Fishery Resources

Appendix B

Trinity River Mainstem
Fishery Restoration

October 1999

Go To TOC

CONTENTS

CONTENTS, CONTINUED

Page

Tables

CONTENTS, CONTINUED

CONTENTS, CONTINUED

CONTENTS, CONTINUED

Figures

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-2. 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-2). A description of sportfishing activity along the Trinity River is presented in the Recreation Technical Appendix D.

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-3. (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.

Go To TOC

- 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, 1997). (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).

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

Go To TOC

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 1996, CDFG estimated that total spring chinook spawner escapements, upstream of the Junction City weir, have averaged approximately 14,200 and have ranged from approximately 2,000-54,000 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). Escapement estimates for the years 1982 through 1997 (excluding 1983 and 1995) indicated that an average of 65 percent of the inriver spawner escapement of Trinity River spring chinook salmon were hatchery produced (Table B-4). Conversely, only 35 percent (2,370 annually) were naturally produced, which represents approximately 40 percent of the TRRP goal of 6,000 spring chinook in the Trinity River.

Fall Chinook Salmon. Annual pre-dam estimates averaged 45,700 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 45,700 would represent approximately 23,100 adults and jacks in the Trinity River upstream of Lewiston, and 22,600 adults and jacks from the North Fork to Lewiston prior to construction of the dams (Table B-5).

CDFG's 1978 through 1997 fall chinook salmon run-size estimates for the Trinity River Basin upstream of the Willow Creek weir have averaged approximately 44,100 adults and jacks (Table B-4) 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-4, the average annual inriver spawner escapement estimate is approximately 34,670 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-4 provides an estimate of Trinity River naturally and hatchery-produced fall chinook salmon spawner escapement for the years 1982 through 1997(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 1997 averaged 34,670 fall chinook salmon, of which an average of 22,440 fish are hatchery-produced fish. Naturally produced fish have ranged from 10-94 percent of inriver spawner escapements, with an average of 47 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 1982-1997 mean annual estimated naturally produced spawner escapement upstream of Willow Creek is 12,230, approximately 20 percent of the restoration goal of 62,000 naturally produced fall chinook salmon for the Trinity River Basin (Table B-5). 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, inriver 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 1997 are shown in Attachment B1, Table B1-3 (California Department of Fish and Game, 1997; U.S. Fish and Wildlife Service, 1998).

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 inriver 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 total annual average coho basin escapement for the Trinity River below Lewiston Dam for 1973 through 1980 was approximately 3,300 adults.

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 1978 through 1996 are shown in Table B-4. Since 1978, CDFG has estimated that coho inriver escapements have ranged from approximately 850 (1994) to 55,700 (1987) (Attachment B1, Table B1-4), with an annual average of 16,400 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 through 1995 have been made (U.S. Fish and Wildlife Service, 1998). Table B-4 shows the average estimated spawner escapement of naturally and hatchery-produced coho salmon for the years 1991 through 1995. From 1991 through 1995 naturally produced coho salmon spawning in the Trinity River upstream of the Willow Creek weir averaged 200 fish, ranging from 0-14 percent of the total annual escapement (an annual average of 3 percent). Approximately 8,100 of the coho salmon spawning inriver are produced by the hatchery.

The summary of estimated naturally and hatchery-produced coho spawner escapements is shown in Attachment B1, Table B1-4. This average is greatly influenced by the year 1992 when an estimated 928 naturally produced coho salmon returned to the river to spawn. In 3 of the 5 years, none of the returning coho were attributable to natural production.

The estimated 200 naturally produced coho spawning in the mainstem Trinity River upstream of the Willow Creek weir represents approximately 14 percent of the restoration program spawner escapement goal of 1,400 for naturally produced adult coho (Table B-5).

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 1996 (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 9,700 (California Department of Fish and Game, 1997). 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 through 1996 were made by the CDFG (1998). On the average for those years, approximately 4,400 naturally produced winter steelhead spawned in the Trinity River upstream of the Willow Creek weir (Table B-4). 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 1992-1996 was 1,870 fish. The overall average (4,400) represents approximately 11 percent of the restoration goal of 40,000 adult steelhead, while the 1992-1996 average represents 5 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.

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 (NMFS), the Southern Oregon/Northern California evolutionarily significant unit (ESU) 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, NMFS extended the period of review and final determination of this ESU's proposed listing for 6 months until April 25, 1997. On April 25, 1997, NMFS 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, NMFS 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 February 7, 1998, when NMFS determined that this species did not warrant listing as threatened at that time; however, it is still considered a candidate species pursuant to the ESA.

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.

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-6). 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-6). 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-6). 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-6).

Go To TOC

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-6) (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 1996 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-7).

- Hatchery production goals are not to be exceeded (Table B-7).

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, NMFS, 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/inriver fisheries, respectively. The mixed-stock ocean population is harvested by commercial and sport fisheries; and the inriver 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 salmon harvest has been prohibited along virtually the entire west coast since 1994. Steelhead are rarely caught in the ocean commercial and sport fisheries, but are harvested by the inriver 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. Information on tribal fisheries is presented in the Tribal Trust section (3.6).

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] 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].)

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.

<u>Food Production</u>. 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.

<u>Habitat Restoration Projects</u>. Since the early 1980s, the Trinity River Basin Fish and Wildlife Restoration Program conducted a variety of restoration activities in the mainstem Trinity

Go To TOC

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.

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. Information on tribal fisheries is presented in the Tribal Trust section (3.6).

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.

This section describes 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. These regions are defined as follows:

- Northern/Central Oregon: Ledbetter Point, Washington, to Humbug Mountain, Oregon, including the port areas of Columbia River, Tillamook, Newport, and Coos Bay. Counties within this region include Clatsop, Tillamook, Lincoln, Lane, Douglas, and Coos.
- Klamath Management Zone (KMZ)-Oregon: Humbug Mountain, Oregon, to Point St. George, California, including the port area of Brookings in Curry County.
- Klamath Management Zone (KMZ)-California: Point St. George to Horse Mountain, California, including the port areas of Crescent City and Eureka. Counties within this region include Del Norte and Humboldt.
- Mendocino: Horse Mountain to Point Arena, California, including the port area of Fort Bragg in Mendocino County.
- San Francisco: Point Arena to Point San Pedro, California, including the port area of San Francisco. Counties within this region include Sonoma, Marin, Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara counties.
- Monterey: Point Arena to Point Conception, California, including the port area of Monterey. Counties within this region include Santa Cruz, Monterey, and San Luis Obispo counties.

Ocean Sportfishing. This section describes recent ocean sport salmon fishing activity in the study region and the economic benefits of this activity to anglers and charter boat operators.

