.0
1949	4	3.0	0.7	0.1	0.4
1955	4	15.3	0.9	0.2	8.4
1960	4	19.3	0.7	0.4	17.9
1961	4	26.6	1.6	0.2	42.4
1964	4	19.1	0.5	0.1	14.5
1981	4	12.3	0.5	0.2	8.6
1985	4	10.5	0.4	0.1	2.8
1987	4	22.4	1.2	0.1	16.0
1989	4	17.7	1.2	0.2	11.3
1924	5	29.6	1.1	99.6	96.6
1929	5	34.5	5.6	0.6	31.7
1931	5	35.8	1.9	92.1	99.1
1933	5	42.4	4.1	73.0	100.0
1934	5	35.8	3.2	100.0	99.0
1976	5	19.4	3.2	0.4	19.0
1977	5	36.8	1.5	93.4	99.2
1988	5	34.3	1.5	2.7	95.7
1990	5	31.8	1.8	1.4	85.8
1991	5	37.0	2.6	3.0	98.7
1992	5	37.6	2.1	68.3	99.4
Average		18.2	1.4	8.5	25.3

Sacramento River Salmon Mortality (%)
(Version 1 with revised Spawning Distributions*)

No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.0	1.2	0.2	5.7
	MED	11.4	0.8	0.2	5.1
	MAX	21.8	4.5	0.6	14.8
	MIN	1.5	0.3	0.1	2.0
Above Normal	AVG	10.1	0.6	0.3	4.8
	MED	11.5	0.5	0.2	4.5
	MAX	13.7	1.3	1.1	9.1
	MIN	5.3	0.2	0.1	1.6
Below Normal	AVG	15.9	1.4	0.7	19.6
	MED	14.0	0.6	0.2	6.4
	MAX	35.6	4.7	3.2	92.7
	MIN	3.0	0.3	0.1	1.1
Dry	AVG	19.6	1.3	3.5	24.1
	MED	18.8	1.0	0.2	14.8
	MAX	40.0	4.3	46.2	99.9
	MIN	2.4	0.4	0.1	0.4
Critical	AVG	33.8	2.5	45.9	81.2
	MED	36.0	2.1	58.9	96.5
	MAX	42.3	5.8	100.0	100.0
	MIN	20.0	1.1	0.4	19.4

Revised Mech. Alt

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.5	1.2	0.3	6.4
	MED	11.2	0.9	0.2	4.9
	MAX	22.0	4.6	0.6	17.5
	MIN	2.2	0.3	0.1	2.4
Above Normal	AVG	11.2	0.7	0.3	5.3
	MED	12.7	0.7	0.2	5.1
	MAX	15.9	1.2	1.1	11.2
	MIN	5.8	0.2	0.1	1.8
Below Normal	AVG	17.2	1.5	0.8	21.3
	MED	14.8	0.7	0.2	6.5
	MAX	35.1	4.7	5.0	96.3
	MIN	3.9	0.3	0.1	1.5
Dry	AVG	20.1	1.3	3.8	25.6
	MED	19.2	1.2	0.3	15.3
	MAX	39.9	4.2	54.4	99.9
	MIN	3.0	0.4	0.1	0.4
Critical	AVG	34.1	2.6	48.6	84.0
	MED	35.8	2.1	68.3	98.7
	MAX	42.4	5.6	100.0	100.0
	MIN	19.4	1.1	0.4	19.0

Difference = Revised Mech. Alt.- No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	0.6	0.0	0.0	0.8
	MED	-0.2	0.1	0.0	-0.2
	MAX	0.2	0.0	0.0	2.8
	MIN	0.7	0.0	0.0	0.4
Above Normal	AVG	1.1	0.1	0.0	0.5
	MED	1.2	0.2	0.0	0.7
	MAX	2.2	0.0	0.0	2.1
	MIN	0.4	0.0	0.0	0.2
Below Normal	AVG	1.4	0.1	0.1	1.7
	MED	0.8	0.1	0.0	0.0
	MAX	-0.5	0.0	1.8	3.6
	MIN	0.8	0.1	0.0	0.4
Dry	AVG	0.5	0.0	0.3	1.5
	MED	0.4	0.2	0.0	0.5
	MAX	-0.1	-0.1	8.2	0.0
	MIN	0.6	0.0	0.0	0.0
Critical	AVG	0.2	0.1	2.7	2.8
	MED	-0.2	0.0	9.5	2.2
	MAX	0.1	-0.2	0.0	0.0
	MIN	-0.6	0.0	0.0	-0.5

Revised Mechanical:Sacramento River Salmon Mortality (%) for Critical Water Years

Year	Sac Index	Fall	Late Fall	**Winter**	Spring
1924	5	29.6	1.1	**99.6**	96.6
1929	5	34.5	5.6	**0.6**	31.7
1931	5	35.8	1.9	**92.1**	99.1
1933	5	42.4	4.1	**73.0**	100.0
1934	5	35.8	3.2	**100.0**	99.0
1976	5	19.4	3.2	**0.4**	19.0
1977	5	36.8	1.5	**93.4**	99.2
1988	5	34.3	1.5	**2.7**	95.7
1990	5	31.8	1.8	**1.4**	85.8
1991	5	37.0	2.6	**3.0**	98.7
1992	5	37.6	2.1	**68.3**	99.4
	Average	34.1	2.6	**48.6**	84.0

Sacramento River Salmon (Fall, Late-fall, Winter,Spring) Loss (%)

Modifed Percent Inflow Alternative (version 1 revised)

Year	Sac Index	Fall	Late Fall	Winter	Spring
1927	1	15.2	0.9	0.1	6.2
1938	1	16.9	1.8	0.4	11.9
1941	1	11.2	1.4	0.2	3.1
1942	1	9.8	0.8	0.2	3.0
1943	1	12.8	0.6	0.1	5.3
1952	1	7.1	0.8	0.2	2.6
1953	1	9.2	0.3	0.1	2.5
1956	1	9.8	2.1	0.3	3.3
1958	1	21.8	4.8	0.3	13.4
1963	1	15.2	0.8	0.3	15.0
1965	1	16.0	1.0	0.4	7.2
1967	1	21.4	3.1	0.2	9.8
1969	1	8.4	1.9	0.2	3.1
1970	1	19.6	0.9	0.2	19.6
1971	1	10.5	0.9	0.2	5.5
1974	1	13.7	1.9	0.4	5.1
1975	1	14.1	0.9	0.2	7.7
1982	1	2.1	0.8	0.2	3.2
1983	1	16.0	0.6	0.1	5.5
1984	1	10.5	0.4	0.6	5.9
1986	1	9.8	0.5	0.5	4.4
1922	2	8.8	0.5	0.2	2.9
1928	2	16.9	1.0	0.3	11.7
1940	2	15.6	1.4	0.4	9.1
1951	2	9.3	0.5	0.1	2.4
1954	2	15.0	0.7	0.1	8.7
1957	2	15.7	0.7	0.2	11.0
1973	2	7.5	0.9	0.3	4.1
1978	2	18.2	1.1	1.1	7.8
1980	2	6.4	0.2	0.1	1.9
1993	2	12.3	0.5	0.2	3.4
1923	3	16.7	1.6	2.3	7.6
1935	3	33.8	2.6	9.8	98.4
1936	3	37.0	5.3	1.8	63.0
1937	3	7.4	0.8	0.3	5.0
1945	3	16.1	0.6	0.1	6.5
1946	3	7.3	0.3	0.1	1.6
1948	3	10.2	0.5	0.2	4.4
1950	3	4.8	0.7	0.2	2.8
1959	3	36.1	4.6	0.9	78.1
1962	3	25.2	2.6	0.2	29.0
1966	3	17.1	1.0	0.1	12.4
1968	3	21.3	1.0	0.3	25.2
1972	3	15.8	0.4	0.3	12.1
1979	3	13.2	0.5	0.2	7.8
1925	4	23.1	1.4	0.5	31.5
1926	4	31.7	2.3	1.8	86.4
1930	4	18.1	1.9	0.8	8.9
1932	4	40.1	4.4	50.2	99.9
1939	4	19.0	1.5	0.9	43.7
1944	4	18.9	0.6	0.3	13.5
1947	4	23.2	1.2	1.5	42.8
1949	4	3.7	1.0	0.1	0.4
1955	4	18.3	1.1	0.2	11.5
1960	4	23.0	0.9	0.4	27.0
1961	4	27.4	1.6	0.2	46.2
1964	4	24.8	0.8	0.1	33.9
1981	4	13.0	0.5	0.2	9.9
1985	4	11.6	0.5	0.1	2.5
1987	4	22.3	1.2	0.1	16.0
1989	4	16.6	1.0	0.2	9.5
1924	5	29.8	1.1	99.4	96.8
1929	5	34.3	5.5	0.7	31.0
1931	5	36.2	2.0	89.7	99.2
1933	5	42.9	4.4	62.4	100.0
1934	5	35.7	2.8	100.0	99.0
1976	5	20.6	3.4	0.4	21.3
1977	5	36.8	1.3	93.5	99.2
1988	5	34.5	1.4	1.3	97.0
1990	5	33.1	2.0	2.1	93.6
1991	5	37.8	2.5	4.8	99.4
1992	5	37.3	2.1	72.6	99.3
Average		19.1	1.5	8.5	27.5

Sacramento River Salmon Mortality (%)

(Version 1 with revised Spawning Distributions*)

No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.0	1.2	0.2	5.7
	MED	11.4	0.8	0.2	5.1
	MAX	21.8	4.5	0.6	14.8
	MIN	1.5	0.3	0.1	2.0
Above Normal	AVG	10.1	0.6	0.3	4.8
	MED	11.5	0.5	0.2	4.5
	MAX	13.7	1.3	1.1	9.1
	MIN	5.3	0.2	0.1	1.6
Below Normal	AVG	15.9	1.4	0.7	19.6
	MED	14.0	0.6	0.2	6.4
	MAX	35.6	4.7	3.2	92.7
	MIN	3.0	0.3	0.1	1.1
Dry	AVG	19.6	1.3	3.5	24.1
	MED	18.8	1.0	0.2	14.8
	MAX	40.0	4.3	46.2	99.9
	MIN	2.4	0.4	0.1	0.4
Critical	AVG	33.8	2.5	45.9	81.2
	MED	36.0	2.1	58.9	96.5
	MAX	42.3	5.8	100.0	100.0
	MIN	20.0	1.1	0.4	19.4

Mod Perc Alt

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.9	1.3	0.3	6.8
	MED	12.8	0.9	0.2	5.5
	MAX	21.8	4.8	0.6	19.6
	MIN	2.1	0.3	0.1	2.5
Above Normal	AVG	12.6	0.7	0.3	6.3
	MED	13.6	0.7	0.2	6.0
	MAX	18.2	1.4	1.1	11.7
	MIN	6.4	0.2	0.1	1.9
Below Normal	AVG	18.7	1.6	1.2	25.3
	MED	16.4	0.9	0.3	10.0
	MAX	37.0	5.3	9.8	98.4
	MIN	4.8	0.3	0.1	1.6
Dry	AVG	20.9	1.4	3.6	30.2
	MED	20.6	1.2	0.3	21.5
	MAX	40.1	4.4	50.2	99.9
	MIN	3.7	0.5	0.1	0.4
Critical	AVG	34.5	2.6	47.9	85.1
	MED	35.7	2.1	62.4	99.0
	MAX	42.9	5.5	100.0	100.0
	MIN	20.6	1.1	0.4	21.3

Difference = Mod Perc Alt - No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	0.9	0.1	0.0	1.2
	MED	1.4	0.1	0.0	0.4
	MAX	0.0	0.3	0.0	4.9
	MIN	0.6	0.0	0.0	0.5
Above Normal	AVG	2.5	0.1	0.0	1.5
	MED	2.2	0.2	0.0	1.5
	MAX	4.5	0.1	0.0	2.6
	MIN	1.0	0.0	0.0	0.3
Below Normal	AVG	2.8	0.2	0.5	5.7
	MED	2.4	0.3	0.0	3.5
	MAX	1.4	0.6	6.6	5.7
	MIN	1.8	0.1	0.0	0.5
Dry	AVG	1.3	0.0	0.1	6.1
	MED	1.8	0.1	0.0	6.8
	MAX	0.1	0.1	3.9	0.0
	MIN	1.4	0.0	0.0	0.0
Critical	AVG	0.6	0.0	2.0	3.9
	MED	-0.2	0.1	3.5	2.4
	MAX	0.7	-0.3	0.0	0.0
	MIN	0.6	0.0	0.0	1.9

Modified Percent Inflow: Sacramento River Salmon Mortality (%) for Critical Water Years

Year	Sac Index	Fall	Late Fall	**Winter**	Spring
1924	5	29.8	1.1	**99.4**	96.8
1929	5	34.3	5.5	**0.7**	31.0
1931	5	36.2	2.0	**89.7**	99.2
1933	5	42.9	4.4	**62.4**	100.0
1934	5	35.7	2.8	**100.0**	99.0
1976	5	20.6	3.4	**0.4**	21.3
1977	5	36.8	1.3	**93.5**	99.2
1988	5	34.5	1.4	**1.3**	97.0
1990	5	33.1	2.0	**2.1**	93.6
1991	5	37.8	2.5	**4.8**	99.4
1992	5	37.3	2.1	**72.6**	99.3
	Average	34.5	2.6	**47.9**	85.1

Sacramento River Salmon (Fall, Late-fall, Winter,Spring) Loss (%)

Existing Conditions (version 1 revised)

Year	Sac Index	Fall	Late Fall	Winter	Spring
1927	1	11.1	0.8	0.1	4.1
1938	1	13.2	1.4	0.2	6.8
1941	1	11.1	1.2	0.2	2.9
1942	1	9.7	0.7	0.1	2.4
1943	1	10.8	0.5	0.1	4.8
1952	1	6.5	0.6	0.1	1.9
1953	1	9.1	0.3	0.1	2.6
1956	1	9.5	2.0	0.2	2.6
1958	1	21.7	4.5	0.2	12.7
1963	1	12.9	0.8	0.3	8.7
1965	1	12.9	0.8	0.3	5.6
1967	1	21.4	3.0	0.1	9.5
1969	1	7.9	1.8	0.1	2.9
1970	1	13.9	0.8	0.2	11.7
1971	1	10.3	0.8	0.2	5.2
1974	1	13.6	1.7	0.2	3.9
1975	1	14.0	0.7	0.2	6.9
1982	1	1.6	0.7	0.2	2.1
1983	1	16.0	0.6	0.1	5.4
1984	1	9.5	0.4	0.6	5.4
1986	1	8.6	0.4	0.4	3.6
1922	2	5.9	0.4	0.2	2.3
1928	2	11.3	0.9	0.3	6.5
1940	2	9.8	1.0	0.3	6.2
1951	2	6.3	0.3	0.1	2.4
1954	2	14.0	0.7	0.1	7.0
1957	2	11.9	0.5	0.2	8.8
1973	2	4.8	0.9	0.3	4.2
1978	2	14.2	0.9	1.1	4.7
1980	2	6.3	0.2	0.1	1.8
1993	2	11.9	0.5	0.2	3.2
1923	3	14.0	1.4	1.6	4.2
1935	3	30.0	2.3	2.2	85.8
1936	3	34.0	4.9	1.5	47.1
1937	3	6.3	0.6	0.2	3.7
1945	3	13.7	0.5	0.1	3.8
1946	3	4.2	0.3	0.1	1.1
1948	3	9.9	0.5	0.2	3.7
1950	3	2.9	0.5	0.2	1.9
1959	3	35.5	4.7	0.8	62.3
1962	3	21.1	2.4	0.2	16.6
1966	3	16.2	0.6	0.2	12.1
1968	3	15.4	0.8	0.3	14.5
1972	3	10.7	0.3	0.3	7.2
1979	3	10.6	0.5	0.2	5.0
1925	4	19.7	1.2	0.4	21.7
1926	4	29.9	2.8	4.8	72.7
1930	4	16.6	1.7	0.5	8.6
1932	4	39.9	4.6	37.3	99.8
1939	4	23.9	2.6	0.3	23.8
1944	4	16.5	0.4	0.3	9.9
1947	4	18.5	1.0	1.1	18.4
1949	4	2.2	0.7	0.1	0.4
1955	4	16.9	1.0	0.2	8.8
1960	4	18.9	0.7	0.4	17.0
1961	4	23.2	1.5	0.1	23.1
1964	4	19.4	0.6	0.1	14.0
1981	4	9.3	0.4	0.2	8.0
1985	4	10.0	0.4	0.1	1.9
1987	4	23.6	1.2	0.1	20.9
1989	4	15.6	1.0	0.2	8.9
1924	5	29.9	1.1	99.4	96.7
1929	5	37.8	5.8	1.2	51.6
1931	5	35.6	1.9	95.0	99.0
1933	5	43.2	4.5	23.4	100.0
1934	5	36.8	2.5	96.3	99.3
1976	5	19.7	2.6	0.4	20.5
1977	5	37.0	1.6	93.0	99.3
1988	5	37.6	1.6	5.1	99.6
1990	5	31.4	1.8	1.0	82.4
1991	5	37.9	2.5	4.8	99.5
1992	5	37.5	2.1	81.9	99.4
Average		17.4	1.4	7.8	24.1

Sacramento River Salmon Mortality (%)

(Version 1 with revised Spawning Distributions*)