Ocean sport salmon fishing takes place primarily from privately-owned pleasure craft or charter boat. Table B-8 presents estimates of the number of charter and private trips for the California and Oregon coastal areas in 5-year increments between 1976 and 1995.

Average recreational salmon fishing effort off the California coast for the 1981-1985 period declined by approximately 14 percent relative to the average level for 1976-1980 (Table B-8). This decline was shared approximately equally between charter boat fishing and private boat fishing. Ocean sport salmon fishing activity during the 1986-1990 period then increased by 68 percent compared with the previous 5-year period. Between 1991 and 1995, effort declined, with the average number of annual trips falling by more than 10 percent during this period compared to the 1986-1990 period. Angler trips totaled an estimated 234,000 trips in 1997 (Pacific Fishery Management Council, 1998).

Ocean sport salmon fishing effort off the Oregon coast was 16 percent lower for the 1981-1985 period than for the 1976-1980 period (Table B-8). Charter boat fishing effort activity declined by 40 percent, while private boat activity declined by 8 percent. Total fishing effort then increased by 3 percent during the 1986-1990 period. Between 1991 and 1995, angler trips dramatically decreased, with average annual trips declining by nearly

60 percent during this period compared to the 1986-1990 period. Angler trips in Oregon totaled an estimated 30,300 trips in 1997 (Pacific Fishery Management Council, 1998).

Based on a study of ocean sport salmon fishing (Huppert and Thomson, 1987), the monetary benefits of ocean sport salmon fishing to anglers are estimated at $72 per trip (indexed to 1997 dollars). This value, which is also referred to as net economic value, represents the difference between the amount that an individual is willing to pay to ocean sport fish for salmon and the amount that an individual does pay. Based on 264,300 trips taken in the study region (Monterey, California, to the Oregon/Washington border) in 1997, the benefits of ocean sport salmon fishing are estimated at $19.0 million.

Businesses that supply goods and services to anglers also benefit from ocean sport salmon fishing activity, particularly those businesses that rely almost exclusively on sales to anglers. In many coastal communities, operators of charter boat businesses provide services for ocean salmon anglers. Based on a study of recreation-serving businesses in the Trinity River area (Frederikson, Kamine, and Associates, 1980), it is estimated that the net income received by charter boat operators is about 30 percent of the total revenues received from ocean salmon anglers. Based on angler expenditures of $76 per trip and 106,000 charter boat trips taken for salmon in 1997, net income to charter boat operators from ocean salmon fishing is estimated to have been about $2.4 million.

Ocean Commercial Fishing. This section describes recent ocean commercial salmon fishing harvest levels, gross income, and net income for the six study regions. Gross income is defined as the gross revenue received directly by the ocean commercial salmon harvesting sector for the sale of salmon to processors, wholesalers, and consumers. Net income is defined as profits received by the salmon harvesting sector.

Harvest. Ocean salmon stocks within the study regions include salmon originating naturally from various river systems along the West Coast and salmon produced in fish hatcheries. Salmon originating naturally from the Klamath/Trinity river system and from the TRSSH contribute to the ocean commercial salmon fishery along the West Coast.

The proportion of the commercial harvest in each region originating from Klamath/Trinity river system stocks varies annually but was estimated by Gall et. al., (1992) for the 1987-1988 period using genetic stock identification. The Gall study estimated that Klamath River system salmon accounted for 10 percent-12 percent of the total salmon harvest in Oregon coastal waters north of Humbug Mountain in Oregon (the Northern/Central Oregon Region), 30-36 percent of the harvest between Humbug Mountain and Horse Mountain, California (the Oregon and California KMZ regions), and 8 percent-11 percent of the harvest south of Horse Mountain (the San Francisco and Monterey regions).

No data are readily available on the percentage of total Klamath/Trinity River harvest attributable to Trinity River naturally produced (i.e., non-hatchery born) salmon; however, escapement data provides an indication of the natural contribution. According to escapement data for the Klamath/Trinity system for the 1982-1995 period, naturally produced Trinity River escapement accounted for approximately 11 percent of total escapement for the Klamath/Trinity system (Polos pers. comm.).

Commercial salmon fishing in the coastal regions is regulated by NMFS, CDFG, and the Oregon Department of Fish and Wildlife. Harvests have been intensely regulated since 1977 in California, and 1979 in Oregon. Regulation of commercial salmon fishing to protect various stocks of salmon has substantially affected the fishing effort along the West Coast in certain years by reducing the number of days allowed for fishing compared to the traditional season (May 1-October 1). This has led to reductions in total catch and associated reductions in gross and net income received by the salmon harvesting industry. This has been especially true since 1985 in the Klamath Management Zone (KMZ), a special management area established primarily to protect Klamath and Trinity River salmon that ranges south from above Gold Beach, Oregon, to below Eureka, California. For example, restrictions on ocean commercial salmon fishing effort virtually eliminated commercial salmon harvests in the KMZ in 1992. Harvesting restrictions have been somewhat eased in the last few years; however, commercial salmon fishing in the KMZ is still highly restricted. In 1996, commercial fishing for chinook salmon was restricted to 22 days in the California portion of the KMZ and from 18-23 days in portions of the KMZ in Oregon.

The period since 1990 also reflects the effects of a reallocation of the harvest of Klamath Basin fall chinook salmon that provides the inriver tribal fishery with 50 percent of the allowable harvest and reduces the number of fish available for the ocean troll and other non-tribal fisheries in the coastal areas near the Klamath River. Because of this reallocation, harvest restrictions were implemented in Coos Bay, KMZ, and Fort Bragg to reduce the impacts of the ocean troll fishery on the Klamath River Basin fall chinook salmon, allowing larger numbers of fish to return to the Klamath River Basin. Large ocean troll fisheries remained in northern Oregon and in the San Francisco and Monterey areas.

Ocean commercial salmon harvest levels from 1971-1990 in the six coastal regions are summarized in Table B-9. The ocean commercial fishery was the dominant harvester of salmon originating from the Klamath Basin during this period, and relatively large troll fisheries existed in the KMZ and adjacent ports, as well as in the northern Oregon, San Francisco, and Monterey regions, although regional harvest levels have varied over this period.

In the Northern/Central Oregon Region, average annual harvest levels fell from more than 1 million salmon and 7.2 million pounds during the 1971-1975 to 403,000 salmon and 2.7 million pounds during the 1981-85 period. Harvest levels rose again between 1986 and 1990, but have generally fallen since, although levels have started to rise again in the last few years. In 1996, approximately 167,000 salmon were commercially harvested in the Northern/Central Oregon Region, representing an 83 percent reduction in average annual harvests since the 1971-75 period (Pacific Fishery Management Council, 1997).