2001 Exist Cond

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	11.7	1.2	0.2	5.3
	MED	11.1	0.8	0.2	4.8
	MAX	21.7	4.5	0.6	12.7
	MIN	1.6	0.3	0.1	1.9
Above Normal	AVG	9.6	0.6	0.3	4.7
	MED	10.5	0.6	0.2	4.5
	MAX	14.2	1.0	1.1	8.8
	MIN	4.8	0.2	0.1	1.8
Below Normal	AVG	16.0	1.5	0.6	19.2
	MED	13.8	0.6	0.2	6.1
	MAX	35.5	4.9	2.2	85.8
	MIN	2.9	0.3	0.1	1.1
Dry	AVG	19.0	1.4	2.9	22.4
	MED	18.7	1.0	0.2	15.5
	MAX	39.9	4.6	37.3	99.8
	MIN	2.2	0.4	0.1	0.4
Critical	AVG	34.9	2.5	45.6	86.1
	MED	37.0	2.1	23.4	99.3
	MAX	43.2	5.8	99.4	100.0
	MIN	19.7	1.1	0.4	20.5

2020 No Act

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.0	1.2	0.2	5.7
	MED	11.4	0.8	0.2	5.1
	MAX	21.8	4.5	0.6	14.8
	MIN	1.5	0.3	0.1	2.0
Above Normal	AVG	10.1	0.6	0.3	4.8
	MED	11.5	0.5	0.2	4.5
	MAX	13.7	1.3	1.1	9.1
	MIN	5.3	0.2	0.1	1.6
Below Normal	AVG	15.9	1.4	0.7	19.6
	MED	14.0	0.6	0.2	6.4
	MAX	35.6	4.7	3.2	92.7
	MIN	3.0	0.3	0.1	1.1
Dry	AVG	19.6	1.3	3.5	24.1
	MED	18.8	1.0	0.2	14.8
	MAX	40.0	4.3	46.2	99.9
	MIN	2.4	0.4	0.1	0.4
Critical	AVG	33.8	2.5	45.9	81.2
	MED	36.0	2.1	58.9	96.5
	MAX	42.3	5.8	100.0	100.0
	MIN	20.0	1.1	0.4	19.4

Difference = 2020 No Act - 2001 Exist Cond

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	0.3	0.0	0.0	0.4
	MED	0.2	0.0	0.0	0.3
	MAX	0.1	0.0	0.0	2.1
	MIN	-0.1	0.0	0.0	0.2
Above Normal	AVG	0.4	0.0	0.0	0.1
	MED	0.9	-0.1	0.0	0.0
	MAX	-0.5	0.3	0.0	0.3
	MIN	0.6	0.0	0.0	-0.2
Below Normal	AVG	-0.1	0.0	0.1	0.4
	MED	0.2	-0.1	0.0	0.3
	MAX	0.0	-0.2	1.0	6.9
	MIN	0.1	0.0	0.0	0.0
Dry	AVG	0.6	0.0	0.6	1.8
	MED	0.1	0.0	0.0	-0.7
	MAX	0.1	-0.3	8.9	0.0
	MIN	0.1	0.0	0.0	0.0
Critical	AVG	-1.1	0.0	0.3	-4.9
	MED	-1.0	0.0	35.5	-2.7
	MAX	-0.9	0.0	0.6	0.0
	MIN	0.3	0.0	0.0	-1.0

Existing Conditions: Sacramento River Salmon Mortality (%) in Critical Water Years

Year	Sac Index	Fall	Late Fall	**Winter**	Spring
1924	5	29.9	1.1	**99.4**	96.7
1929	5	37.8	5.8	**1.2**	51.6
1931	5	35.6	1.9	**95.0**	99.0
1933	5	43.2	4.5	**23.4**	100.0
1934	5	36.8	2.5	**96.3**	99.3
1976	5	19.7	2.6	**0.4**	20.5
1977	5	37.0	1.6	**93.0**	99.3
1988	5	37.6	1.6	**5.1**	99.6
1990	5	31.4	1.8	**1.0**	82.4
1991	5	37.9	2.5	**4.8**	99.5
1992	5	37.5	2.1	**81.9**	99.4
Average		34.9	2.5	**45.6**	86.1

Sacramento River Salmon (Fall, Late-fall, Winter,Spring) Loss (%)

OCAP Preferred Alternative

Year	Sac Index	Fall	Late Fall	Winter	Spring
1927	1	15.2	0.9	0.1	5.8
1938	1	16.1	1.7	0.3	12.4
1941	1	11.7	1.4	0.3	3.3
1942	1	10.4	0.8	0.2	2.9
1943	1	14.8	0.7	0.1	8.3
1952	1	7.0	0.9	0.3	2.9
1953	1	10.4	0.4	0.1	3.4
1956	1	10.9	2.1	0.3	4.0
1958	1	22.1	4.7	0.3	13.6
1963	1	20.4	1.3	0.4	23.8
1965	1	17.6	1.1	0.4	8.8
1967	1	21.6	3.1	0.2	9.9
1969	1	9.1	2.3	0.2	4.1
1970	1	23.5	1.2	0.3	27.8
1971	1	12.2	0.9	0.2	6.8
1974	1	14.1	1.9	0.4	6.2
1975	1	14.1	0.9	0.3	7.8
1982	1	4.0	0.7	0.2	2.5
1983	1	16.0	0.6	0.1	5.6
1984	1	12.5	0.4	0.6	7.2
1986	1	13.8	0.8	0.5	6.4
1922	2	11.8	0.7	0.2	3.8
1928	2	18.4	1.2	0.4	13.9
1940	2	19.7	1.6	0.4	16.0
1951	2	12.4	0.6	0.1	3.6
1954	2	16.8	0.7	0.1	11.3
1957	2	18.5	1.0	0.2	15.4
1973	2	8.6	0.9	0.3	4.2
1978	2	17.0	1.2	1.1	6.4
1980	2	7.9	0.2	0.1	2.0
1993	2	12.1	0.6	0.2	3.4
1923	3	20.3	1.9	2.1	13.6
1935	3	34.4	2.5	16.4	98.7
1936	3	43.4	5.9	2.9	94.6
1937	3	12.3	1.2	0.3	5.2
1945	3	20.5	0.8	0.1	14.3
1946	3	10.3	0.5	0.1	2.3
1948	3	9.6	0.5	0.3	4.6
1950	3	5.2	0.7	0.3	3.5
1959	3	36.7	4.3	1.4	88.4
1962	3	26.8	2.5	0.2	41.2
1966	3	24.1	1.5	0.2	23.8
1968	3	25.4	1.3	0.4	40.0
1972	3	18.2	0.6	0.3	16.8
1979	3	15.1	0.6	0.2	8.8
1925	4	29.5	1.6	1.8	86.0
1926	4	36.5	2.5	6.3	99.4
1930	4	25.6	2.3	0.2	29.9
1932	4	39.9	4.2	69.7	99.9
1939	4	32.4	3.8	0.5	65.0
1944	4	20.3	0.7	0.6	17.6
1947	4	26.0	1.6	0.8	50.9
1949	4	5.1	1.3	0.1	0.4
1955	4	22.7	1.2	0.3	22.9
1960	4	28.6	1.2	1.0	64.7
1961	4	31.5	1.8	1.2	87.6
1964	4	24.1	0.9	0.2	29.1
1981	4	18.7	0.5	0.2	27.8
1985	4	17.7	0.7	0.1	10.9
1987	4	29.6	1.7	0.2	59.5
1989	4	22.0	1.2	0.2	27.3
1924	5	29.5	1.1	100.0	96.5
1929	5	37.0	5.6	0.3	69.0
1931	5	34.8	1.7	99.0	98.8
1933	5	41.2	3.6	86.4	100.0
1934	5	35.5	2.8	100.0	98.9
1976	5	25.7	4.3	0.4	26.2
1977	5	35.7	1.1	96.9	98.8
1988	5	37.4	1.6	7.3	99.5
1990	5	35.7	2.0	8.2	99.0
1991	5	38.7	2.3	21.0	99.6
1992	5	37.0	2.0	85.6	99.3
Average		21.4	1.6	10.0	34.4

Sacramento River Salmon Mortality (%)

(Version 1 with revised Spawning Distributions*)

No Action (Trinity No Action)

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	12.0	1.2	0.2	5.7
	MED	11.4	0.8	0.2	5.1
	MAX	21.8	4.5	0.6	14.8
	MIN	1.5	0.3	0.1	2.0
Above Normal	AVG	10.1	0.6	0.3	4.8
	MED	11.5	0.5	0.2	4.5
	MAX	13.7	1.3	1.1	9.1
	MIN	5.3	0.2	0.1	1.6
Below Normal	AVG	15.9	1.4	0.7	19.6
	MED	14.0	0.6	0.2	6.4
	MAX	35.6	4.7	3.2	92.7
	MIN	3.0	0.3	0.1	1.1
Dry	AVG	19.6	1.3	3.5	24.1
	MED	18.8	1.0	0.2	14.8
	MAX	40.0	4.3	46.2	99.9
	MIN	2.4	0.4	0.1	0.4
Critical	AVG	33.8	2.5	45.9	81.2
	MED	36.0	2.1	58.9	96.5
	MAX	42.3	5.8	100.0	100.0
	MIN	20.0	1.1	0.4	19.4

OCAP Future EWA

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	14.2	1.4	0.3	8.3
	MED	14.1	0.9	0.3	6.4
	MAX	23.5	4.7	0.6	27.8
	MIN	4.0	0.4	0.1	2.5
Above Normal	AVG	14.3	0.9	0.3	8.0
	MED	14.6	0.8	0.2	5.3
	MAX	19.7	1.6	1.1	16.0
	MIN	7.9	0.2	0.1	2.0
Below Normal	AVG	21.6	1.8	1.8	32.6
	MED	20.4	1.2	0.3	15.5
	MAX	43.4	5.9	16.4	98.7
	MIN	5.2	0.5	0.1	2.3
Dry	AVG	25.6	1.7	5.2	48.7
	MED	25.8	1.4	0.4	40.4
	MAX	39.9	4.2	69.7	99.9
	MIN	5.1	0.5	0.1	0.4
Critical	AVG	35.3	2.6	55.0	89.6
	MED	35.7	2.0	85.6	98.9
	MAX	41.2	5.6	100.0	100.0
	MIN	25.7	1.1	0.3	26.2

Difference = OCAP Future EWA - No Action

40-30-30 YRT		Fall	Late Fall	Winter	Spring
Wet	AVG	2.2	0.2	0.0	2.6
	MED	2.8	0.1	0.1	1.3
	MAX	1.7	0.2	0.0	13.1
	MIN	2.5	0.1	0.0	0.4
Above Normal	AVG	4.2	0.3	0.0	3.2
	MED	3.1	0.3	0.0	0.8
	MAX	6.0	0.3	0.0	6.9
	MIN	2.6	0.1	0.0	0.4
Below Normal	AVG	5.7	0.3	1.1	12.9
	MED	6.4	0.6	0.1	9.1
	MAX	7.8	1.2	13.2	6.0
	MIN	2.2	0.2	0.0	1.2
Dry	AVG	6.0	0.4	1.7	24.6
	MED	7.0	0.4	0.2	25.6
	MAX	-0.1	-0.1	23.4	0.0
	MIN	2.7	0.1	0.0	0.0
Critical	AVG	1.4	0.0	9.1	8.4
	MED	-0.3	-0.1	26.7	2.3
	MAX	-1.0	-0.2	0.0	0.0
	MIN	5.7	-0.1	-0.1	6.8

Attachment B9
Evaluation of Riparian Vegetation and Sediment Transport for All Alternatives

Evaluation of Riparian Vegetation and Sediment Transport for all Alternatives

Sediment management considerations

Trinity and Lewiston dams alter fine and coarse sediment supply and storage downstream of Lewiston Dam, as well as reduce the fine and coarse sediment transport capability via reduced high flows. Overall, this has caused: (1) coarse sediment supply and storage to be in deficit, primarily between Lewiston Dam and Indian Creek, (2) local long-term accumulation of coarse sediment at the Rush Creek, Grass Valley Creek, and Indian Creek deltas, and (3) accumulation of fine sediment storage in the channel, particularly downstream of Grass Valley Creek. Efforts have been made to increase coarse sediment storage (e.g., gravel introduction), as well as reduce fine sediment supply (e.g., dredging, sediment traps, and watershed rehabilitation). The flow and sediment management actions in each alternative benefits and impacts the sediment regime on the Trinity River. The Preferred Alternative attempts to balance the coarse sediment budget by transporting Rush Creek sediments at a rate equal to input, and by augmenting coarse sediment immediately downstream from Lewiston Dam to compensate that transported by the high flow release hydrograph. Additionally, the Preferred Alternative attempts to transport fine sediment at a rate greater than input from tributaries to reduce fine sediment storage in the mainstem Trinity River. Watershed rehabilitation and continued operation of sediment traps in Grass Valley Creek is also included in the Preferred Alternative.

As a comparative tool, fine and coarse sediment transport was computed for each alternative and for each water year for that alternative. The weighted average sediment transport for each alternative is summarized in Table 1. The fine and coarse sediment transport rates for the Lewiston and Limekiln gaging stations as reported in the TRFES were averaged for the results shown in Table 1. The largest flow where sediment transport was measured was 6,000 cfs, so the computed sediment transport from those alternatives with flow magnitudes significantly greater than 6,000 cfs should be considered relative magnitudes, not absolute magnitudes.

Table 1. Summary of weighted average annual fine and coarse sediment transport for differing alternatives.

ALTERNATIVE	Weighted average <u>coarse</u> sediment transport	% different from Preferred Alternative	Weighted average <u>fine</u> sediment transport	% different from Preferred Alternative
Preferred alternative	8,570 yd^3	0%	1,870 yd^3	0%
70% inflow	16,900 yd^3	+97%	3,220 yd^3	+72%
Maximum Flow[a]	156,000 yd^3	+1,700%	21,500 yd^3	+1,050%
Modified Percent Inflow	5,370 yd^3	-37%	1,100 yd^3	-41%
Revised Mechanical	1,070 yd^3	-88%	370 yd^3	-80%
No Action	680 yd^3	-92%	230 yd^3	-88%

[a] rating curve is extended far beyond measured data, resulting in abnormally large predictions of sediment transport. Results should be considered qualitatively "very large".

The implications of the computed fine and coarse sediment transport rates are considered in light of: (1) ability to transport and route coarse sediment delivered from tributaries, (2) coarse sediment imbalance in the reach immediately downstream of Lewiston Dam, which would require compensating coarse sediment introduction to maintain coarse sediment storage, and (3) ability to transport large volumes of fine sediment, which would reduce fine sediment storage in the mainstem Trinity River. These results are summarized for both fine and coarse sediment (Table 2).

Riparian regeneration considerations

The seed dispersal timing of target woody riparian species (black cottonwood, Fremont cottonwood, shiny willow) desired to be regenerated on Trinity River floodplains occurs in the late spring and early summer months, corresponding to the historic snowmelt hydrograph of the Trinity River. Successful plant initiation requires that: (1) a higher elevation bar, scour channel, or floodplain surface be exposed and wetted during the seed dispersal period, (2) the surface be exposed and moist for a short duration to allow seed germination (usually created by fine sediment deposition and/or scouring of annual plants), (3) the subsurface capillary fringe declines at a rate less than the root growth rate of the initiating seedling, and (4) when the flow recession transitions into the summer baseflow period, the seedling roots are at the summer baseflow capillary fringe (Mahoney and Rood 1992, Segelquist et al. 1993, Amlin and Rood 2002, McBride, et al. 1988). Riparian initiation modelers initially assume that, for coarse alluvial sediment, the capillary fringe on higher elevation bars, scour channels, or floodplains is approximated by the water surface elevation of the river. Black cottonwood is often used as a target riparian indicator species. Black cottonwood has an approximate maximum root growth rate of 2.5 cm/day (0.082 ft/day); therefore, recession rates from the spring peak flow greater than 2.5 cm/day will likely prevent riparian initiation and establishment (Mahoney and Rood, 1998). Under natural conditions, cottonwood recruitment is infrequent, and usually occurs during abnormally wet years (Merigliano 1996, Mahoney and Rood 1998). Therefore, riparian recruitment on floodplains and other higher elevation surfaces during Extremely Wet years, and perhaps some Wet water years, is an appropriate riparian restoration objective for the future.

Using the stage-discharge curve at the Lewiston gaging station and assuming a target floodplain surface for riparian initiation being inundated at 6,000 cfs, the annual hydrograph for each alternative was evaluated for riparian initiation. The simulated snowmelt hydrograph release occurs during the cottonwood seed dispersal period (may-June) for all Alternatives, and a groundwater recession rate of 2.5 cm/day is assumed as the threshold for plant survival and plant desiccation. It is also assumed that the shallow groundwater table elevation is identical to the water surface in the river on each day.

The hydrographs for Extremely Wet and Wet water years were plotted, and the receding hydrograph necessary for riparian initiation is also plotted (See figures 1 through 9). For the 70% Inflow Alternative and Modified Percent Inflow Alternative, median Extremely Wet and Wet years were used from the 1912-2002 period of record. For each alternative, if the solid line (hydrograph for that alternative) is under the dashed line (hydrograph needed to cause riparian initiation), the recession limb of that alternative is too steep to recruit black cottonwood (See Figures 1 through 9). Of the alternatives, the Preferred Alternative, 70% Inflow Alternative, Maximum Flow Alternative, and the Revised Mechanical Alternative provide hydrographs during Extremely Wet years that would likely result in riparian initiation on floodplains (Table 3). The Modified Percent Inflow Alternative and No Action Alternative all have recession limbs steeper than that required to initiate riparian vegetation on floodplains. Because the analyses for the Modified Percent Inflow Alternative use the median years for Extremely Wet and Wet water years, the median year does not represent all years for those two water years classes, and there could be an individual year within the record where the recession limb is sufficient to initiate riparian vegetation. Testing this would require an analysis of all Extremely Wet and Wet water years within the period of record, which was not done.

Table 2. Summary of impacts and benefits to fine and coarse sediment regime for differing alternatives.

Alternative	Transport tributary coarse sediments	Coarse sediment deficit	Fine sediment deficit
Preferred Alternative	Transports coarse sediment from Rush Creek at rate equal to input, may not be able to transport largest boulders contributed from Rush Creek. Mechanical means would be required to remove these larger particles.	Would cause moderate coarse sediment deficit, to be replaced by moderate amounts of mechanically introduced coarse sediments.	Moderate volume of fine sediment reduction, causing moderate deficit if Grass Valley Creek sediment traps are maintained.
70% inflow	Larger peak flow magnitude (up to 19,000 cfs) would transport greater volumes of coarse sediment from Rush Creek, and would be better able to transport largest boulders contributed from Rush Creek.	Larger peak flow magnitude (up to 19,000 cfs) would create larger coarse sediment deficit below Lewiston Dam, requiring greater augmentation to maintain coarse sediment storage.	Larger peak flow magnitude (up to 19,000 cfs) would create larger fine sediment deficit below Lewiston Dam, improving aquatic habitat and depositing more fine sediment on floodplains.
Maximum Flow[a]	Larger peak flow magnitude (30,000 cfs) would transport greater volumes of coarse sediment from Rush Creek, and would be better able to transport largest boulders contributed from Rush Creek.	Larger peak flow magnitude (30,000 cfs) would create very large coarse sediment deficit below Lewiston Dam, requiring greater augmentation to maintain coarse sediment storage.	Larger peak flow magnitude (30,000 cfs) would create larger fine sediment deficit below Lewiston Dam, improving aquatic habitat and depositing more fine sediment on floodplains.
Modified Percent Inflow	Larger peak flow magnitude (13,000 cfs) and shorter duration of flow would transport lower volumes of coarse sediment from Rush Creek, but the larger magnitude would be better able to transport largest boulders contributed from Rush Creek.	Larger peak flow magnitude (13,000 cfs) and shorter duration would create a smaller coarse sediment deficit below Lewiston Dam, requiring less augmentation to maintain coarse sediment storage.	Larger peak flow magnitude (13,000 cfs) but of shorter duration would not transport as much fine sediment as Preferred Alternative, reducing fine sediment deficit or possibly allowing fine sediment accumulation below Lewiston Dam.
Revised Mechanical	Unable to transport coarse sediment from Rush Creek at rate equal to input, and will not be able to transport largest boulders contributed from Rush Creek. Mechanical means would be required to remove these larger particles and accumulations of smaller delta particles.	Would cause small coarse sediment deficit, to be replaced by small amounts of mechanically introduced coarse sediments.	Much lower fine sediment transport rates than Preferred Alternative, fine sediments may accumulate in channel without additional fine sediment supply reduction efforts (in addition to Grass Valley Creek sediment traps).
No Action	Unable to transport coarse sediment from Rush Creek at rate equal to input, and will	Would cause small coarse sediment deficit, to be replaced by small	Much lower fine sediment transport rates than Preferred Alternative, fine sediments may

	not be able to transport largest boulders contributed from Rush Creek. Mechanical means would be required to remove these larger particles and accumulations of smaller delta particles.	amounts of mechanically introduced coarse sediments.	accumulate in channel without additional fine sediment supply reduction efforts (in addition to Grass Valley Creek sediment traps).

Table 3. Summary of riparian regeneration evaluation for variety of alternatives, assuming target floodplains are inundated at 6,000 cfs.

Alternative	Natural riparian initiation?	Explanation
Preferred alternative	Yes	Riparian initiation occurs on Extremely Wet years, recession is slightly too steep on Wet and Normal years for riparian initiation, fine sediment deposition would occur in Extremely Wet and Wet water years.
70% inflow	Yes	Riparian initiation likely occurs on most Extremely Wet and Wet years; high flows up to 19,000 cfs would deposit fine sediment during Extremely Wet and Wet water years.
Maximum Flow	Yes	Riparian initiation occurs on Extremely Wet years, recession is slightly too steep on Wet and Normal years for riparian initiation, fine sediment deposition would occur in Extremely Wet and Wet water years.
Modified Percent Inflow	No	Recession rate too steep for riparian initiation in median Extremely Wet and Wet water years; however, fine sediment deposition would occur in Extremely Wet and Wet water years.
Revised Mechanical	Yes	Riparian initiation occurs on Extremely Wet and Wet years, no overbank fine sediment deposition except during safety of dams releases or tributary floods in downstream reaches.
No Action	No	Releases identical for all water years, recession rate too steep for riparian initiation, no overbank fine sediment deposition except during safety of dams releases or tributary floods in downstream reaches.

Figure 1.
Example hydrograph of No Action Alternative (all years) and EXTREMELY WET water year for the Preferred Alternative, showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station

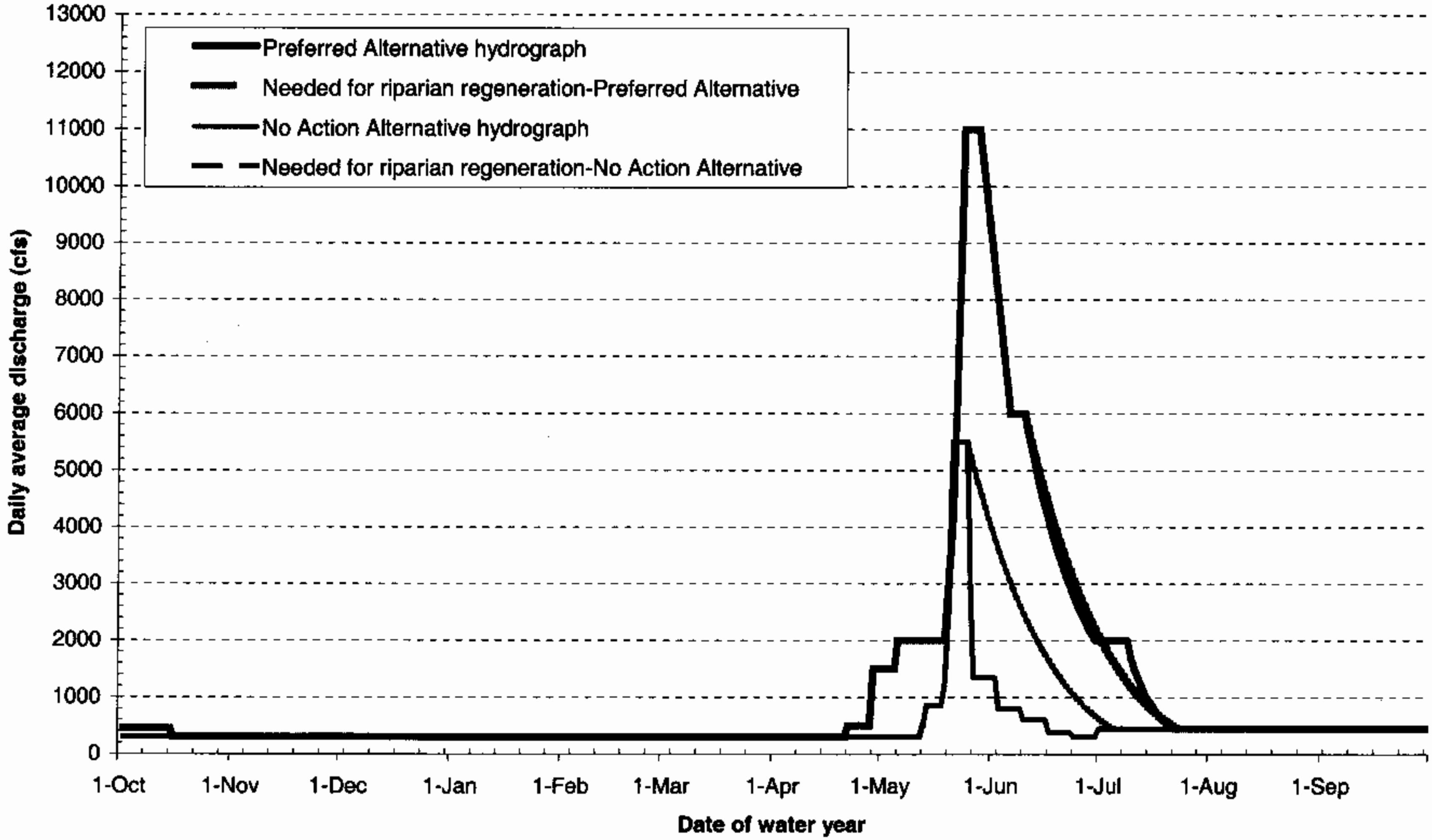


Figure 2.
Example hydrograph of EXTREMELY WET water year for Maximum Flow Alternative and Preferred Alternative, showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station

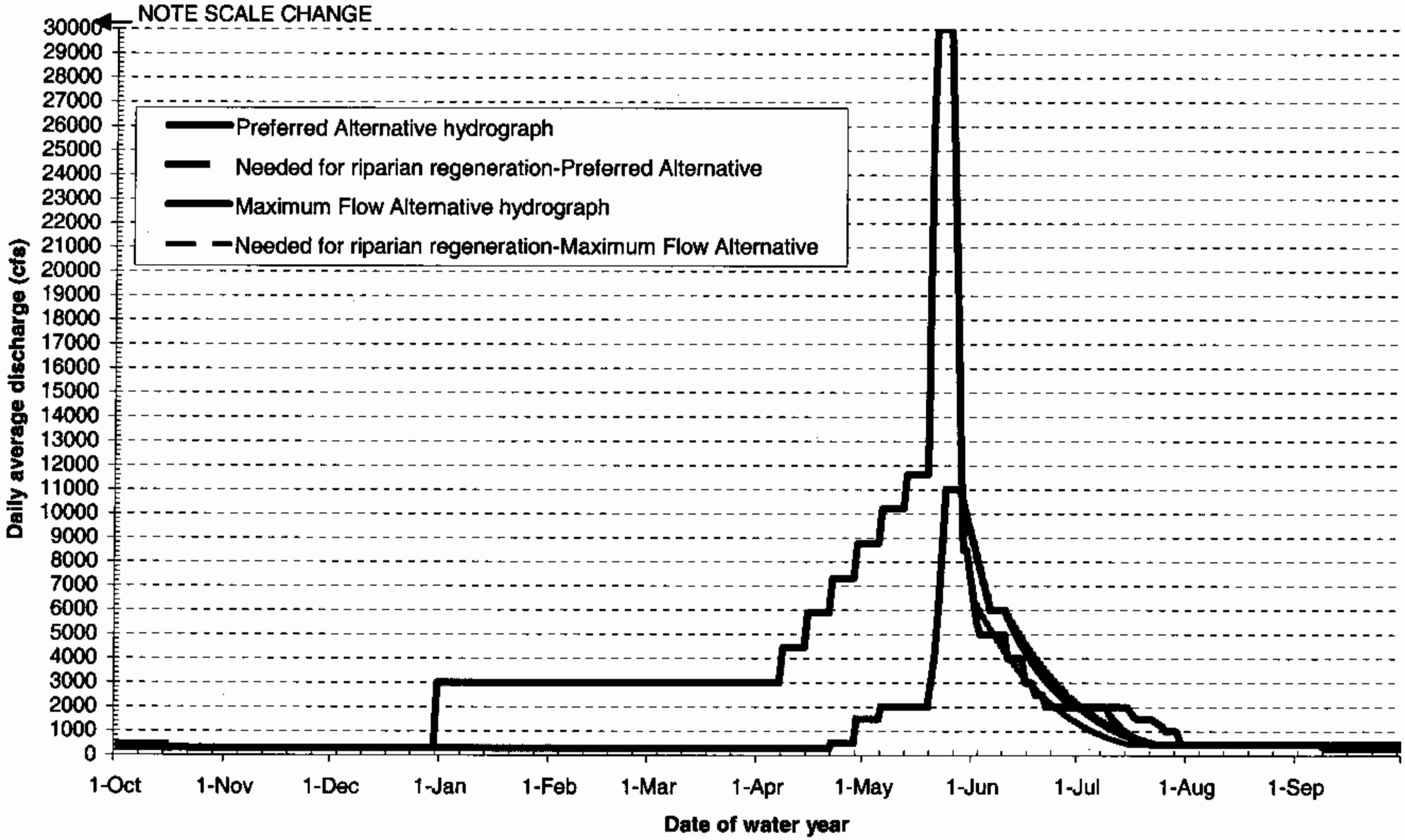


Figure 3.
Example hydrograph of WET water year for Maximum Flow Alternative and Preferred Alternative, showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station

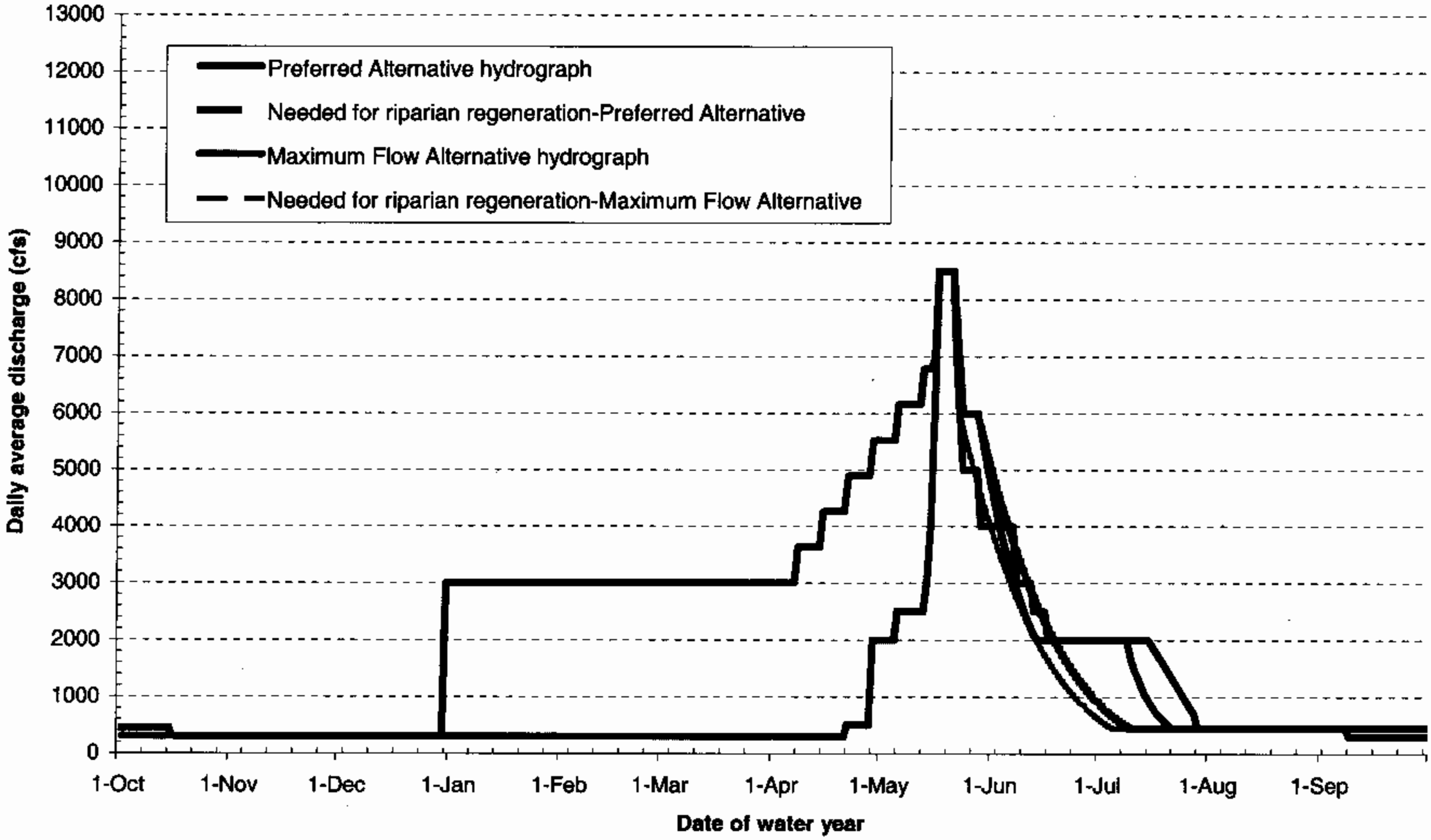


Figure 4.
Example hydrograph of EXTREMELY WET water years for 70 Percent Inflow Alternative and Preferred Alternative showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station