Ocean commercial salmon harvests in the KMZ-Oregon Region have generally fallen since 1971. As Table B-9 shows, average annual harvest levels fell from 177,000 salmon (922,000 pounds) during the 1971-1975 period to 34,000 salmon (260,000 pounds) during the 1986-1990 period. As discussed previously, commercial salmon fishing in the KMZ has been highly restricted in recent years. In 1996, only 8,500 salmon were commercially harvested in the KMZ-Oregon Region, representing a 95 percent reduction in harvests relative to average levels seen during the 1971-1975 period.

In the California portion of the KMZ, commercial salmon harvest trends have been similar to the KMZ-Oregon Region since 1971. Average annual harvest levels have fallen from

Go To TOC

388,000 salmon (2.8 million pounds) during the 1971-1975 period to 56,000 salmon (465,000 pounds) during the 1986-1990 period. In 1996, landings were only 11,700 salmon, or 97 percent less than during the 1971-1975 period, in the KMZ-California Region.

Salmon harvest trends have been somewhat different south of the KMZ, with average harvest levels remaining relatively high through the late 1980s. In the Mendocino Region, commercial harvests have annually averaged 205,000 salmon and 1.9 million pounds between 1971 and 1990. As Table B-9 shows, harvest levels generally declined between 1976 and 1985, but substantially increased between 1986 and 1990. Since 1989, commercial salmon harvest in the region has fallen, almost disappearing between 1992 and 1995, before rebounding to a harvest level of 20,000 salmon in 1996. This harvest level is still 90 percent lower than average levels between 1971 and 1990.

Commercial salmon harvests in the San Francisco Region have remained relatively constant over the last 25 years, although harvests declined dramatically during 1992 when harvest levels along the West Coast fell substantially. Between 1971 and 1990, harvest levels averaged 242,000 salmon and 2.4 million pounds. In 1996, 152,000 salmon were harvested in the San Francisco Region.

In the Monterey Region, average annual harvest levels increased during every 5-year period between 1971 and 1990, growing from an average harvest of 84,000 salmon (878,000 pounds) to 146,000 salmon (1.6 million pounds). Since 1990, harvest levels in the region have been erratic, falling to 70,000 in 1994 but rising to 313,000 one year later. In 1996, 181,000 salmon were harvested in the Monterey Region, exceeding the 104,000 average over the 1971-1990 period.

Gross Value of Commercial Harvest. Revenues generated by the commercial salmon harvest in the six coastal study regions have generally risen and fallen in direct relationship to the harvest levels shown in Table B-9 and, to a lesser extent, in relationship to prices paid at the processing and wholesale level for salmon.

Market prices for salmon annually change based on local and world supply and demand conditions. Additionally, prices received by individual fishers (referred to as ex-vessel prices) are affected by marketing avenues used for selling salmon (e.g., sales to dockside buyers// processors or through farmers' markets). Future prices for fishers along the California and Oregon coast may be affected by numerous factors, including supply levels for pen-raised salmon, economic and political conditions in major buying countries, Alaskan troller yields, and changes in equipment technology (e.g., slush freezers) that may provide greater flexibility in delivering salmon to the first point of sale.

Real (i.e., adjusted for inflation) salmon prices varied substantially from year to year and among the coastal regions between 1980 and 1996. According to PFMC data (1997), average chinook salmon prices over this period ranged from $1.55-3.81 per dressed pound (in 1997 dollars) in Oregon and from $1.44-3.41 per pound in California. Salmon prices along the West Coast generally have been declining since the early 1990s and averaged $1.56 per pound in Oregon and $1.44 per pound in California in 1996, well below average prices during the 1970s and 1980s.

Go To TOC

The Oregon ocean commercial salmon fishing industry generated approximately $3.0 million in gross revenue in 1996, with approximately 93 percent of this revenue generated in the Northern/Central Oregon Region and the remainder in the KMZ-Oregon Region. Gross revenues generated statewide in 1996 were substantially below historic revenue levels, which averaged $16.9 million (in 1997 dollars) between 1971 and 1990 (Pacific Fishery Management Council, 1997).

In California, gross revenues from commercial salmon fishing totaled $5.7 million in 1996, substantially lower than the $22.7 million (in 1997 dollars) in average gross income generated by the commercial salmon fishing industry between 1971 and 1990. The distribution of gross revenue among California coastal regions in 1996 was as follows: KMZ-California, 3.7 percent; Mendocino, 6.6 percent; San Francisco, 38.5 percent; Monterey, 51.2 percent. Historically, the KMZ-California and Mendocino Regions have registered much larger shares of gross revenues generated statewide by the ocean commercial salmon industry.

Net Income. No information is readily available concerning levels of net income (i.e., profit to salmon harvesters) historically generated directly by the ocean commercial salmon industry. Net income trends, however, would generally follow trends in gross revenues generated by the salmon harvesting industry. Based on information derived through the micro-IMPLAN economic input-output model (Minnesota IMPLAN Group, 1993), net income received by the salmon harvesting industry equals approximately 33 percent of gross revenues in Oregon and 39 percent of gross revenues in California. Based on these relationships, net income totaled an estimated $1.0 million in Oregon and $2.2 million in California in 1996. Similar to trends in gross incomes, net incomes received by the commercial salmon fishing industry recently have been substantially lower than during most years over the 1971-1990 period.

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.

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 NMFS on November 5, 1990. NMFS reclassified winter chinook salmon as endangered on January 4, 1994. On June 16, 1993, NMFS 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, NMFS 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, NMFS 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, NMFS announced that the Central Valley spring chinook ESU would be listed as threatened on or about November 9, 1999. The fall/late-fall ESU would remain as 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 evaluated as a tool for assessing the effects of project alternatives on anadromous salmonids. For the purposes of this Environmental Impact Statement/Environmental Impact Report (EIS/EIR) 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 to determine effects of project alternatives on salmonid fish resources.

The following assumptions were used in the 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 B2.

Trinity River System Attribute Analysis Method. To evaluate the environmental consequences of the proposed project alternatives on anadromous salmonid fish resources 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 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 salmonid temperature and habitat requirements was identified and included in the analysis, with objectives and threshold criteria developed for the purposes of assessment.

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 are shown in Table B-10. A summary of the methods are shown in Attachment B3. 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 Percent Inflow Alternative is based on Table Percent Inflow (Attachment B3) 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 Reservoir (post-dam)(Attachment B2); these are as follows: extremely wet = 0.12; wet = 0.28; normal = 0.20; dry = 0.28; and critically dry = 0.12.