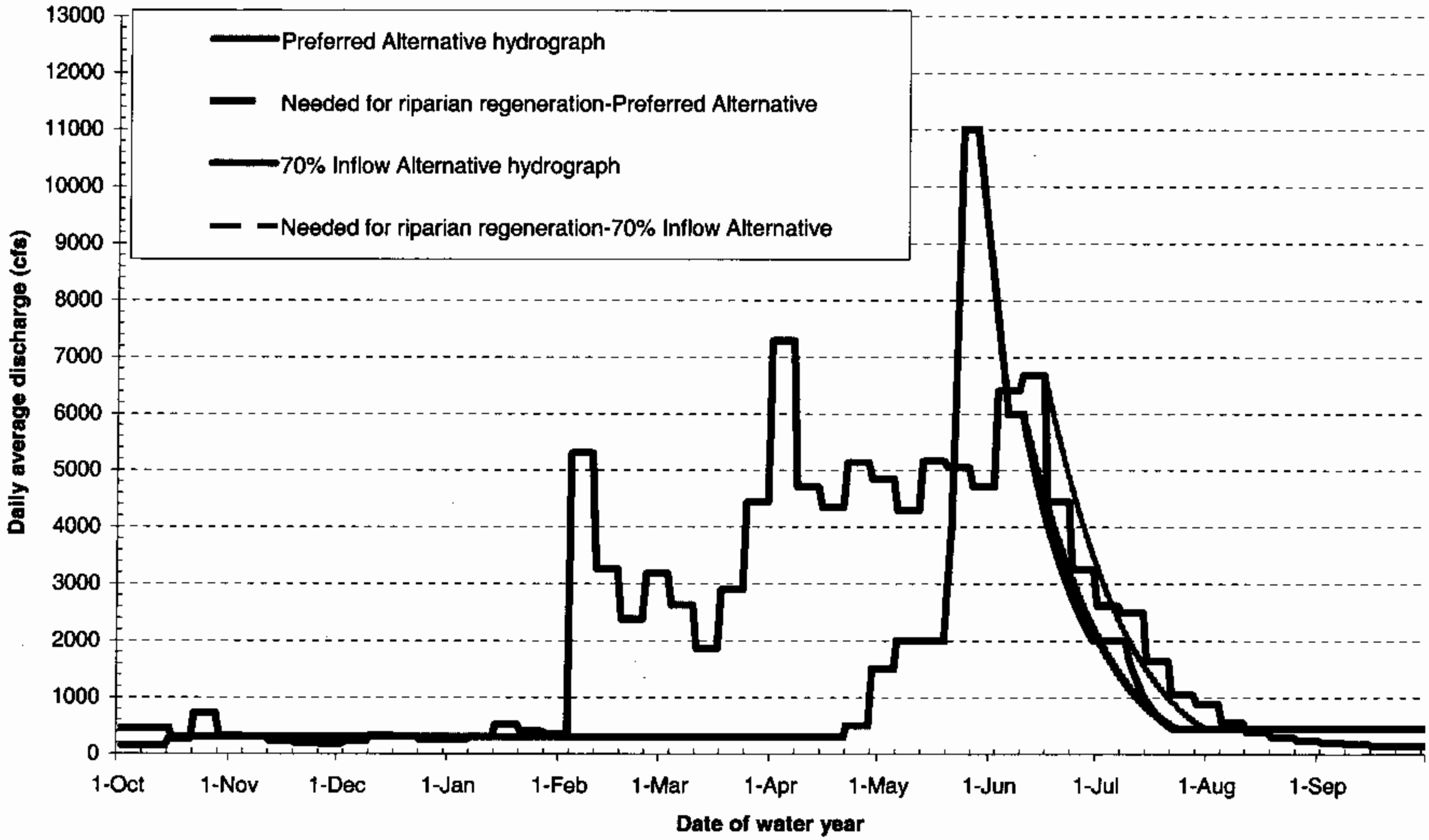


Figure 5.
Example hydrograph of WET water years for 70 Percent Inflow Alternative and Preferred Alternative showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station

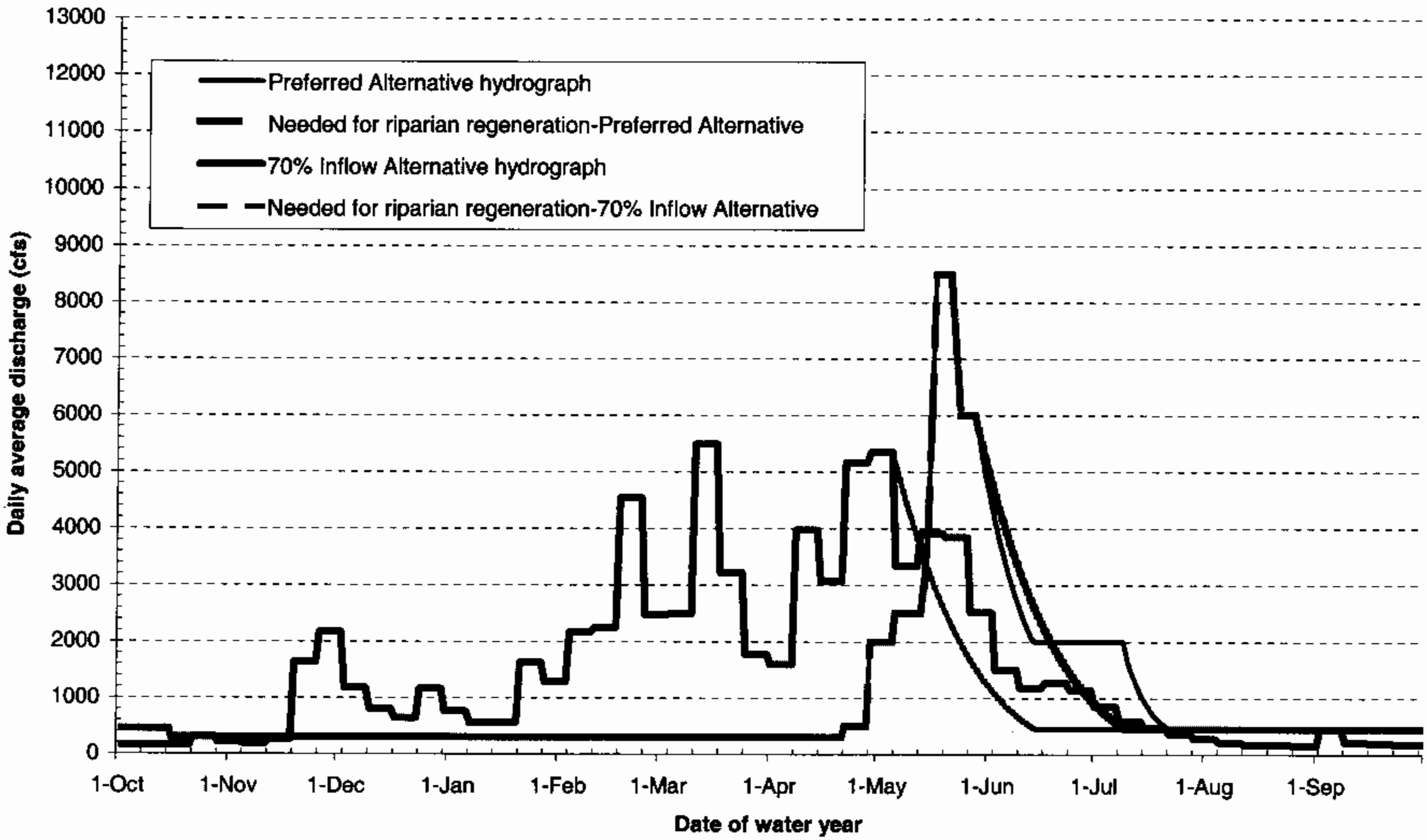


Figure 6.
Example hydrograph of EXTREMELY WET water years for Revised Mechanical Alternative and Flow Evaluation Study showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station

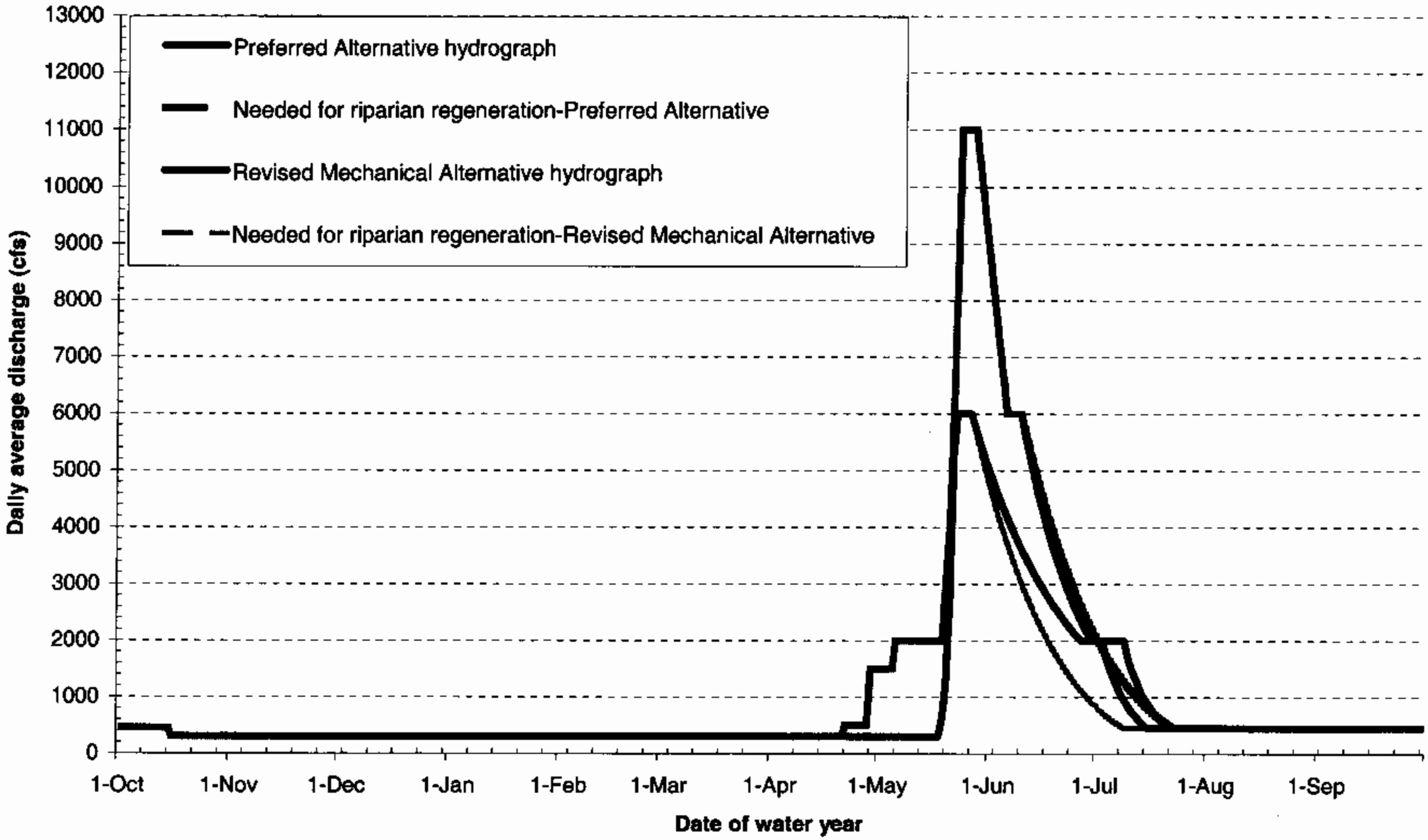


Figure 7.
Example hydrograph of WET water year for Revised Mechanical Alternative and Preferred Alternative, showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station

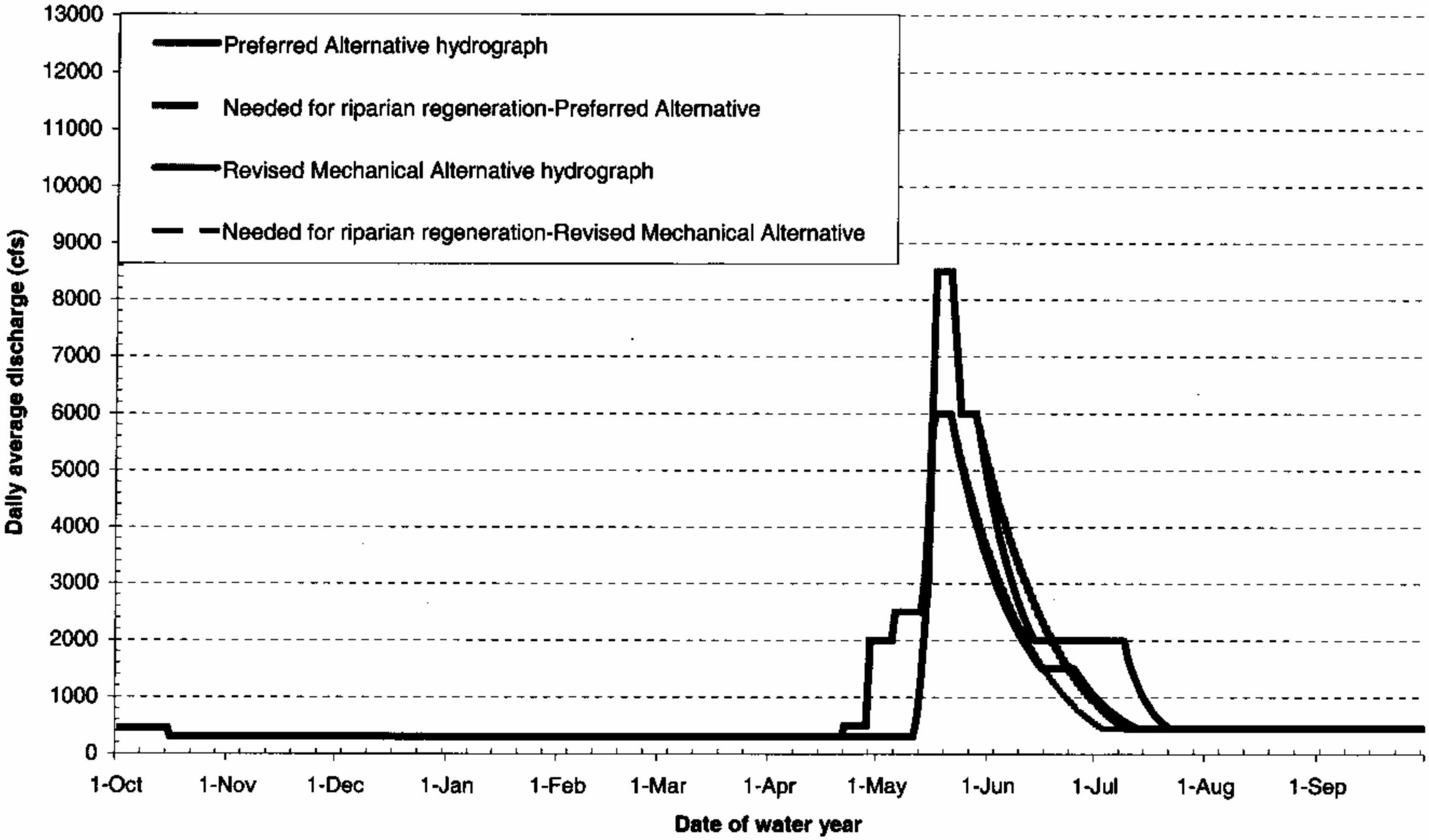


Figure 8.
Example hydrograph of EXTREMELY WET water years for Modified Percent Inflow Alternative and Preferred Alternative showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station

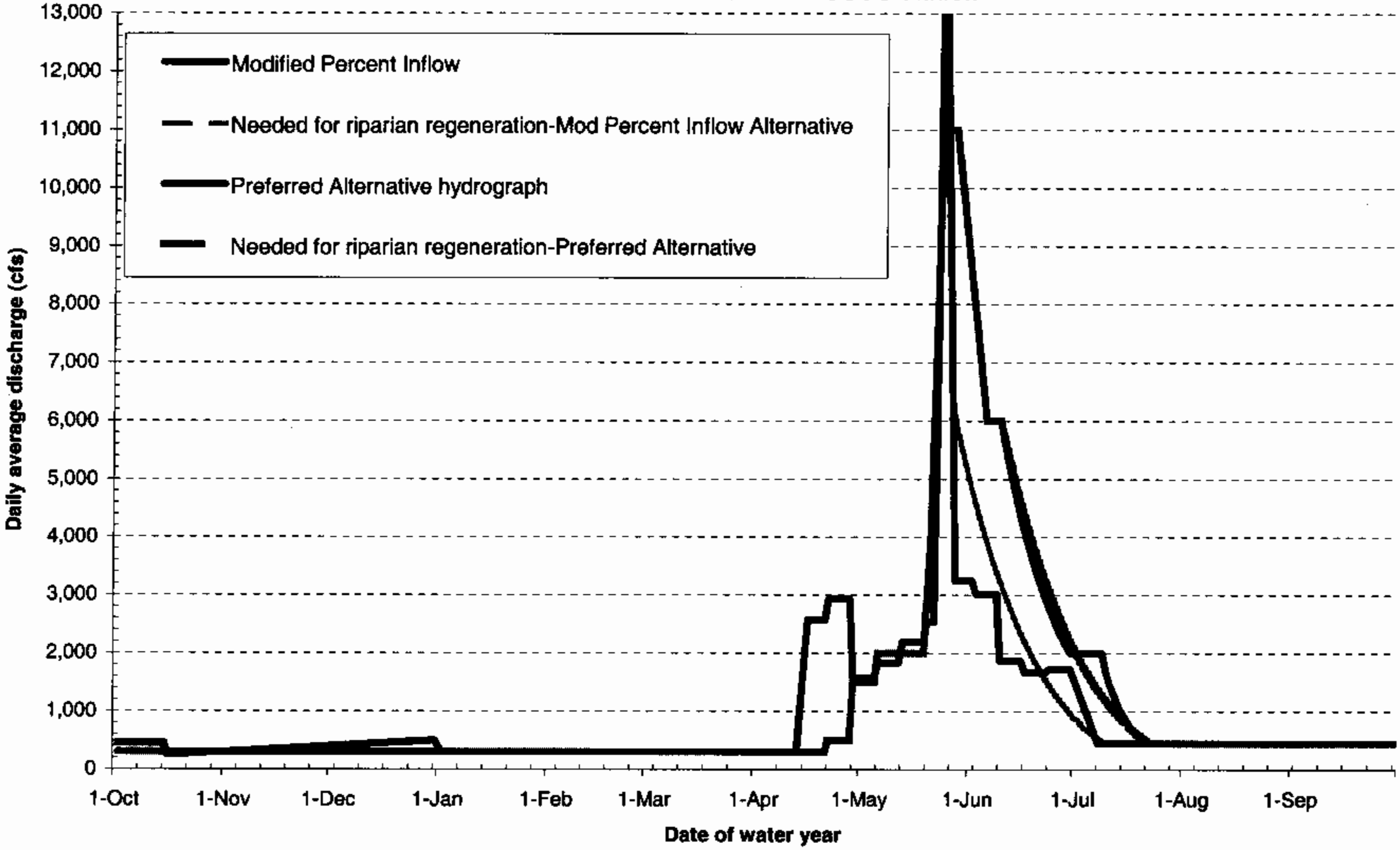
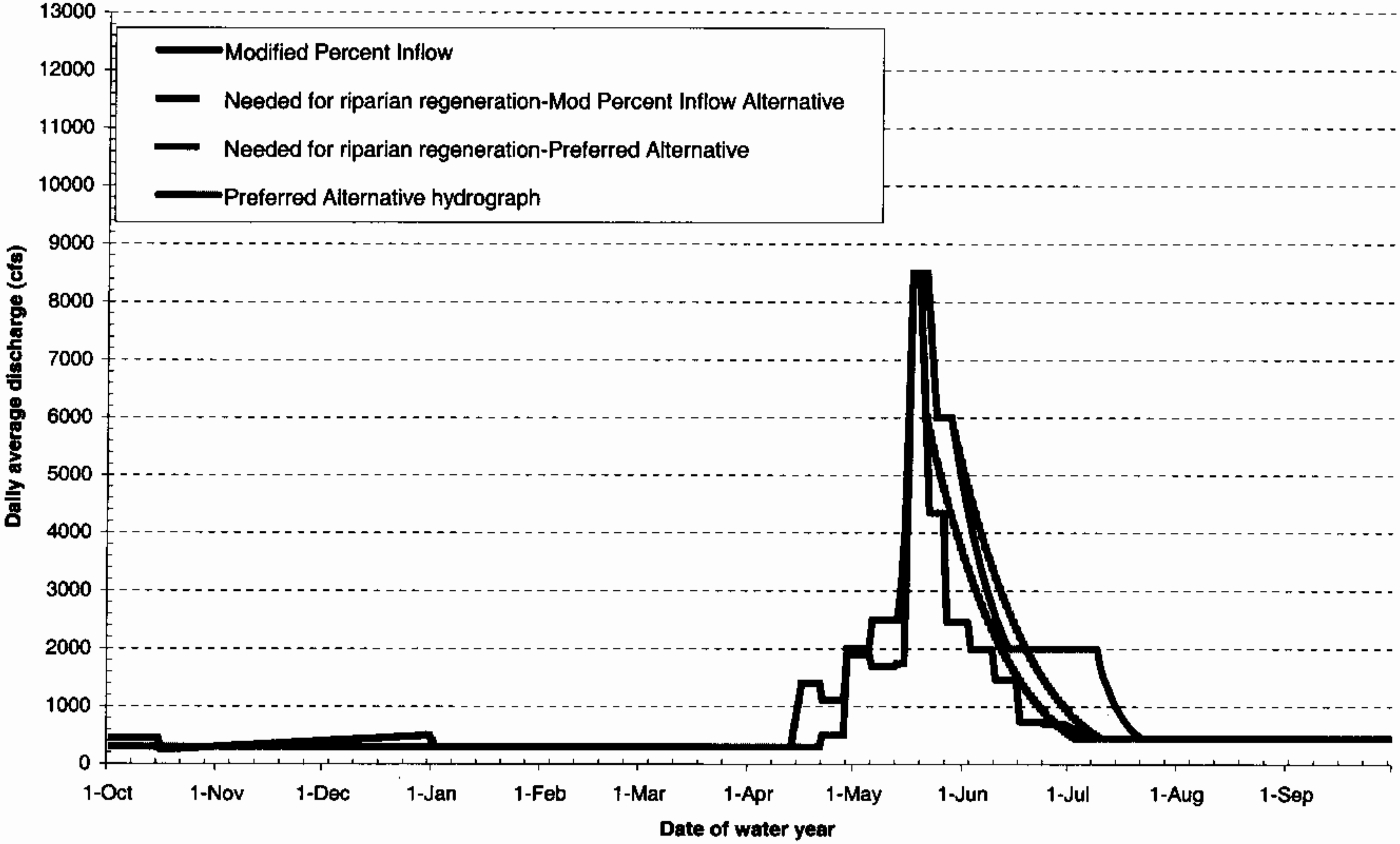


Figure 9.
Example hydrograph of WET water years for Modified Percent Inflow Alternative and Preferred Alternative showing ability for riparian regeneration on floodplains using a 2.5 cm/day recession criteria at Lewiston USGS station



Attachment B10
Analysis of the Frequency and Direction of Changes of the Predicted Position of X2 in the Sacramento-San Joaquin River Delta

Summary of the Change in X2 Position in the Delta compared to the No Action Alternative (1922-1993).

	Compared to No Action Alternative						Pref. vs. Exist. Cond.
Alternative	Max Flow	Flow Eval	70% inflow	Mechanical	Revised Mech	Mod. % Inflow	
February							
# years > 0.5 Km upstream	20	8	18	0	3	5	4
% years > 0.5km upstream	27.8%	11.1%	25.0%	0.0%	4.2%	6.9%	5.6%
# years > 0.5 Km downstream	3	11	1	0	3	4	1
% years > 0.5km downstream	4.2%	15.3%	1.4%	0.0%	4.2%	5.6%	1.4%
March							
# years > 0.5 Km upstream	7	5	7	0	1	2	3
% years > 0.5km upstream	9.7%	6.9%	9.7%	0.0%	1.4%	2.8%	4.2%
# years > 0.5 Km downstream	2	2	2	0	1	2	2
% years > 0.5km downstream	2.8%	2.8%	2.8%	0.0%	1.4%	2.8%	2.8%
April							
# years > 0.5 Km upstream	8	5	9	0	4	2	5
% years > 0.5km upstream	11.1%	6.9%	12.5%	0.0%	5.6%	2.8%	6.9%
# years > 0.5 Km downstream	5	4	2	0	1	4	1
% years > 0.5km downstream	6.9%	5.6%	2.8%	0.0%	1.4%	5.6%	1.4%
May							
# years > 0.5 Km upstream	6	4	6	0	2	3	4
% years > 0.5km upstream	8.3%	5.6%	8.3%	0.0%	2.8%	4.2%	5.6%
# years > 0.5 Km downstream	3	4	2	0	2	3	4
% years > 0.5km downstream	4.2%	5.6%	2.8%	0.0%	2.8%	4.2%	5.6%
June							
# years > 0.5 Km upstream	14	13	14	0	7	11	10
% years > 0.5km upstream	19.4%	18.1%	19.4%	0.0%	9.7%	15.3%	13.9%
# years > 0.5 Km downstream	10	8	5	0	7	6	7
% years > 0.5km downstream	13.9%	11.1%	6.9%	0.0%	9.7%	8.3%	9.7%
All months (Feb-June)							
# years > 0.5 Km upstream	55	35	54	0	17	23	26
% years > 0.5km upstream	15.3%	9.7%	15.0%	0.0%	4.7%	6.4%	7.2%
# years > 0.5 Km downstream	23	29	12	0	14	19	15
% years > 0.5km downstream	6.4%	8.1%	3.3%	0.0%	3.9%	5.3%	4.2%

Changes in X2 Position Compared to No Action for all Alternatives
February

Year	No Action (Km)	Max. Flow (Km)[1]	difference	Flow Eval. (Km)[1]	difference	70% inflow (Km)[1]	difference	Mech. Rest. (Km)[1]	difference	Revised Mech. (Km)[1]	difference	Mod. % Inflow (Km)[1]	difference	Existing Conditions (2001)	Difference (vs. Pref. Alt. 2001)
1922	76.43	77.32	0.89	76.43	0.00	76.43	0.00	76.43	0.00	76.43	0.00	76.43	0.00	66.89	0.00
1923	67.20	67.29	0.08	67.20	0.00	67.14	-0.07	67.20	0.00	67.20	0.00	67.20	0.00	69.75	0.00
1924	82.45	82.67	0.22	82.48	0.03	82.91	0.47	82.45	0.00	82.41	-0.03	82.33	-0.12	77.79	0.35
1925	80.80	80.63	-0.17	80.36	-0.44	80.81	0.01	80.80	0.00	80.73	-0.06	80.35	-0.44	63.68	0.08
1926	78.85	79.02	0.16	77.28	-1.57	78.84	-0.01	78.85	0.00	77.47	-1.38	78.82	-0.03	67.11	-0.16
1927	69.09	69.98	0.89	69.46	0.37	68.71	-0.38	69.09	0.00	69.96	0.87	69.40	0.31	54.65	0.42
1928	74.96	75.55	0.59	75.32	0.36	75.50	0.55	74.96	0.00	74.96	0.00	75.31	0.36	71.69	0.01
1929	83.01	83.43	0.42	83.11	0.09	83.14	0.12	83.01	0.00	82.99	-0.02	83.00	-0.02	78.21	-0.17
1930	74.04	72.67	-1.37	72.59	-1.44	74.12	0.09	74.04	0.00	74.07	0.03	74.05	0.01	72.62	-0.10
1931	79.19	81.22	2.03	80.85	1.66	80.63	1.44	79.19	0.00	79.13	-0.05	79.03	-0.16	80.22	0.13
1932	72.52	72.81	0.30	71.44	-1.08	72.58	0.06	72.52	0.00	72.50	-0.01	72.47	-0.05	70.37	0.11
1933	76.75	76.64	-0.11	79.28	2.54	78.58	1.83	76.75	0.00	76.70	-0.04	76.34	-0.41	78.21	1.26
1934	76.48	76.61	0.12	75.90	-0.58	76.96	0.47	76.48	0.00	77.65	1.17	77.71	1.23	74.73	-0.17
1935	71.08	71.52	0.44	70.43	-0.65	71.59	0.51	71.08	0.00	71.09	0.01	71.27	0.19	74.01	0.04
1936	70.11	70.26	0.15	70.09	-0.02	70.23	0.13	70.11	0.00	70.08	-0.03	70.15	0.04	59.38	-0.09
1937	81.93	82.11	0.17	80.39	-1.54	81.83	-0.10	81.93	0.00	81.90	-0.03	81.70	-0.23	67.17	-0.05
1938	64.00	64.32	0.32	64.03	0.04	64.33	0.33	64.00	0.00	63.89	-0.10	63.90	-0.09	51.99	0.00
1939	80.63	79.78	-0.86	80.71	0.08	80.66	0.03	80.63	0.00	80.50	-0.13	80.62	-0.02	79.42	-0.28
1940	70.49	70.67	0.17	70.58	0.09	70.76	0.26	70.49	0.00	70.40	-0.10	70.41	-0.08	60.92	0.04
1941	56.54	57.45	0.90	56.81	0.27	57.14	0.60	56.54	0.00	56.56	0.01	56.65	0.10	50.99	0.08
1942	57.53	57.72	0.19	57.81	0.28	57.86	0.33	57.53	0.00	57.38	-0.15	57.60	0.07	50.31	-0.07
1943	58.62	59.48	0.86	58.85	0.22	59.08	0.46	58.62	0.00	58.75	0.13	58.87	0.24	57.39	-0.01
1944	81.74	81.72	-0.02	81.75	0.01	81.76	0.03	81.74	0.00	81.71	-0.03	81.75	0.01	72.86	-0.17
1945	80.06	80.09	0.03	81.49	1.43	80.07	0.01	80.06	0.00	79.72	-0.34	79.88	-0.18	66.19	-0.03
1946	61.07	62.03	0.96	61.35	0.28	61.47	0.40	61.07	0.00	61.30	0.23	61.09	0.02	64.80	0.00
1947	81.84	82.15	0.31	81.90	0.06	81.86	0.02	81.84	0.00	81.91	0.07	81.87	0.03	76.06	0.29
1948	80.15	80.35	0.20	80.46	0.31	80.22	0.07	80.15	0.00	80.25	0.10	80.32	0.17	76.95	0.03
1949	83.88	84.17	0.29	83.99	0.11	83.56	-0.32	83.88	0.00	83.89	0.01	83.89	0.02	80.99	0.01
1950	74.69	74.94	0.25	74.90	0.21	74.96	0.27	74.69	0.00	74.77	0.07	74.71	0.01	68.01	0.13
1951	56.03	55.62	-0.41	55.84	-0.19	55.78	-0.25	56.03	0.00	55.65	-0.38	55.90	-0.13	55.33	-0.39
1952	57.19	58.03	0.84	57.69	0.500	58.02	0.83	57.19	0.00	57.45	0.26	57.58	0.39	55.10	0.13
1953	56.01	56.24	0.24	56.22	0.22	56.33	0.33	56.01	0.00	56.26	0.26	56.25	0.25	63.62	0.55
1954	71.98	73.50	1.52	70.98	-1.00	72.32	0.34	71.98	0.00	71.02	-0.96	70.90	-1.08	62.10	0.33
1955	74.47	75.27	0.80	74.90	0.43	75.23	0.76	74.47	0.00	74.76	0.29	74.78	0.32	74.93	0.15
1956	50.37	50.71	0.35	50.52	0.16	50.75	0.39	50.37	0.00	50.43	0.07	50.50	0.13	52.04	0.05
1957	81.85	83.29	1.44	81.96	0.11	83.60	1.75	81.85	0.00	81.78	-0.07	81.76	-0.09	70.49	-0.27
1958	67.03	67.36	0.33	67.47	0.43	67.73	0.70	67.03	0.00	67.32	0.29	67.36	0.32	51.39	0.13
1959	70.78	70.86	0.07	70.69	-0.09	71.20	0.42	70.78	0.00	70.78	-0.01	70.82	0.03	62.06	-0.07
1960	82.37	82.08	-0.29	81.79	-0.58	83.32	0.95	82.37	0.00	81.77	-0.60	83.05	0.68	71.50	0.66
1961	80.13	79.11	-1.02	80.36	0.23	80.15	0.02	80.13	0.00	80.19	0.06	80.15	0.02	70.60	1.06
1962	81.90	81.51	-0.39	81.95	0.05	81.50	-0.41	81.90	0.00	81.92	0.01	81.92	0.02	66.47	0.39
1963	76.43	76.80	0.37	76.56	0.13	77.04	0.61	76.43	0.00	76.45	0.02	76.46	0.03	61.94	0.34
1964	74.98	75.61	0.63	75.50	0.52	75.86	0.88	74.98	0.00	75.09	0.11	75.07	0.08	74.94	0.29
1965	53.81	53.88	0.07	53.90	0.08	53.87	0.05	53.81	0.00	53.79	-0.03	53.77	-0.04	61.23	0.03
1966	69.58	69.15	-0.44	70.04	0.46	70.29	0.71	69.58	0.00	69.96	0.37	69.91	0.32	68.40	0.14
1967	62.59	63.49	0.90	62.75	0.16	62.97	0.38	62.59	0.00	62.70	0.11	62.64	0.05	59.94	0.17
1968	71.02	70.92	-0.10	70.98	-0.04	70.61	-0.41	71.02	0.00	70.89	-0.13	70.92	-0.10	61.36	0.00
1969	57.25	57.39	0.14	57.48	0.23	57.54	0.29	57.25	0.00	57.34	0.09	57.40	0.15	50.61	0.11
1970	49.72	50.10	0.38	49.80	0.08	49.80	0.08	49.72	0.00	49.77	0.05	49.75	0.03	51.43	-0.01
1971	61.34	61.77	0.43	61.62	0.27	61.77	0.43	61.34	0.00	61.53	0.19	61.54	0.20	64.60	0.00
1972	78.73	81.08	2.35	80.55	1.82	81.12	2.39	78.73	0.00	78.90	0.17	78.93	0.20	72.45	0.27
1973	59.20	59.51	0.31	59.36	0.16	60.14	0.95	59.20	0.00	59.21	0.01	59.28	0.09	54.20	0.07
1974	51.47	51.97	0.504	51.74	0.27	51.80	0.33	51.47	0.00	51.70	0.23	51.70	0.23	58.91	0.07
1975	80.59	82.14	1.55	82.13	1.54	82.17	1.59	80.59	0.00	81.62	1.03	80.65	0.06	64.17	-0.10
1976	83.40	83.36	-0.03	83.35	-0.04	82.66	-0.74	83.40	0.00	83.42	0.02	83.51	0.11	80.69	-1.09
1977	84.24	85.06	0.82	84.22	-0.02	84.29	0.05	84.24	0.00	84.21	-0.03	84.21	-0.03	82.31	-0.17
1978	63.44	63.47	0.03	63.50	0.05	63.44	0.00	63.44	0.00	63.44	-0.01	63.45	0.01	59.71	0.40
1979	74.48	74.00	-0.48	73.94	-0.53	73.99	-0.49	74.48	0.00	74.19	-0.29	73.97	-0.51	63.71	0.05
1980	59.09	59.00	-0.10	59.49	0.39	59.79	0.70	59.09	0.00	59.31	0.21	59.41	0.32	51.41	0.07
1981	74.84	74.83	0.00	75.06	0.22	75.93	1.09	74.84	0.00	75.16	0.32	75.07	0.23	69.51	0.23
1982	55.40	55.75	0.35	55.50	0.10	55.83	0.43	55.40	0.00	55.43	0.03	55.42	0.02	52.03	0.02
1983	52.00	52.17	0.17	52.07	0.07	52.13	0.12	52.00	0.00	52.05	0.05	52.05	0.05	46.49	-0.01
1984	53.47	53.51	0.05	53.30	-0.16	53.51	0.05	53.47	0.00	53.29	-0.18	53.29	-0.18	58.64	0.01
1985	79.43	80.21	0.78	79.05	-0.38	79.29	-0.14	79.43	0.00	78.94	-0.49	78.91	-0.52	76.99	0.11
1986	72.62	73.46	0.83	72.71	0.09	72.73	0.11	72.62	0.00	73.11	0.49	73.19	0.56	52.17	0.01
1987	82.19	82.32	0.12	83.14	0.95	82.25	0.05	82.19	0.00	82.21	0.02	83.13	0.94	76.03	0.12
1988	71.23	71.60	0.37	70.50	-0.73	70.74	-0.49	71.23	0.00	71.22	-0.01	70.55	-0.68	74.25	0.03
1989	81.26	81.51	0.25	81.32	0.05	81.35	0.08	81.26	0.00	81.48	0.22	81.23	-0.03	80.11	0.12
1990	79.04	79.43	0.39	78.39	-0.66	79.46	0.41	79.04	0.00	79.08	0.03	78.98	-0.06	76.62	-0.32
1991	84.98	85.38	0.39	85.48	0.497	84.90	-0.08	84.98	0.00	85.41	0.43	85.30	0.32	81.89	0.22
1992	82.70	83.27	0.57	82.92	0.21	83.00	0.30	82.70	0.00	82.72	0.01	82.82	0.12	70.73	0.10
1993	63.89	63.96	0.08	63.85	-0.03	63.81	-0.08	63.89	0.00	63.87	-0.01	63.98	0.10	59.46	0.01
count > + 0.5 Km			20		8		18		0		3		5		4
% > + 0.5km			27.8%		11.1%		25.0%		0.0%		4.2%		6.9%		5.6%
count > - 0.5 Km			3		11		1		0		3		4		1
% > - 0.5km			4.2%		15.3%		1.4%		0.0%		4.2%		5.6%		1.4%
Avg.	71.12	71.45	0.33	71.22	0.10	71.44	0.32	71.12	0.00	71.15	0.03	71.17	0.05	66.05	0.08
Min.	49.72	50.10	-1.37	49.80	-1.57	49.80	-0.74	49.72	0.00	49.77	-1.38	49.75	-1.08	46.49	-1.09
Max.	84.98	85.38	2.35	85.48	2.54	84.90	2.39	84.98	0.00	85.41	1.17	85.30	1.23	82.31	1.26