Go To TOC

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-10) were not analyzed as part of the TRSAAM evaluation for this EIS/EIR. Additionally, objectives 3 and 4 of Attribute 11 were not scored, as it was determined that there was insufficient information available to evaluate those objectives. The remainder of the attribute objectives presented in Service and HVT (1999) were used to evaluate each project alternative. In summary, for each project alternative, a total of 37 objectives were evaluated for the 10 fluvial river system attributes.

Temperature Evaluation. As part of the attribute analysis, mainstem Trinity River water temperatures were evaluated as to their ability in meeting two temperature objectives. A brief summary of this analysis is shown in Attachment B4. These temperature objectives are: flows sufficient in quantity 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 performance of an alternative in meeting salmonid water temperature criteria, the Stream Network Temperature model (SNTEMP) (Theurer et al., 1984), calibrated by the Service for the Trinity River was employed (Zedonis, 1997). For each alternative, the SNTEMP modeling results were compared to target temperature criteria developed for migrating chinook, coho, and steelhead smolts by Zedonis and Newcomb (1997) (Table B-11). Methods for evaluating temperature effects on anadromous salmonids are summarized by the Service and HVT (1999).

For each project alternative, an assessment of meeting each species' smolt migration temperature requirements was conducted by estimating the percentage of time (in total weeks) the temperature criteria (Table B-11) were met during the out-migration period (April 22 through July 8). The ability of each alternative to meet optimal temperature criteria for migrating salmonid smolts was assessed by assigning a score value of 2, 1, or 0 for each week during emigration (out-migration). A score of 2 was assigned to a week if the modeled river temperature was equal to or less than the optimal temperature for smolts of the species likely remaining in the Trinity River during that week. A score of 1 was assigned to a week if the modeled temperature was within the range of marginal temperatures for smolts of the species likely remaining in the Trinity River during that week. Finally, a score of 0 was assigned to a week if the modeled temperature was greater that the marginal temperature for smolts of the species likely remaining in the Trinity River during that week.

Overall, for Objective No.1 to be scored a 2 for the entire out-migration period, the percentage of weeks for which the optimal temperature criteria were met must have been equal to or greater than 90 percent of the time. For Objective No. 1 to have been scored a 1, the percentage of weeks in which the optimal temperature criteria were met must have been equal to or greater than 50 percent, but less than 90 percent of the time. A score of 0 was assigned to Objective No.1 if the percentage of weeks in which the optimal temperature criteria were met was less than 50 percent of the time.

In a similar manner, for Objective No.2, an estimate of the percentage of time (total weeks) a flow of 450 cfs was met in the uppermost reaches of Trinity River during the summer and early fall months (July 1 through October 15) was made. The analysis assessed the performance of each alternative in providing a flow volume (450 cfs) during this summer-early fall period. A flow of 450 cfs has been found to meet summer-early fall temperature criteria established by the North Coast Regional California Water Quality Control Board (NCRWQCB) under nearly all conditions (U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999). For each alternative, performance in meeting the 450 cfs flow requirement was evaluated by assigning a score of 2, 1, or 0 for each week during the July 1 through October 15 period. A score of 2 was given to a week if, during that week, a flow of 450 cfs or greater was provided. A score of 1 was given to a week if, during that week, a flow of greater than or equal to 300 cfs was provided. A score of 0 was assigned to a week in which flows of less than 300 cfs were provided.

Overall, to obtain a score of 2 for Objective No.2, the percentage of weeks in which the flow threshold (450 cfs) was met must have been greater than 90 percent of the time. To score a 1 for the objective, the percentage of weeks in which the flow threshold was met must have been greater than 50 percent, but less than 90 percent of the time. A score of 0 was assigned if the percentage of weeks in which the flow threshold was met was less than 50 percent of the time.

<u>Attribute Scoring</u>. Through consensus, the TRFCRTT developed a scoring system for evaluating the performance of each project alternative in meeting all of the attribute objectives. The following scoring system 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 37 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. 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 total score of 74 was possible if all 37 objective thresholds were always or nearly always met (a score of 2 X 37 objectives = 74). Using this process, the Maximum Flow, Flow Evaluation, and 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 remaining project alternatives, which do not have water-year class dependent flow schedules, attribute assessment and scoring were made using the yearly flow schedules as shown in Attachment B5.

<u>Estimates of Adult Anadromous Salmonid Populations in the Year 2020</u>. In addition to the evaluation of each alternative’s performance in meeting desirable river system attributes for a healthy and functioning river, population/adult production estimates for anadromous salmonids were developed for the mainstem Trinity River. These estimates were developed by the TRFCRTT to provide a population estimate of the numbers of adult anadromous salmonids, in the year 2020, resulting from the implementation of each of the project alternatives. The estimates for chinook and coho salmon and steelhead were developed and used exclusively for assessing the effects of each project alternative on ocean fisheries economics

in the year 2020. This analysis is not, and was not intended to represent, a stock-recruitment or cohort production model. Estimates of the number of adult anadromous salmonids were intended to be used only as a relative measure of adult fish production in response to the project alternatives in meeting critical fluvial requirements necessary to provide diverse habitats required for the restoration and maintenance of Trinity River anadromous salmonids. A brief summary of the approach and methodology is shown in Attachment B3.

An overall assumption was made that the performance of each project alternative in meeting the river system attributes would in turn affect progress in meeting the mainstem TRRP spawner escapement goals. As stated in the Affected Environment section, fall and spring chinook salmon, under existing conditions, average approximately 18 percent and 25 percent of the restoration goals, respectively. Coho salmon and winter steelhead populations average approximately 14 percent and 12 percent of the restoration goals for those species, respectively. It was assumed that without sufficient additional habitat restoration, populations of these species under No Action, in the year 2020, would likely diminish to levels lower than those for existing conditions. Those restorations goals are: 68,000 chinook salmon; 1,400 coho salmon; and 40,000 steelhead (U.S. Fish and Wildlife Service, 1984). To obtain an estimated measure of performance in meeting those numerical escapement goals, the following methodology was employed.