(1) Compared to No Action

Changes in X2 Position for all Alternatives
March

Year	No Action (Km)	Max. Flow (Km)[1]	difference	Flow Eval. (Km)[1]	difference	70% inflow (Km)[1]	difference	Mech. Rest. (Km)[1]	difference	Revised Mech. (Km)[1]	difference	Mod. % Inflow (Km)[1]	difference	Existing Conditions (2001)	Difference (vs. Pref. Alt. 2001)
1922	66.36	66.65	0.29	66.36	0.00	66.36	0.00	66.36	0.00	66.36	0.00	66.36	0.00	65.7	0.00
1923	71.47	71.51	0.04	71.47	0.00	71.45	-0.02	71.47	0.00	71.47	0.00	71.47	0.00	74.1	0.00
1924	78.01	77.83	-0.18	77.69	-0.32	77.88	-0.13	78.01	0.00	78.00	-0.01	77.64	-0.37	77.0	0.11
1925	63.53	63.71	0.18	63.51	-0.02	63.73	0.20	63.53	0.00	63.35	-0.17	63.51	-0.02	64.8	0.03
1926	67.04	67.21	0.17	66.54	-0.499	67.20	0.16	67.04	0.00	66.59	-0.46	66.81	-0.23	73.6	0.01
1927	54.55	55.35	**0.81**	54.70	0.15	54.63	0.09	54.55	0.00	54.71	0.16	54.52	-0.03	59.3	0.10
1928	72.17	72.39	0.22	72.26	0.09	72.37	0.20	72.17	0.00	72.18	0.00	72.26	0.08	57.3	0.01
1929	77.81	78.01	0.20	77.84	0.03	77.86	0.04	77.81	0.00	77.81	-0.01	77.80	-0.01	77.3	-0.02
1930	72.78	73.12	0.34	72.84	0.06	72.98	0.20	72.78	0.00	72.82	0.03	72.80	0.02	68.1	-0.03
1931	79.13	80.28	**1.15**	79.78	**0.65**	79.52	0.39	79.13	0.00	79.51	0.38	78.95	-0.19	81.5	0.21
1932	70.69	70.84	0.15	70.41	-0.28	70.55	-0.14	70.69	0.00	70.74	0.05	70.69	0.00	73.9	0.03
1933	79.11	78.76	-0.35	77.23	**-1.88**	76.76	**-2.34**	79.11	0.00	79.09	-0.01	77.48	**-1.62**	77.4	0.42
1934	74.78	74.85	0.07	74.59	-0.19	74.95	0.16	74.78	0.00	75.17	0.38	75.19	0.40	75.1	-0.06
1935	73.89	74.04	0.15	73.68	-0.21	74.06	0.18	73.89	0.00	73.89	0.00	73.95	0.06	70.2	0.01
1936	59.34	59.26	-0.08	59.33	-0.01	59.22	-0.11	59.34	0.00	59.33	-0.01	59.21	-0.13	63.7	-0.03
1937	67.24	67.47	0.23	66.91	-0.33	67.31	0.07	67.24	0.00	67.40	0.16	67.06	-0.17	62.0	-0.31
1938	52.13	52.24	0.11	52.17	0.05	52.24	0.11	52.13	0.00	52.09	-0.03	52.10	-0.03	47.1	0.00
1939	77.82	77.11	**-0.71**	77.87	0.06	77.40	-0.41	77.82	0.00	77.66	-0.15	77.72	-0.10	76.8	-0.15
1940	60.93	61.24	0.31	60.93	0.00	61.26	0.33	60.93	0.00	60.95	0.02	60.95	0.02	53.6	0.15
1941	51.11	51.37	0.25	51.16	0.04	51.45	0.33	51.11	0.00	51.07	-0.04	51.10	-0.01	51.5	0.04
1942	50.41	50.55	0.14	50.54	0.13	50.52	0.11	50.41	0.00	50.48	0.07	50.55	0.14	60.8	**0.88**
1943	57.68	57.80	0.12	57.77	0.09	57.91	0.23	57.68	0.00	57.74	0.06	57.78	0.10	53.8	0.00
1944	72.60	72.23	-0.37	72.20	-0.40	72.21	-0.39	72.60	0.00	72.19	-0.41	72.20	-0.40	71.3	**0.81**
1945	66.47	66.49	0.02	66.91	0.43	66.53	0.06	66.47	0.00	66.24	-0.23	66.38	-0.10	67.8	-0.13
1946	64.80	64.81	0.02	64.80	0.00	64.80	0.01	64.80	0.00	64.80	0.00	64.80	0.00	69.1	0.01
1947	76.87	76.27	**-0.60**	76.08	**-0.78**	76.18	**-0.68**	76.87	0.00	76.23	**-0.64**	76.21	**-0.65**	73.5	0.42
1948	77.00	77.07	0.07	77.10	0.10	77.02	0.02	77.00	0.00	77.03	0.03	77.06	0.06	76.0	0.03
1949	80.14	80.10	-0.04	80.18	0.04	79.77	-0.37	80.14	0.00	80.05	-0.09	80.15	0.01	67.1	-0.18
1950	68.05	68.17	0.12	68.13	0.08	68.14	0.09	68.05	0.00	68.07	0.02	68.05	0.01	71.1	0.05
1951	55.26	55.03	-0.23	55.16	-0.10	55.13	-0.13	55.26	0.00	55.11	-0.15	55.19	-0.07	62.8	-0.37
1952	55.19	55.48	0.29	55.36	0.17	55.47	0.28	55.19	0.00	55.28	0.09	55.32	0.13	55.4	0.17
1953	64.17	64.17	0.00	64.17	0.00	64.17	0.00	64.17	0.00	64.17	0.00	64.17	0.00	69.1	0.18
1954	62.23	62.48	0.24	61.91	-0.33	62.08	-0.15	62.23	0.00	61.92	-0.31	61.88	-0.35	60.8	0.11
1955	75.01	75.27	0.26	75.15	0.14	75.26	0.25	75.01	0.00	75.10	0.10	75.11	0.10	78.2	-0.03
1956	52.07	52.07	0.00	52.12	0.05	52.21	0.14	52.07	0.00	52.09	0.02	52.12	0.04	59.6	**-0.61**
1957	70.48	71.42	**0.95**	70.43	-0.05	71.21	**0.74**	70.48	0.00	70.26	-0.21	70.27	-0.21	63.8	-0.09
1958	51.44	51.55	0.11	51.59	0.15	51.68	0.24	51.44	0.00	51.55	0.11	51.56	0.12	51.3	0.05
1959	61.95	62.02	0.07	61.92	-0.03	62.04	0.09	61.95	0.00	61.95	0.00	61.96	0.01	66.4	0.00
1960	71.60	71.42	-0.18	72.27	**0.68**	72.28	**0.69**	71.60	0.00	71.40	-0.19	71.83	0.23	71.8	0.22
1961	70.19	71.78	**1.59**	71.64	**1.45**	72.08	**1.89**	70.19	0.00	70.01	-0.18	70.81	**0.62**	72.4	0.19
1962	66.34	66.36	0.02	66.84	0.49	66.38	0.04	66.34	0.00	66.47	0.13	66.59	0.25	68.1	-0.01
1963	61.95	61.90	-0.05	62.09	0.14	62.28	0.33	61.95	0.00	61.90	-0.05	61.91	-0.05	64.5	0.00
1964	75.32	75.52	0.20	75.48	0.17	75.60	0.29	75.32	0.00	75.35	0.04	75.34	0.03	76.9	0.43
1965	61.27	61.10	-0.16	61.30	0.04	61.30	0.03	61.27	0.00	61.26	-0.01	61.26	-0.01	66.9	0.00
1966	68.20	68.07	-0.13	68.35	0.15	68.54	0.34	68.20	0.00	68.32	0.12	68.31	0.11	68.5	0.38
1967	60.11	60.37	0.26	60.02	-0.09	60.16	0.05	60.11	0.00	60.24	0.13	60.11	0.00	58.0	0.06
1968	61.34	61.01	-0.33	61.30	-0.04	60.88	-0.46	61.34	0.00	61.28	-0.06	61.30	-0.04	62.9	0.00
1969	50.59	50.62	0.02	50.67	0.07	50.67	0.07	50.59	0.00	50.62	0.03	50.64	0.05	54.6	0.08
1970	51.58	51.81	0.24	51.61	0.04	51.57	-0.01	51.58	0.00	51.60	0.03	51.60	0.02	58.8	-0.09
1971	64.59	64.60	0.00	64.60	0.00	64.60	0.00	64.59	0.00	64.60	0.00	64.60	0.00	62.3	0.12
1972	72.48	74.11	**1.64**	73.07	**0.60**	74.91	**2.43**	72.48	0.00	72.53	0.06	72.54	0.06	68.2	0.09
1973	54.42	54.28	-0.14	54.47	0.06	54.73	0.32	54.42	0.00	54.42	0.00	54.45	0.03	56.0	0.38
1974	58.84	59.05	0.21	58.94	0.10	59.00	0.16	58.84	0.00	58.92	0.08	58.92	0.08	52.6	0.34
1975	64.04	64.62	**0.58**	64.48	0.43	64.66	**0.61**	64.04	0.00	64.38	0.34	64.09	0.05	56.2	-0.03
1976	79.30	79.38	0.08	79.33	0.02	79.13	-0.17	79.30	0.00	79.32	0.01	79.36	0.06	77.9	**-0.78**
1977	82.09	82.29	0.20	82.08	0.00	82.10	0.01	82.09	0.00	82.08	-0.01	82.08	-0.01	82.3	-0.04
1978	59.68	60.03	0.35	59.66	-0.02	60.03	0.35	59.68	0.00	59.67	-0.01	59.71	0.03	57.0	0.13
1979	64.93	65.31	0.38	65.13	0.20	65.34	0.42	64.93	0.00	64.81	-0.11	65.16	0.23	64.0	0.01
1980	51.41	51.31	-0.10	51.54	0.13	51.52	0.11	51.41	0.00	51.48	0.07	51.51	0.10	55.7	0.03
1981	69.68	69.46	-0.22	69.84	0.16	70.36	**0.68**	69.68	0.00	69.87	0.18	69.84	0.16	66.6	**0.92**
1982	52.39	52.49	0.10	52.42	0.03	52.53	0.15	52.39	0.00	52.40	0.01	52.40	0.01	52.6	0.01
1983	46.55	46.63	0.08	46.58	0.03	46.59	0.05	46.55	0.00	46.58	0.03	46.58	0.03	42.0	0.00
1984	59.08	59.21	0.13	58.92	-0.17	58.99	-0.09	59.08	0.00	58.89	-0.19	58.89	-0.19	61.5	0.01
1985	76.77	77.07	0.30	76.66	-0.11	76.75	-0.02	76.77	0.00	76.61	-0.16	76.60	-0.17	76.1	0.06
1986	52.20	52.94	**0.74**	52.37	0.17	52.50	0.31	52.20	0.00	52.38	0.18	52.42	0.22	48.1	0.06
1987	74.60	74.44	-0.16	76.05	**1.45**	75.76	**1.16**	74.60	0.00	75.15	**0.56**	76.04	**1.44**	70.9	0.03
1988	74.15	74.21	0.07	74.14	0.00	74.14	0.00	74.15	0.00	74.15	0.00	74.14	0.00	77.8	0.01
1989	80.10	80.17	0.07	80.11	0.01	80.12	0.02	80.10	0.00	80.16	0.06	80.09	-0.01	67.1	0.04
1990	76.51	76.63	0.13	76.29	-0.22	76.64	0.14	76.51	0.00	76.52	0.01	76.49	-0.02	77.3	0.42
1991	82.15	82.16	0.00	82.17	0.02	82.02	-0.14	82.15	0.00	82.13	-0.03	82.21	0.05	70.7	0.32
1992	70.40	70.60	0.20	70.47	0.07	70.50	0.10	70.40	0.00	70.40	0.00	70.44	0.04	71.6	0.04
1993	59.48	59.52	0.04	59.47	-0.01	59.46	-0.02	59.48	0.00	59.47	0.00	59.51	0.03	60.7	-0.07
count			**7**		**5**		**7**		**0**		**1**		**2**		**3**
% > +0.5km			**9.7%**		**6.9%**		**9.7%**		**0.0%**		**1.4%**		**2.8%**		**4.2%**
count > - 0.5 Km			**2**		**2**		**2**		**0**		**1**		**2**		**2**
% > - 0.5km			**2.8%**		**2.8%**		**2.8%**		**0.0%**		**1.4%**		**2.8%**		**2.8%**
Avg.	66.06	66.20	0.15	66.10	0.04	66.19	0.13	66.06	0.00	66.05	0.00	66.06	0.00	65.64	0.07
Min.	46.55	46.63	-0.71	46.58	-1.88	46.59	-2.34	46.55	0.00	46.58	-0.64	46.58	-1.62	42.03	-0.78
Max.	82.15	82.29	1.64	82.17	1.45	82.10	2.43	82.15	0.00	82.13	0.56	82.21	1.44	82.33	0.92