The ratio of each alternative's estimated total system attribute performance score (described above) to the total maximum possible score (score of 74) was multiplied by the species' restoration goal to obtain an estimate of that alternative's spawner escapement in the year 2020 (Equations 1a, 1b, and 1c). Equation 1a, 1b, and 1c are given as:

Equation 1a (chinook):	(TS/PS) X ChG = ChE
where:	TS = Total attribute score
	PS = Possible attribute score
	ChG = Chinook salmon spawner escapement goal (68,000)
	ChE = Estimated chinook salmon spawner escapement
Equation 1b (coho):	(TS/PS) X CoG = CoE
where:	TS = Total attribute score
	PS = Possible attribute score
	CoG = Coho salmon spawner escapement goal (1,400)
	CoE = Estimated coho salmon spawner escapement
Equation 1c (steelhead):	(TS/PS) X StG = StE
where:	TS = Total attribute score
	PS = Possible attribute score
	StG = Steelhead spawner escapement goal (40,000)
	StE = Estimated steelhead spawner escapement

For example, if an alternative was assigned a total score (TS) of 6 out of a possible score (PS) of 74, then it was assumed that the alternative would have met approximately 8 percent (6/74 = 8 percent) of the objectives required for a healthy functioning fluvial river system. This performance measure was then multiplied by the chinook fishery restoration goal (ChG) of 68,000 adult spawners. This calculation (8 percent x 68,000) would result in an estimate of approximately 5,500 chinook salmon spawners, on the average, in the year 2020 for that alternative (Equation 1a). Similarly, ratio of the system attribute score and total score (TS/PS) for that alternative was multiplied by the restoration goals for Coho (CoG) of 1,400 (Equation 1b) and steelhead (StG) of 40,000 (Equation 1c) to obtain the numerical spawner escapement estimates for those species, for that alternative.

<u>Calculation of Harvest Factors and Allocations</u>. 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 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. Two methods were employed for estimating harvest factors. For chinook salmon, the long-term equilibrium harvest rate model (HRM-EQ) used for the management of Klamath Basin fall chinook by the Klamath River Technical Advisory Team was used. For coho salmon and steelhead, harvest factors were derived by algebraic manipulation rate equations and harvest rate data specific to each species. This method was necessary because there is a lack of sufficient data to construct a harvest rate model similar to that used for chinook salmon (HRM-EQ).

To allocate fishery resources among user groups, current harvest-sharing regulations and agreements were used. Salmon species were equally allocated between tribal and non-tribal fisheries (50/50 sharing), and the non-tribal share was allocated among the ocean commercial and sport fisheries (85 percent of the non-tribal share) and to the inriver sport fishery (15 percent of the non-tribal share). Steelhead were allocated to the inriver sport fishery only. It was assumed that the ocean harvest of steelhead would be insignificant.

Harvest Management Alternative (HMA). Under the Harvest Management Alternative, commercial, sport, and tribal fishery harvests would be reduced to levels necessary to meet the spawner escapement goals of the TRRP (Table B-12) and presumably increase natural production. This alternative was fundamentally different from other alternatives of this EIS/EIR in that its action was to restore fish production by reducing or eliminating fishery-related mortality, while other alternatives investigated restoring fish production through freshwater habitat restoration. Under this alternative, flows in the Trinity River would be the same as the No Action level of 340,000 acre-feet per year (af/yr), the existing channel rehabilitation projects would be mechanically maintained, and no new channel rehabilitation projects would be constructed.

The TRFCRTT examined three methodologies presented by various team members to assess the effectiveness of the HMA in meeting the purpose and need of this EIS/EIR (Attachments B7, B8, and B9). These analyses focused on fall chinook salmon because 1) an extensive database exists for Klamath Basin (including Trinity River) fall chinook, and 2) harvest models for this species have been developed and are used by harvest management agencies. The first method utilized harvest and escapement data for Trinity River fall chinook from

Go To TOC

1984-1995 to reconstruct populations (cohort reconstruction) and investigated whether eliminating various components of harvest would result in meeting the fall chinook escapement goals of the TRRP (Attachment B7).

The second method (Attachment B8) utilized the harvest and escapement data compiled for the first analysis detailed above (presented in Attachment B7) and investigated the effects of harvest rates on meeting escapement goals and the magnitude of harvest. These were assessed under different assumptions of a Beverton-Holt spawner-recruit relationship (Full Capacity, Maximum Sustained Yield, and Low Productivity).

The third method (Attachment B9) used the harvest rate model (HRM) used for annual management of fisheries that harvest Klamath Basin (including Trinity River) chinook in conjunction with information generated by the TRFCRTT pertaining to the effect of activities associated with the No Action Alternative on the habitat of the Trinity River.

The TRFCRTT discussed the three methodologies and determined that the HRM methodology (Attachment B9) linked with the Trinity River habitat assessment information was the most appropriate manner to evaluate this alternative. The primary reasons for not using the other two methods follow: 1) use of the harvest and escapement data (used in both methodologies) was problematic because large numbers of hatchery-produced fish were included in the data set, and the intent of evaluating this alternative was to determine the effect on natural production, and 2) changing the stock/recruit parameters (Low Productivity scenario) was not deemed appropriate because this implies that some change in the freshwater environment is occurring to bring about changes in the stock-recruit parameters, while the management of the freshwater habitat (Trinity River) was the same as the No Action Alternative.

The primary reasons for using the HRM methodology, rather than the other two presented, were 1) compatibility of assumptions and methods used to evaluate other alternatives, 2) established use of the HRM by the KFMC and the PFMC processes, and 3) availability of data specific for Trinity (or Klamath Basin) chinook, specifically harvest impact rates and life history parameters. This approach assumed that the only difference between the Harvest Management and the No Action Alternatives is that, in the Harvest Management Alternative, fishery impacts are managed (reduced) to increase spawner escapement. The HRM was seeded with an age-structured equilibrium ocean population size, and harvest was reduced in increments (25, 50, 75, 90, and 100 percent). The resulting harvest (ocean and inriver) and escapement for each level of harvest restriction were summarized, and the sum of harvest and escapement were used as an index of fish production. The methodology and results of this analysis is presented in Attachment B9.

State Permit Alternative. For the State Permit Alternative, the TRFCRTT found that it was likely that given the current deterioration of the habitat conditions and the depression of naturally produced anadromous salmonid populations, it was likely that there would be no distinguishable natural production of chinook and coho salmon and steelhead in the mainstem Trinity River in the year 2020. A summary of the rationale for this conclusion is provided in Attachment B10.

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. Changes in ocean salmon populations from Trinity River stocks would occur primarily along coastal areas ranging from California's central coast (Monterey) to the Oregon-Washington border. The ocean sport and commercial fishery impact assessments evaluated project-related changes in sportfishing trips, benefits to anglers and charter boat operators, and commercial salmon harvest and net income levels in the six coastal regions listed previously.

<u>Ocean Sportfishing</u>. Ocean sport salmon fishing trips were estimated by applying use-estimating regression models developed by Hanemann and Dumas (1996). The models estimate the number of ocean sport salmon fishing trips originating from different ports within the study region. The California ports include Monterey, San Francisco, Fort Bragg, Eureka, and Crescent City. The Oregon ports include Brookings, Coos Bay, and Tillamook. The model developed for Coos Bay also was used to estimate ocean sport salmon fishing trips originating from Newport, Oregon, and the Brookings model was used to estimate trips originating from Astoria, Oregon .