(1) = Compared to No Action

Changes in X2 Position Compared to No Action for all Alternatives
April

Year	No Action (Km)	Max. Flow (Km)[1]	difference	Flow Eval. (Km)[1]	difference	70% inflow (Km)[1]	difference	Mech. Rest. (Km)[1]	difference	Revised Mech. (Km)[1]	difference	Mod. % Inflow (Km)[1]	difference	Existing Conditions (2001)	Difference (vs. Pref. Alt. 2001)
1922	66.26	66.18	-0.08	66.26	0.00	66.26	0.00	66.26	0.00	66.26	0.00	66.26	0.00	66.28	0.01
1923	74.24	74.26	0.02	73.57	-0.67	73.56	-0.68	74.24	0.00	74.24	0.00	73.57	-0.67	68.77	0.02
1924	77.10	77.05	-0.06	77.00	-0.10	77.06	-0.04	77.10	0.00	77.10	0.00	76.99	-0.12	80.24	0.00
1925	64.76	64.82	0.06	64.75	-0.01	64.82	0.07	64.76	0.00	64.70	-0.06	64.75	-0.01	66.94	0.00
1926	72.89	74.00	1.11	74.00	1.11	73.56	0.68	72.89	0.00	73.49	0.60	74.00	1.11	69.86	0.05
1927	59.31	59.36	0.05	59.16	-0.15	59.12	-0.18	59.31	0.00	59.17	-0.14	59.10	-0.20	59.18	0.04
1928	57.78	58.17	0.39	57.77	-0.01	58.21	0.43	57.78	0.00	57.71	-0.07	57.76	-0.03	63.00	-0.04
1929	76.60	76.76	0.16	76.85	0.25	77.49	0.89	76.60	0.00	76.94	0.34	76.77	0.17	79.75	0.00
1930	68.00	68.63	0.63	68.53	0.53	68.47	0.47	68.00	0.00	68.55	0.55	68.55	0.55	73.77	0.00
1931	80.95	81.64	0.69	81.52	0.57	81.25	0.30	80.95	0.00	81.06	0.11	80.84	-0.12	81.25	0.05
1932	73.87	73.08	-0.79	73.77	-0.10	73.82	-0.05	73.87	0.00	73.89	0.02	73.87	0.00	74.95	0.01
1933	77.78	77.70	-0.08	77.16	-0.62	77.02	-0.76	77.78	0.00	77.77	0.00	77.25	-0.53	76.95	0.13
1934	74.99	75.13	0.14	75.05	0.06	75.04	0.05	74.99	0.00	75.24	0.25	75.12	0.13	76.22	-0.02
1935	69.77	69.85	0.07	69.71	-0.07	69.55	-0.23	69.77	0.00	69.77	0.00	69.15	-0.63	61.87	-0.07
1936	63.87	63.26	-0.62	63.81	-0.06	63.70	-0.17	63.87	0.00	63.77	-0.11	63.44	-0.44	66.05	0.01
1937	62.08	62.15	0.07	62.02	-0.06	62.08	0.00	62.08	0.00	62.21	0.13	61.99	-0.09	64.43	-0.16
1938	47.13	47.17	0.04	47.13	0.00	47.17	0.04	47.13	0.00	47.12	-0.01	47.12	-0.01	51.43	0.00
1939	75.46	74.77	-0.69	75.43	-0.03	75.08	-0.38	75.46	0.00	76.15	0.69	75.40	-0.06	76.47	0.23
1940	53.69	53.69	0.00	53.68	-0.01	53.76	0.08	53.69	0.00	53.68	0.00	53.68	-0.01	54.50	0.05
1941	51.61	51.71	0.10	51.63	0.02	51.73	0.12	51.61	0.00	51.60	0.00	51.61	0.01	53.04	0.02
1942	61.93	62.02	0.09	60.85	-1.08	61.98	0.04	61.93	0.00	62.60	0.67	61.04	-0.89	59.18	0.29
1943	53.94	54.06	0.12	53.97	0.03	54.12	0.18	53.94	0.00	53.96	0.02	53.97	0.03	61.03	0.00
1944	71.59	71.49	-0.10	71.47	-0.12	71.50	-0.09	71.59	0.00	71.47	-0.12	71.47	-0.11	73.91	0.31
1945	67.61	67.84	0.22	67.95	0.34	67.79	0.17	67.61	0.00	67.74	0.12	67.78	0.16	71.29	-0.02
1946	69.47	69.44	-0.03	69.80	0.33	69.91	0.45	69.47	0.00	69.50	0.04	69.62	0.15	72.50	0.00
1947	73.58	73.66	0.08	73.57	-0.01	73.61	0.02	73.58	0.00	73.45	-0.14	73.49	-0.09	74.71	0.24
1948	75.30	75.05	-0.25	75.33	0.04	75.31	0.01	75.30	0.00	75.31	0.01	75.32	0.02	69.40	0.03
1949	66.47	66.78	0.31	66.52	0.05	67.46	0.99	66.47	0.00	66.31	-0.16	66.45	-0.02	72.49	-0.19
1950	70.90	70.98	0.08	70.95	0.05	70.94	0.03	70.90	0.00	70.91	0.01	70.91	0.00	70.56	0.00
1951	62.35	62.40	0.04	62.51	0.16	62.51	0.15	62.35	0.00	62.45	0.10	62.50	0.15	68.66	-0.12
1952	55.41	55.61	0.20	55.56	0.16	55.60	0.20	55.41	0.00	55.53	0.13	55.42	0.02	54.87	-0.19
1953	69.17	69.21	0.04	69.18	0.01	69.19	0.02	69.17	0.00	69.18	0.00	69.18	0.01	69.66	1.20
1954	60.71	61.08	0.36	60.61	-0.11	61.08	0.36	60.71	0.00	60.61	-0.10	60.60	-0.11	60.99	0.07
1955	77.60	77.74	0.14	77.55	-0.04	77.99	0.39	77.60	0.00	77.55	-0.05	77.62	0.02	75.33	0.27
1956	59.56	59.06	-0.501	59.42	-0.14	59.52	-0.04	59.56	0.00	59.46	-0.10	59.50	-0.06	65.97	-0.20
1957	63.99	64.22	0.23	63.76	-0.23	64.12	0.13	63.99	0.00	63.70	-0.29	63.71	-0.29	67.67	-0.03
1958	51.41	51.31	-0.10	51.46	0.05	51.50	0.08	51.41	0.00	51.45	0.04	51.45	0.04	50.93	0.02
1959	66.44	66.44	0.00	66.44	0.00	66.44	0.00	66.44	0.00	66.44	0.00	66.44	0.00	74.29	0.00
1960	72.16	72.10	-0.06	72.38	0.22	72.42	0.26	72.16	0.00	72.10	-0.06	72.24	0.08	74.14	0.07
1961	72.19	72.64	0.45	71.98	-0.21	73.47	1.28	72.19	0.00	71.66	-0.53	71.90	-0.29	75.21	0.06
1962	67.99	68.03	0.04	68.14	0.15	68.00	0.01	67.99	0.00	68.16	0.16	68.07	0.08	73.02	0.00
1963	64.54	64.54	0.00	64.54	0.00	64.54	0.00	64.54	0.00	64.54	0.00	64.54	0.00	56.23	0.04
1964	77.61	77.36	-0.26	77.71	0.10	77.75	0.14	77.61	0.00	77.65	0.04	78.08	0.47	75.88	-0.09
1965	66.89	66.88	-0.01	66.89	0.00	66.89	0.00	66.89	0.00	66.89	0.00	66.89	0.00	62.09	-0.01
1966	68.15	67.85	-0.30	68.63	0.49	68.70	0.56	68.15	0.00	68.58	0.43	68.19	0.04	71.31	0.60
1967	58.18	58.41	0.23	58.15	-0.03	58.34	0.16	58.18	0.00	58.22	0.04	58.18	0.00	57.62	0.02
1968	62.73	62.95	0.21	62.72	-0.01	63.07	0.33	62.73	0.00	62.72	-0.02	62.72	-0.01	69.77	0.00
1969	54.63	54.58	-0.06	54.66	0.03	54.58	-0.05	54.63	0.00	54.64	0.01	54.65	0.02	55.72	0.03
1970	58.98	58.96	-0.02	58.88	-0.10	58.98	0.01	58.98	0.00	58.88	-0.10	58.87	-0.10	67.60	-0.01
1971	62.64	62.14	-0.51	63.02	0.37	63.41	0.76	62.64	0.00	62.98	0.34	62.69	0.05	66.56	-0.85
1972	68.19	69.51	1.32	68.39	0.20	70.03	1.83	68.19	0.00	68.21	0.02	68.22	0.02	74.00	0.00
1973	56.44	56.10	-0.34	56.52	0.08	56.61	0.17	56.44	0.00	56.50	0.06	56.45	0.01	65.86	0.13
1974	52.81	52.84	0.02	52.85	0.03	52.87	0.05	52.81	0.00	52.84	0.03	52.84	0.03	53.81	0.13
1975	56.18	56.31	0.13	56.12	-0.06	56.19	0.02	56.18	0.00	56.28	0.10	56.16	-0.02	62.58	1.00
1976	76.89	76.95	0.06	76.90	0.01	76.87	-0.02	76.89	0.00	76.89	0.00	76.91	0.02	78.00	0.39
1977	82.28	82.32	0.05	82.28	0.00	82.28	0.00	82.28	0.00	82.28	0.00	82.28	0.00	81.21	-0.01
1978	56.93	56.44	-0.48	56.88	-0.05	57.04	0.11	56.93	0.00	56.92	0.00	56.93	0.00	58.72	0.05
1979	64.32	64.68	0.35	64.33	0.00	64.62	0.29	64.32	0.00	64.28	-0.04	64.38	0.06	67.83	0.02
1980	55.67	55.27	-0.40	55.74	0.07	55.34	-0.34	55.67	0.00	55.72	0.05	55.73	0.06	64.26	0.02
1981	66.30	67.69	1.39	66.91	0.61	68.24	1.94	66.30	0.00	66.52	0.22	66.55	0.25	69.62	1.44
1982	52.22	52.38	0.16	52.23	0.01	52.35	0.13	52.22	0.00	52.22	0.00	52.22	0.00	48.45	0.00
1983	42.08	42.14	0.06	42.09	0.01	42.09	0.02	42.08	0.00	42.09	0.01	42.09	0.01	48.61	0.01
1984	61.79	61.30	-0.49	61.74	-0.06	61.96	0.17	61.79	0.00	61.72	-0.07	61.72	-0.07	67.86	0.00
1985	75.23	75.36	0.13	75.55	0.32	75.59	0.36	75.23	0.00	75.53	0.30	75.53	0.30	74.97	0.02
1986	48.21	48.44	0.24	48.26	0.05	48.30	0.10	48.21	0.00	48.27	0.06	48.28	0.07	60.38	0.02
1987	69.94	71.04	1.10	70.94	0.99	69.53	-0.42	69.94	0.00	69.06	-0.88	70.92	0.98	74.14	0.00
1988	77.75	77.76	0.02	77.74	0.00	77.74	0.00	77.75	0.00	77.75	0.00	77.74	0.00	78.56	1.21
1989	67.47	67.13	-0.33	67.38	-0.09	67.45	-0.02	67.47	0.00	67.38	-0.09	67.29	-0.18	69.45	0.02
1990	77.55	77.37	-0.18	77.04	-0.51	77.70	0.15	77.55	0.00	77.10	-0.45	77.53	-0.02	77.07	0.13
1991	70.83	70.98	0.15	70.84	0.01	70.79	-0.04	70.83	0.00	70.58	-0.25	70.85	0.02	73.31	0.43
1992	71.07	71.16	0.09	71.10	0.02	71.11	0.04	71.07	0.00	71.08	0.00	71.09	0.02	74.81	0.01
1993	60.53	61.49	0.96	60.48	-0.05	61.46	0.93	60.53	0.00	60.64	0.11	60.47	-0.06	61.37	-0.02
count			8		5		9		0		4		2		5
% > +0.5km			11.1%		6.9%		12.5%		0.0%		5.6%		2.8%		6.9%
count > - 0.5 Km			5		4		2		0		1		4		1
% > - 0.5km			6.9%		5.6%		2.8%		0.0%		1.4%		5.6%		1.4%
Avg.	65.60	65.68	0.08	65.63	0.04	65.77	0.18	65.60	0.00	65.62	0.03	65.60	0.00	67.62	0.10
Min.	42.08	42.14	-0.79	42.09	-1.08	42.09	-0.76	42.08	0.00	42.09	-0.88	42.09	-0.89	48.45	-0.85
Max.	82.28	82.32	1.39	82.28	1.11	82.28	1.94	82.28	0.00	82.28	0.69	82.28	1.11	81.25	1.44

(1) = Compared to No Action

Changes in X2 Position Compared to No Action for all Alternatives

May

Year	No Action (Km)	Max. Flow (Km)(1)	difference	Flow Eval. (Km)(1)	difference	70% inflow (Km)(1)	difference	Mech. Rest. (Km)(1)	difference	Revised Mech. (Km)(1)	difference	Mod. % Inflow (Km)(1)	difference	Existing Conditions (2001)	Difference (vs. Pref. Alt. 2001)
1922	66.77	66.65	-0.11	66.78	0.01	66.78	0.02	66.77	0.00	66.77	0.00	66.78	0.01	60.77	0.01
1923	68.85	68.41	-0.43	68.64	-0.20	68.69	-0.16	68.85	0.00	68.85	0.00	68.64	-0.20	70.25	-0.49
1924	80.29	80.28	0.00	80.28	0.00	80.28	0.00	80.29	0.00	80.29	0.00	80.28	-0.01	84.76	-0.02
1925	66.70	66.84	0.14	66.69	0.00	66.81	0.11	66.70	0.00	66.68	-0.01	65.60	-1.09	70.82	-0.04
1926	68.51	69.60	1.10	69.70	1.19	69.86	1.35	68.51	0.00	69.15	0.64	69.67	1.17	73.55	0.38
1927	59.13	59.18	0.05	59.08	-0.05	59.09	-0.03	59.13	0.00	59.08	-0.05	59.06	-0.07	64.27	0.01
1928	63.61	63.39	-0.22	63.27	-0.34	63.40	-0.21	63.61	0.00	63.25	-0.36	63.27	-0.34	68.46	-0.01
1929	79.58	79.62	0.04	79.65	0.07	79.81	0.23	79.58	0.00	79.67	0.09	79.62	0.04	81.00	0.00
1930	73.21	73.49	0.28	73.33	0.12	73.43	0.22	73.21	0.00	73.41	0.20	73.40	0.19	75.87	-0.01
1931	81.13	81.30	0.17	81.27	0.14	81.20	0.07	81.13	0.00	81.15	0.03	81.10	-0.03	84.18	0.07
1932	74.82	74.34	-0.49	74.65	-0.17	74.55	-0.27	74.82	0.00	74.60	-0.22	74.75	-0.07	74.56	0.63
1933	77.06	77.04	-0.02	76.87	-0.19	76.82	-0.24	77.06	0.00	77.06	0.00	76.89	-0.17	81.11	0.03
1934	76.19	76.23	0.05	76.20	0.02	76.20	0.02	76.19	0.00	76.26	0.08	76.23	0.04	81.00	0.00
1935	61.65	61.91	0.26	61.64	-0.01	61.63	-0.02	61.65	0.00	61.65	0.00	61.39	-0.26	64.36	0.00
1936	66.05	65.76	-0.30	65.89	-0.17	65.89	-0.16	66.05	0.00	65.87	-0.18	65.74	-0.32	69.03	0.15
1937	64.45	64.55	0.10	64.52	0.07	64.56	0.11	64.45	0.00	64.60	0.15	64.50	0.05	67.99	-0.15
1938	51.38	51.30	-0.09	51.40	0.02	51.29	-0.09	51.38	0.00	51.27	-0.11	51.27	-0.11	53.00	0.03
1939	76.29	76.12	-0.18	75.74	-0.55	76.03	-0.26	76.29	0.00	76.52	0.22	76.27	-0.02	76.83	0.42
1940	54.43	54.53	0.10	54.52	0.09	54.55	0.12	54.43	0.00	54.52	0.09	54.52	0.09	65.04	0.01
1941	53.09	53.05	-0.04	53.02	-0.07	53.05	-0.04	53.09	0.00	53.01	-0.08	53.01	-0.08	57.58	0.23
1942	59.36	59.57	0.20	59.13	-0.23	59.55	0.19	59.36	0.00	59.70	0.34	59.19	-0.17	60.82	0.21
1943	61.05	60.98	-0.07	60.94	-0.12	60.99	-0.06	61.05	0.00	60.93	-0.12	60.94	-0.12	65.59	0.00
1944	73.11	73.69	0.57	73.38	0.26	73.85	0.74	73.11	0.00	73.38	0.26	73.38	0.27	75.52	0.45
1945	71.23	71.00	-0.23	70.91	-0.33	70.93	-0.31	71.23	0.00	70.83	-0.40	70.85	-0.39	72.17	0.01
1946	72.08	72.55	0.47	72.67	0.58	72.70	0.62	72.08	0.00	72.57	0.49	72.61	0.53	73.16	0.00
1947	74.43	74.64	0.22	73.91	-0.52	74.86	0.44	74.43	0.00	74.52	0.10	74.56	0.13	77.62	-0.77
1948	68.99	69.05	0.06	69.03	0.04	69.06	0.07	68.99	0.00	68.97	-0.02	68.98	-0.01	66.88	-0.01
1949	72.15	71.46	-0.69	71.44	-0.72	72.42	0.27	72.15	0.00	71.39	-0.76	71.48	-0.67	74.27	-0.06
1950	70.34	70.29	-0.04	70.38	0.04	70.35	0.02	70.34	0.00	70.32	-0.01	70.34	0.01	71.14	-0.12
1951	68.88	68.08	-0.79	68.55	-0.33	68.54	-0.33	68.88	0.00	68.52	-0.35	68.54	-0.34	68.78	0.43
1952	54.79	55.20	0.41	55.09	0.30	55.24	0.45	54.79	0.00	55.21	0.43	54.99	0.21	54.12	0.48
1953	70.56	70.63	0.07	70.58	0.01	70.65	0.08	70.56	0.00	70.57	0.01	70.57	0.01	67.61	0.48
1954	60.97	61.59	0.61	60.97	0.00	61.58	0.61	60.97	0.00	60.94	-0.03	61.13	0.16	65.72	0.00
1955	75.51	76.04	0.53	75.77	0.26	75.34	-0.17	75.51	0.00	75.76	0.25	75.75	0.23	76.40	0.07
1956	65.95	65.55	-0.40	65.60	-0.35	65.69	-0.26	65.95	0.00	65.61	-0.34	65.63	-0.32	62.05	0.40
1957	67.73	67.80	0.07	67.66	-0.07	67.77	0.04	67.73	0.00	67.64	-0.09	67.64	-0.09	70.23	0.00
1958	50.83	50.80	-0.03	50.91	0.08	50.93	0.09	50.83	0.00	50.91	0.07	50.91	0.08	55.40	0.14
1959	74.13	74.30	0.18	74.13	0.01	74.14	0.01	74.13	0.00	74.13	0.00	74.13	0.00	76.76	-0.18
1960	74.25	74.23	-0.02	74.32	0.07	74.34	0.09	74.25	0.00	74.23	-0.02	74.28	0.03	75.60	-0.02
1961	75.15	75.29	0.14	75.08	-0.07	75.55	0.41	75.15	0.00	74.98	-0.17	75.05	-0.09	77.02	0.32
1962	72.92	73.08	0.17	72.97	0.05	72.92	0.01	72.92	0.00	72.97	0.06	72.94	0.03	74.20	0.00
1963	56.13	55.96	-0.17	56.13	0.00	56.00	-0.13	56.13	0.00	56.11	-0.02	56.11	-0.02	61.20	0.01
1964	75.29	76.05	0.75	73.67	-1.63	73.66	-1.63	75.29	0.00	75.29	0.00	75.28	-0.01	75.88	0.57
1965	61.83	61.74	-0.09	61.89	0.06	62.12	0.29	61.83	0.00	61.94	0.11	61.78	-0.05	65.54	0.00
1966	72.07	71.78	-0.29	72.59	0.52	73.40	1.33	72.07	0.00	72.21	0.14	72.52	0.45	74.21	0.19
1967	57.68	57.65	-0.03	57.56	-0.12	57.62	-0.06	57.68	0.00	57.58	-0.10	57.57	-0.11	57.04	0.26
1968	69.74	69.78	0.04	69.74	0.00	69.81	0.07	69.74	0.00	69.74	0.00	69.74	0.00	75.85	0.01
1969	55.94	55.91	-0.04	56.01	0.06	55.91	-0.03	55.94	0.00	56.00	0.06	56.00	0.06	54.95	0.35
1970	67.62	67.61	0.00	67.61	-0.01	67.62	0.00	67.62	0.00	67.61	-0.01	67.61	-0.01	73.20	-0.75
1971	66.57	66.54	-0.03	66.63	0.05	66.75	0.17	66.57	0.00	66.61	0.04	66.57	0.00	65.16	0.94
1972	73.88	73.29	-0.60	74.00	0.12	73.46	-0.42	73.88	0.00	73.89	0.00	73.89	0.00	77.77	0.00
1973	65.54	65.79	0.24	65.92	0.37	65.95	0.41	65.54	0.00	65.91	0.36	65.90	0.35	69.12	0.06
1974	53.99	54.00	0.01	53.93	-0.06	54.01	0.02	53.99	0.00	53.91	-0.08	53.97	-0.02	62.02	0.46
1975	63.00	63.30	0.30	63.24	0.23	63.26	0.26	63.00	0.00	63.29	0.28	63.25	0.25	63.48	0.85
1976	77.70	77.68	-0.02	77.70	0.00	77.67	-0.03	77.70	0.00	77.70	0.00	77.70	0.00	84.19	0.12
1977	81.20	81.21	0.01	81.20	0.00	81.20	0.00	81.20	0.00	81.20	0.00	81.20	0.00	84.59	0.01
1978	58.22	59.07	0.84	58.55	0.32	58.68	0.46	58.22	0.00	58.63	0.41	58.59	0.37	63.64	0.01
1979	68.00	68.41	0.42	68.35	0.36	68.46	0.47	68.00	0.00	68.33	0.34	68.37	0.37	70.58	0.04
1980	64.26	64.02	-0.24	64.14	-0.12	64.03	-0.23	64.26	0.00	64.13	-0.13	64.13	-0.12	68.02	0.496
1981	70.02	69.89	-0.13	70.20	0.19	70.64	0.62	70.02	0.00	70.09	0.07	70.10	0.08	75.59	-0.82
1982	48.55	48.65	0.10	48.60	0.05	48.64	0.09	48.55	0.00	48.60	0.05	48.60	0.05	55.56	-0.13
1983	48.70	48.73	0.03	48.62	-0.08	48.71	0.01	48.70	0.00	48.61	-0.09	48.66	-0.04	51.59	0.02
1984	67.89	67.84	-0.05	67.88	-0.01	67.90	0.02	67.89	0.00	67.88	-0.01	67.88	-0.01	72.36	0.00
1985	74.06	74.39	0.33	74.62	0.56	74.64	0.58	74.06	0.00	74.60	0.54	74.60	0.54	75.92	0.18
1986	60.58	60.43	-0.15	60.35	-0.23	60.37	-0.21	60.58	0.00	60.35	-0.22	60.36	-0.22	68.33	-0.55
1987	74.13	74.14	0.01	74.14	0.01	74.13	0.00	74.13	0.00	74.13	0.00	74.14	0.01	77.70	-0.01
1988	79.17	79.23	0.06	78.95	-0.22	79.21	0.05	79.17	0.00	78.02	-1.15	78.38	-0.78	80.76	0.24
1989	69.80	69.86	0.05	69.78	-0.02	69.87	0.06	69.80	0.00	69.80	0.00	69.76	-0.04	74.13	0.00
1990	77.14	77.08	-0.06	76.98	-0.16	77.19	0.05	77.14	0.00	77.00	-0.14	77.13	-0.01	81.54	0.25
1991	72.56	73.01	0.45	72.87	0.31	72.99	0.43	72.56	0.00	72.48	-0.08	72.71	0.15	78.01	0.14
1992	74.73	74.73	0.00	74.26	-0.47	74.41	-0.32	74.73	0.00	73.97	-0.76	74.73	0.00	79.51	0.36
1993	61.35	61.78	0.43	61.41	0.06	61.74	0.40	61.35	0.00	61.41	0.06	61.39	0.04	63.66	-0.35
count			6		4		6		0		2		3		4
% > +0.5km			8.3%		5.6%		8.3%		0.0%		2.8%		4.2%		5.6%
count > - 0.5 Km			3		4		2		0		2		3		4
% > - 0.5km			4.2%		5.6%		2.8%		0.0%		2.8%		4.2%		5.6%
Avg.	67.57	67.62	0.06	67.56	-0.01	67.66	0.09	67.57	0.00	67.57	0.00	67.56	-0.01	70.37	0.08
Min.	48.55	48.65	0.10	48.60	0.05	48.64	0.09	48.55	0.00	48.60	0.05	48.60	0.05	51.59	-0.82
Max.	81.20	81.30	0.10	81.27	0.07	81.20	0.00	81.20	0.00	81.20	0.00	81.20	0.00	84.76	0.94

(1) = Compared to No Action

Changes in X2 Position Compared to No Action for all Alternatives

June

Year	No Action (Km)	Max. Flow (Km)(1)	difference	Flow Eval. (Km)(1)	difference	70% inflow (Km)(1)	difference	Mech. Rest. (Km)(1)	difference	Revised Mech. (Km)(1)	difference	Mod. % Inflow (Km)(1)	difference	Existing Conditions (2001)	Difference (vs. Pref. Alt. 2001)
1922	61.22	61.25	0.03	61.24	0.02	61.24	0.02	61.22	0.00	61.22	0.00	61.24	0.01	61.57	0.00
1923	70.82	70.33	-0.48	70.75	-0.07	70.23	-0.58	70.82	0.00	70.82	0.00	70.75	-0.07	76.17	-1.69
1924	84.89	84.73	-0.16	84.89	0.01	84.91	0.02	84.89	0.00	84.89	0.00	84.88	-0.01	84.43	0.04
1925	71.16	70.25	-0.91	70.01	-1.14	71.28	0.12	71.16	0.00	71.17	0.01	70.78	-0.38	76.04	0.00
1926	73.14	73.98	0.84	73.80	0.66	73.91	0.77	73.14	0.00	73.62	0.49	73.74	0.60	81.00	0.00
1927	64.48	64.51	0.03	64.46	-0.02	64.47	-0.01	64.48	0.00	64.46	-0.02	64.46	-0.02	72.72	0.00
1928	68.64	68.57	-0.06	68.54	-0.10	68.58	-0.06	68.64	0.00	68.53	-0.11	68.54	-0.10	78.25	0.00
1929	80.94	81.00	0.06	81.00	0.06	81.00	0.06	80.94	0.00	80.97	0.03	81.00	0.06	82.02	0.00
1930	76.19	76.11	-0.07	76.26	0.08	75.88	-0.30	76.19	0.00	76.30	0.12	76.29	0.11	80.21	-0.01
1931	84.15	84.21	0.06	84.15	0.00	84.55	0.40	84.15	0.00	84.53	0.38	84.52	0.37	84.55	-0.02
1932	76.14	75.29	-0.85	75.56	-0.58	76.19	0.06	76.14	0.00	76.06	-0.07	75.43	-0.71	75.90	0.20
1933	81.14	81.10	-0.04	81.09	-0.04	80.33	-0.81	81.14	0.00	81.09	-0.05	81.07	-0.07	82.05	0.01
1934	81.00	81.00	0.00	81.00	0.00	81.00	0.00	81.00	0.00	81.00	0.00	81.00	0.00	81.00	0.00
1935	64.35	64.36	0.00	64.35	0.00	64.35	0.00	64.35	0.00	64.35	0.00	64.35	0.00	71.89	-0.02
1936	69.62	69.15	-0.46	69.16	-0.46	69.20	-0.42	69.62	0.00	69.10	-0.52	69.08	-0.54	75.88	0.02
1937	67.07	67.73	0.65	67.56	0.49	67.74	0.67	67.07	0.00	67.52	0.45	67.71	0.64	74.12	0.00
1938	53.18	53.09	-0.09	53.12	-0.06	53.09	-0.09	53.18	0.00	53.08	-0.10	53.08	-0.10	57.49	0.38
1939	77.13	77.23	0.11	76.97	-0.16	77.45	0.33	77.13	0.00	77.16	0.03	77.01	-0.12	81.86	-0.17
1940	64.96	65.15	0.19	65.14	0.17	65.16	0.19	64.96	0.00	65.14	0.17	65.14	0.17	74.17	0.22
1941	57.65	58.11	0.45	57.73	0.07	58.11	0.45	57.65	0.00	57.50	-0.15	57.83	0.18	67.47	0.02
1942	60.69	61.36	0.67	60.94	0.25	61.33	0.65	60.69	0.00	61.13	0.44	60.96	0.27	65.54	0.81
1943	65.79	65.52	-0.27	65.52	-0.27	65.53	-0.27	65.79	0.00	65.52	-0.27	65.52	-0.27	75.97	-2.21
1944	74.47	76.04	1.57	75.63	1.16	75.79	1.32	74.47	0.00	75.63	1.16	75.63	1.17	78.11	0.66
1945	73.16	72.29	-0.87	72.52	-0.64	72.71	-0.45	73.16	0.00	72.50	-0.66	72.59	-0.57	75.97	0.00
1946	72.90	73.37	0.47	73.51	0.61	73.52	0.62	72.90	0.00	73.47	0.57	73.48	0.58	76.62	0.00
1947	77.70	77.37	-0.33	77.47	-0.23	77.84	0.13	77.70	0.00	76.95	-0.76	77.65	-0.05	79.81	0.07
1948	67.10	67.01	-0.09	67.07	-0.03	67.13	0.03	67.10	0.00	67.01	-0.08	67.01	-0.08	72.23	0.08
1949	74.17	73.16	-1.01	73.20	-0.97	74.26	0.09	74.17	0.00	73.22	-0.96	73.25	-0.92	78.10	-0.02
1950	71.33	70.93	-0.40	71.01	-0.32	71.21	-0.11	71.33	0.00	71.24	-0.09	71.26	-0.07	74.27	0.00
1951	69.64	68.86	-0.78	69.63	-0.01	69.58	-0.06	69.64	0.00	69.56	-0.08	69.63	-0.01	75.49	0.59
1952	54.24	54.81	0.57	54.77	0.53	54.91	0.67	54.24	0.00	54.64	0.40	54.64	0.40	58.57	0.23
1953	67.93	68.39	0.45	68.03	0.10	68.40	0.47	67.93	0.00	68.02	0.09	68.02	0.09	69.66	1.66
1954	65.72	65.74	0.02	65.72	0.00	65.74	0.02	65.72	0.00	65.72	0.00	65.72	0.01	76.89	-0.85
1955	75.93	76.54	0.62	75.99	0.07	75.96	0.04	75.93	0.00	75.99	0.07	75.96	0.04	79.31	0.02
1956	62.30	62.98	0.67	62.70	0.40	63.01	0.71	62.30	0.00	62.31	0.01	62.81	0.51	69.80	0.18
1957	69.45	69.37	-0.07	69.43	-0.02	69.48	0.04	69.45	0.00	69.42	-0.03	69.43	-0.02	75.49	0.00
1958	55.26	55.79	0.53	55.57	0.31	55.81	0.55	55.26	0.00	55.44	0.18	55.65	0.39	60.80	0.87
1959	76.79	76.72	-0.07	76.68	-0.12	76.49	-0.31	76.79	0.00	76.78	-0.02	76.77	-0.03	77.81	-0.09
1960	75.23	75.49	0.26	75.24	0.00	75.54	0.30	75.23	0.00	75.16	-0.07	75.23	0.00	80.80	0.00
1961	77.26	76.56	-0.70	76.50	-0.76	76.96	-0.30	77.26	0.00	76.59	-0.67	77.16	-0.10	81.00	-1.32
1962	73.59	73.64	0.06	74.20	0.62	73.59	0.00	73.59	0.00	74.20	0.62	74.19	0.61	79.19	-1.34
1963	61.60	61.36	-0.24	61.42	-0.18	61.39	-0.21	61.60	0.00	61.41	-0.19	61.41	-0.19	71.14	0.00
1964	76.77	76.76	-0.01	75.75	-1.02	75.74	-1.03	76.77	0.00	76.76	-0.01	76.79	0.02	80.05	-0.39
1965	65.53	65.53	0.00	65.53	0.00	65.54	0.01	65.53	0.00	65.54	0.00	65.53	0.00	75.29	0.00
1966	73.66	73.81	0.15	74.46	0.80	74.74	1.09	73.66	0.00	73.70	0.04	73.82	0.16	77.26	0.01
1967	57.20	57.30	0.11	57.27	0.07	57.29	0.09	57.20	0.00	57.21	0.01	57.27	0.07	58.70	0.64
1968	75.77	75.26	-0.51	75.77	0.00	75.80	0.03	75.77	0.00	75.77	0.00	75.77	0.00	77.82	-0.13
1969	55.03	55.49	0.46	55.54	0.505	55.51	0.48	55.03	0.00	55.19	0.16	55.27	0.24	59.97	0.25
1970	73.50	72.48	-1.02	72.98	-0.52	72.99	-0.52	73.50	0.00	72.98	-0.52	72.98	-0.52	77.63	0.60
1971	66.13	65.47	-0.65	65.78	-0.34	65.83	-0.30	66.13	0.00	65.64	-0.48	65.71	-0.41	71.65	1.04
1972	77.56	77.31	-0.25	77.77	0.20	77.57	0.01	77.56	0.00	77.56	0.00	77.55	-0.01	76.24	-0.05
1973	68.92	69.40	0.49	69.54	0.63	69.56	0.64	68.92	0.00	69.53	0.62	69.53	0.62	74.26	0.00
1974	62.39	62.50	0.11	62.47	0.08	62.50	0.11	62.39	0.00	62.21	-0.18	62.48	0.09	69.34	0.78
1975	63.69	64.68	1.00	64.59	0.90	64.67	0.98	63.69	0.00	64.41	0.72	64.56	0.88	68.33	0.85
1976	84.09	83.94	-0.15	83.69	-0.40	83.85	-0.24	84.09	0.00	83.70	-0.39	83.70	-0.40	85.42	0.47
1977	84.61	84.45	-0.17	84.60	-0.01	84.58	-0.03	84.61	0.00	84.61	-0.01	84.61	-0.01	84.59	-0.11
1978	63.92	63.92	0.00	63.69	-0.23	63.78	-0.14	63.92	0.00	63.72	-0.21	63.70	-0.22	69.62	0.00
1979	70.88	71.48	0.59	71.42	0.54	71.57	0.69	70.88	0.00	71.41	0.52	71.42	0.54	74.42	0.00
1980	68.29	67.78	-0.51	67.81	-0.48	68.30	0.01	68.29	0.00	67.80	-0.49	67.81	-0.48	74.94	0.16
1981	75.74	75.40	-0.34	75.80	0.06	75.94	0.20	75.74	0.00	75.76	0.03	75.77	0.03	81.00	0.00
1982	54.77	54.98	0.21	54.95	0.17	54.96	0.19	54.77	0.00	55.06	0.29	55.06	0.29	63.99	-0.01
1983	51.77	51.94	0.17	51.62	-0.15	51.89	0.12	51.77	0.00	51.59	-0.18	51.61	-0.15	52.27	0.01
1984	71.77	72.44	0.68	72.46	0.69	72.48	0.71	71.77	0.00	72.46	0.69	72.46	0.69	76.59	0.00
1985	75.94	76.02	0.08	76.13	0.19	76.13	0.19	75.94	0.00	76.12	0.18	76.12	0.18	80.78	-0.13
1986	68.12	68.08	-0.04	67.53	-0.59	67.53	-0.59	68.12	0.00	67.53	-0.58	67.54	-0.58	74.46	-0.56
1987	77.59	78.93	1.35	78.45	0.87	77.86	0.27	77.59	0.00	77.44	-0.15	78.44	0.85	80.86	0.14
1988	81.00	80.98	-0.02	80.99	-0.01	81.00	0.00	81.00	0.00	80.77	-0.23	81.00	0.00	81.00	0.00
1989	74.13	74.13	0.00	74.13	0.00	74.13	0.00	74.13	0.00	74.13	0.00	74.13	0.00	80.28	-0.59
1990	80.05	81.34	1.29	80.23	0.18	80.31	0.26	80.05	0.00	80.06	0.00	80.19	0.13	85.27	-0.04
1991	77.45	77.86	0.40	77.81	0.35	77.59	0.14	77.45	0.00	77.42	-0.03	77.50	0.05	84.19	0.05
1992	80.29	80.34	0.05	80.23	-0.06	80.27	-0.02	80.29	0.00	80.05	-0.24	79.94	-0.35	81.00	0.00
1993	62.67	63.54	0.87	63.17	0.50	63.49	0.82	62.67	0.00	62.69	0.02	62.66	0.00	68.31	-0.10
count			14		13		14		0		7		11		10
% > +0.5km			19.4%		18.1%		19.4%		0.0%		9.7%		15.3%		13.9%
count > - 0.5 Km			10		8		5		0		7		6		7
% > - 0.5km			13.9%		11.1%		6.9%		0.0%		9.7%		8.3%		9.7%
Avg.	70.41	70.47	0.07	70.44	0.03	70.53	0.12	70.41	0.00	70.41	0.00	70.46	0.05	74.96	4.52
Min.	51.77	51.94	0.17	51.62	-0.15	51.89	0.12	51.77	0.00	51.59	-0.18	51.61	-0.15	52.27	0.66
Max.	84.89	84.73	-0.16	84.89	0.01	84.91	0.02	84.89	0.00	84.89	0.00	84.88	-0.01	85.42	0.53

(1) = Compared to No Action