For California ports, separate models were estimated to predict the number of trips taken by charter (for-hire) and private boats. For Oregon ports, one model was estimated to predict the number of trips taken by both charter and private boats.

The specification of the regression models for estimating the annual number of ocean sport salmon fishing trips (per 1,000 population residing in each port area) is as follows:

(angler trips/1,000 Pop) = B0 * B1(SAI) * B2(RLFUEL)

where:

> **SAI** is the salmon abundance index for a given port in a specific year. The salmon abundance index is the sum of commercial landings of chinook and coho salmon plus the sport catch of chinook and coho salmon by both private and charter boats divided by 100,000.

Go To TOC

RLFUEL is the real (inflation-adjusted) price of diesel fuel, measured in cents per gallon.

B0, B1, and **B2** are model parameters that were estimated.

It should be noted that each port has a different constant term (B0) to reflect the unique characteristics of the port, such as local population conditions.

The overall models are significant at the 99 percent confidence level, as indicated by an F-test. The models explain a substantial amount of the variation in the dependent variable (number of trips taken per 1,000 population), ranging from 41 percent for the California charter-boat model to 86 percent for the California private-boat model. All of the estimated parameters (which are reported in Hanemann and Dumas, 1996) are significant at the 99 percent confidence level except the fuel price parameter (RLFUEL) in the Oregon model.

The key independent (policy) variable in the models is the Salmon Abundance Index (SAI). The SAI was calculated for the no action and with-project alternatives based on estimates of ocean commercial harvest and sport catch (Table B-13). The estimates of the ocean commercial harvest were developed by TRFCRTT (Attachment B16). The estimates of the ocean sport catch were developed based on the ratio of the ocean sport to commercial salmon harvest in each region, as derived from the 10-year average between 1987 and 1996. PFMC (1998) data were used for this calculation.

Estimates of ocean sportfishing trips per 1,000 population by port area were calibrated to the average annual number of trips taken between 1993 and 1997 at California ports and between 1989 and 1993 at Oregon ports. The calibrated estimate of trips per 1,000 population were then expanded by the projected 2020 population for the county (or counties in the cases of San Francisco) surrounding each port. Population projections available from the California Department of Finance and the Oregon Office of Economic Analysis were used for this expansion.

The angler benefits of the predicted number of ocean sport salmon fishing trips in each port area for each alternative were derived by applying an average value of $72 per trip, as estimated by Thomson and Huppert (1987), and indexed to 1996.

The benefits to charter boat operators were estimated using a 30 percent profitability factor applied to estimated charter boat revenues. Charter boat revenues were estimated assuming an average expenditure of $76 per trip multiplied by the predicted number of trips for each alternative. The 30 percent profitability factor was derived from a study of recreation-serving businesses in the Trinity River area (Frederikson, Kamine, and Associates, 1980).

<u>Ocean Commercial Fishing</u>. The number of salmon available for commercial harvest varies throughout the coastal regions, with salmon stock sizes determining the allowable harvest in each region. As any particular stock size increases or decreases, relative numbers of salmon available for harvest in each region shift. Changes in the abundance of naturally produced Trinity River salmon would, therefore, affect overall harvest levels throughout coastal regions.

The following analytical tasks, incorporating appropriate factors to adjust for shifts in harvest impacts based on the magnitude of allowable harvest, were undertaken to assess project-related effects on ocean commercial salmon harvest levels.

Task 1. Estimate Total Change in Ocean Commercial Salmon Harvest Levels. The impact analysis focused on estimating changes in the total ocean commercial harvest of chinook salmon resulting from various changes in the harvest of salmon originating naturally from the Trinity River under the project alternatives. Project-related changes in commercial harvest levels were measured by comparing with-project harvest levels to base-line harvest levels, as characterized by the No Action Alternative. No action conditions are assumed to reflect harvest levels that would exist without implementation of any of the project alternatives.

Salmon are harvested by various users of the fishery resource, including ocean commercial and sport fishers, interior sportfishers, and interior commercial harvesters (e.g., Columbia River and Puget Sound non-Indian and treaty Indian fishers, and Klamath River tribal fishers). It should be noted that harvest estimates for the project alternatives assume that an increase in Trinity River salmon populations would lead to an increase in harvest levels for all user groups, including ocean commercial harvesters. This assessment focuses only on evaluating the potential total change in the ocean commercial harvest and the economic changes that would result from this assumed harvest increase under with-project conditions.

Changes in harvest were estimated for the six coastal regions identified above. The following steps were used to estimate changes in commercial salmon harvest.

Step A: Estimate Availability of Trinity River Natural Salmon for Ocean Commercial Harvest. Based on estimated changes in escapement and other factors, the number of coho and spring and fall chinook salmon naturally originating from the Trinity River that would be available for harvest were estimated by the TRFCRTT for each alternative. Estimated totals across the six coastal regions (Table B-13) are as follows for each alternative.

- No Action Alternative-3,400 chinook, 70 coho
- Maximum Flow Alternative-34,600 chinook, 700 coho
- Flow Evaluation Alternative-28,700 chinook, 600 coho
- Percent Inflow Alternative-9,800 chinook, 200 coho
- Mechanical Restoration Alternative-7,400 chinook, 140 coho
- State Permit Alternative-0 chinook, 0 coho
- Preferred Alternative-28,700 chinook, 600 coho

(For the State Permit Alternative, the TRFCRTT assessment of the harvest availability of Trinity River naturally produced chinook and coho salmon indicated that habitat conditions would be so poor that it was unlikely naturally produced fish from the Trinity River would be available for harvest by the various fisheries. Salmon originating from other sources would be available for harvest; however, anadromous fishery resources of the Trinity River presumably would be listed under the ESA, resulting in closure of the fishery in the two KMZ regions, the Mendocino Region, and the Coos Bay port area.) For the Preferred Alternative, harvest levels are assumed to be the same as under the Flow Evaluation Alternative, although the restoration component of the Preferred Alternative would likely result in somewhat higher harvest levels. For all alternatives, harvest estimates of spring and fall chinook salmon were modified for use with the Klamath River Ocean Harvest Model (KOHM),

Go To TOC

which is used to evaluate Klamath River Basin fall chinook salmon harvest impacts. The KOHM treats harvests of Klamath Basin spring chinook as contributions from other stocks. To use the harvest estimate data available through the KOHM, the number of Trinity River natural fall chinook available for the ocean troll fishery was calculated by multiplying the number of chinook salmon for each alternative by the ratio of fall chinook salmon to total chinook salmon (62,000/68,000 = 0.9118). This ratio reflects the relative numbers of fall chinook to fall and spring chinook, as stated in the TRRP's escapement goals and subsequently used by the TRFCRTT in their estimates. Applying this ratio resulted in the following estimates of Trinity River natural fall chinook available for the ocean troll harvest.

- No Action Alternative-3,100
- Maximum Flow Alternative-31,500
- Flow Evaluation Alternative-26,200
- Percent Inflow Alternative-8,900
- Mechanical Restoration Alternative-6,700
- State Permit Alternative-0
- Preferred Alternative-26,200

Step B: Estimate Availability of Klamath River Basin Fall Chinook Salmon for Commercial Harvest. The number of Trinity River naturally produced fall chinook for each alternative was then expanded to account for other fall chinook salmon from the Klamath River Basin (both naturally and hatchery produced). Although restoration activities undertaken on the Trinity River may have some positive affect on salmonid populations in the lower Klamath River (below the confluence with the Trinity River), it is unlikely that they would affect populations throughout the basin such that other populations would increase at the same rate as the Trinity River natural populations.

In order to adjust for this effect, the number of Klamath River Basin fall chinook salmon available for harvest by the ocean troll fishery was estimated by assuming that the production from the Klamath River Basin, excluding Trinity River naturally produced fall chinook, was constant for each alternative and equal to the number available for the No Action Alternative. To this number (18,100), the number of Trinity River naturally produced fall chinook was added for each alternative to estimate the total number of Klamath River Basin fall chinook available for harvest by the ocean troll fishery. This methodology is demonstrated by the following calculations.

1. Number of Trinity River naturally produced fall chinook available for harvest under the No Action Alternative = 3,100

2. Number of Klamath River Basin fall chinook salmon available for harvest under the No Action Alternative = 21,200

3. Number of Klamath River Basin fall chinook salmon available for harvest under the No Action Alternative, excluding Trinity River naturally produced fall chinook = 18,100

This method was used to derive the following estimates of troll ocean harvests of Klamath River Basin fall chinook salmon (including Trinity River naturally produced fall chinook salmon).

- No Action Alternative-21,200
- Maximum Flow Alternative-49,600
- Flow Evaluation Alternative-44,300
- Percent Inflow Alternative-27,100
- Mechanical Restoration Alternative-24,900
- State Permit Alternative-10,600
- Preferred Alternative-44,300

Step C: Estimate Total Ocean Commercial Chinook Salmon Harvest for Coastal Regions. Commercial ocean salmon stocks of the six study regions are composed of salmon originating from various river systems; however, when regional ocean commercial harvests are restricted to protect natural salmon originating from the Klamath/ Trinity River system, harvests of salmon originating from all river systems (including hatchery-produced salmon originating from the Trinity River) are also restricted. Therefore, easing harvest restrictions on naturally produced Trinity River salmon because of increased populations under project conditions could also ease harvest restrictions on the entire fishery, resulting in an indirect increase in the ocean harvest of salmon originating from all river systems. Similarly, imposing more stringent restrictions on the commercial harvest of naturally produced Trinity River salmon would also result in more stringent restrictions on the harvest of all salmon within the range of the Trinity River salmon.

This study assumes that increased populations of Trinity River salmon would result in eased harvest restrictions for all affected fisheries; however, ocean commercial harvests are also periodically restricted to protect salmon originating from other rivers, such as the Snake River. The simplifying assumption that all ocean commercial harvest restrictions would be eased in the future reflects this study's 2020 planning horizon and the presumption that actions to restore fishery habitat conditions on other rivers would be successful by 2020. Additionally, harvest levels estimated by this study represent long-term averages. Salmon originating from the Klamath River Basin are harvested in all six coastal study regions. A spreadsheet model, the Ocean Troll Fishery Management Model (OTFHM), was developed to estimate chinook salmon harvest by the ocean troll fishery by port; and these data were summarized by coastal region for each alternative (Attachment B16). The model was calibrated for the No Action Alternative using the average chinook salmon landings for each port for the 1991-1997 period and data derived from the KOHM database regarding the Klamath River Basin fall chinook salmon contribution to landings. Landings from the 1991-1997 period were used because these best represent ocean troll fishery management based on the current harvest allocation scheme. The model was calibrated by adjusting the contribution rates until the total estimated landings of Klamath River Basin fall chinook salmon were equal to 21,200 (the number available for harvest under the No Action Alternative). This was done by adjusting the Klamath River Basin fall-run contribution to the ocean troll fishery using contribution data from the KOHM. These calibrations were necessary because the data used for contribution rates and landings were from different time periods.

The OTFHM was initialized with the average chinook salmon landings for each port for the 1991-1997 period. For all alternatives, it was assumed that landings in the San Francisco, Monterey, and portions of the Northern/Central Oregon (i.e., Columbia, Tillamook, Newport

Go To TOC

port areas) coastal regions would remain constant because the fisheries in these areas have been less affected by restraints imposed to protect Klamath River Basin fall-run abundance than the regions nearer to the Klamath River. For this analysis, harvest levels for regions near the Klamath River (i.e., KMZ-Oregon, KMZ-California, and Mendocino) and a portion of the Northern/Central Oregon Region (i.e., Coos Bay) were increased with increasing availability of Klamath River Basin fall chinook.

For each alternative, landings were adjusted by iteration so that the total landings of Klamath River Basin fall chinook salmon were equal to the projected number of Klamath River Basin fall chinook available for that harvest. Landings for the ports of Coos Bay, Brookings, Crescent City, Eureka, and Fort Bragg were increased by the same factor until the total landings of Klamath River Basin fall chinook were equal to the number available for that alternative. Total landings were calculated by dividing the number of Klamath River Basin fall chinook salmon harvested by the adjusted contribution rate for each port. These data were then summarized for each coastal region, resulting in the regional commercial chinook salmon harvest totals shown in Table B-14.

For the State Permit Alternative, the anadromous fishery resources of the Trinity River presumably were assumed to be listed under the ESA, eliminating harvests in the two KMZ regions, the Mendocino Region, and the Coos Bay portion of the Northern/Central Oregon Region. The ocean harvest rate for salmon originating from other sources was assumed to be reduced by 50 percent from that allowed under the No Action Alternative for the remaining San Francisco Region, the Monterey Region, and areas of the Northern/Central Oregon Region other than the Coos Bay port area. These three regions are farther from the Klamath River Basin and would face less stringent harvest restrictions.

(This study assumes that fishery resource managers would allow ocean commercial catch levels to rise to the levels estimated by this analysis; however, salmon available for harvesting within the overall fishery are shared and allocated among other users of the salmon fishery, including ocean sportfishers, inriver sportfishers, and Klamath River tribal fishers.)

Step D. Estimate Total Commercial Coho Harvest for Coastal Regions. Coho salmon represent a small portion (approximately 2 percent) of the estimated number of natural Trinity River salmon available for ocean commercial harvest; however, potential restrictions on their catch could have substantial negative implications for the overall harvest in some regions, such as the Northern/Central Oregon Region, where coho have historically represented an important share of the overall harvest.

Because Trinity River coho account for a relatively small percentage of the total ocean coho harvest, the TRFCRTT did not estimate total harvest effects related to changes in the availability of natural Trinity River coho salmon. Instead, coho harvests under project conditions were estimated based on historic average annual harvest levels over the 1986-1990 period. This period was considered to represent conditions in 2020, assuming habitat restoration efforts result in the recovery of coho stocks along the West Coast. For all alternatives other than the No Action Alternative and the State Permit Alternative, average annual coho harvest levels for each region over the 1986-1990 period were added to the estimated total chinook harvest level. The following coho harvest levels were estimated for each region:

Go To TOC

- Northern/Central Oregon-385,000
- KMZ-Oregon-14,000
- KMZ-California-12,000
- Mendocino-24,000
- San Francisco-9,000
- Monterey-2,000

For the No Action Alternative and State Permit Alternative, it was assumed that, to protect Trinity River stocks, no coho originating from any source would be harvested in the two KMZ regions, the Mendocino Region, and the Coos Bay portion of the Northern/Central Oregon Region. Additionally, it was assumed that no coho would be harvested in the San Francisco Region and south because there are virtually no coho produced in the central California area, making it unlikely that there would be targeted coho harvests in this region. Coho harvests for the remaining areas (i.e., the Mendocino Region and non-Coos Bay portions of the Northern/Central Oregon Region) would vary for the two alternatives. Under the No Action Alternative, coho harvests are assumed to be similar to average annual levels over the 1986-1990 period. For the State Permit Alternative, coho harvests are assumed to be approximately 50 percent of this average.

Task 2. Assess Effects on Gross Value of Harvest. Changes in harvest level would directly affect gross revenues for the salmon harvesting sector in each region.

The value of the commercial salmon harvest under both no action and with-project conditions was assessed based on estimated harvest levels and assumed market prices received by commercial fishers. Harvest levels for each region were estimated as described above. Harvest levels were converted to harvested weight based on harvest and weight data from 1986-1990 (Pacific Fishery Management Council, 1997). Average pounds per harvested salmon were derived by weighting calculated averages for chinook and coho by the proportion of the overall salmon harvest attributable to each species. This procedure resulted in average salmon weights of 9.7 pounds (dressed weight) in California and 7.2 pounds in Oregon over this period. (Coho salmon, which are generally smaller than chinook, have historically represented a much larger share of the Oregon harvest.)

Real (i.e., adjusted for inflation) salmon prices varied substantially from year to year and among the study regions between 1980 and 1996. According to PFMC data (1997), average chinook salmon prices over this period ranged from $1.55-3.81 per dressed pound (in 1997 dollars) in Oregon and from $1.44-3.41 per pound in California. Salmon prices along the West Coast generally have been declining since the early 1990s.

To avoid speculation concerning future market price levels, an average sales price of $3.01 per pound (dressed weight) for Oregon and $3.04 per pound for California were used to estimate both no action and with-project harvest values. Prices were calculated based on price data reported by the PFMC in 1997 for 1981-1990, adjusted to 1997 dollars using the Producer Price Index. The 1981-1990 period represents an era when regional harvest levels were relatively high and before highly restrictive management measures were imposed. The use of constant, average prices assumes that changes in harvest levels will have little effect on prices received by the salmon harvesting sector.

Go To TOC

Estimated gross harvest revenues under no action and with-project conditions are presented for each region in Table B-15.

Task 3. Assess Effects on Net Income. Changes in harvest level and gross revenues would directly affect net income levels for the salmon harvesting sector in each region.

Net personal income for vessel owners (i.e., profit) generated by the commercial salmon harvest was estimated using proprietary income coefficients (i.e., the amount of income per dollar's worth of output) derived through the Micro-IMPLAN input-output model (Minnesota IMPLAN Group, 1993). The model was constructed to generate income coefficients for coastal areas affected by the project. Coefficients generated for the commercial fishing sector are as follows:

- Oregon (Northern/Central and KMZ-Oregon Regions): 0.332
- KMZ-California and Mendocino Regions: 0.390
- San Francisco Region: 0.392
- Monterey Region: 0.353

The estimated changes in output (i.e., gross harvest value) for each region were applied to the net income coefficients for each region to estimate total net income within the commercial fishing sector generated by the salmon harvest under no action and with-project conditions (Table B-16). Project-related changes in net income were calculated for each region by comparing with-project income levels for each alternative to no action levels.

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, (LSALMON2) (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 (LSACTEM3) (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. Recent (1990 through 1996) spawning distributions for winter chinook salmon were used in the salmon mortality model (Rowell, 1997; Attachment B11). 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 LSALMON2 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 25 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.

For all but one of the project alternatives, salmon harvest levels are predicted to be higher than under no action conditions, which would result in beneficial economic effects within the sportfishing and commercial harvesting sector. However, harvest levels would be lower under the State Permit Alternative. For these alternatives, impacts were considered significant if commercial harvest levels within a region were estimated to be 30 percent less than under the No Action Alternative, or if ocean sport salmon fishing activity decreased by more than 20 percent. These thresholds were selected because they are similar to the standard deviation in harvest and activity levels within the coastal regions between 1970 and 1990. (The standard deviation was actually higher within the KMZ regions; however, harvest levels within these regions have been dramatically affected by harvest management actions in recent years.), and Percent Inflow Alternatives.

1.1.2.3 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-17. The individual scoring worksheets are shown in Attachment B12. The assumptions and rationale for scoring each attribute objective is shown in Attachment B13. A summary of the total score of the attributes for all project alternatives is shown in Table B-18. Attachment B4 provides summaries of the analysis of temperature attribute objectives (attribute 11-objectives 1 and 2) for the mainstem Trinity River for the project alternatives.

As shown in Table B-18, the No Action Alternative scored only 6 of the total possible 74 attribute objectives points believed necessary for a restored fluvial river system. For 33 of the 37 attribute objectives, thresholds were rated as never or nearly never exceeded (Table B-19). For only two objectives (attribute 2-objectives 3 and 4) did the proposed No Action Alternative sometimes meet the attribute objective thresholds. For only two 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) and meeting state board temperature objectives for water temperatures (attribute 11-objective 2) (Table B-19).

The No Action Alternative performed poorly in meeting the river system and habitat 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 estimated average annual number of anadromous adult salmonids in the mainstem Trinity River in the year 2020 under the No Action Alternative is shown in Table B-20. The average annual inriver spawner escapement for naturally produced coho in the year 2020 was estimated to be approximately 100 for the No Action Alternative (Table B-20). It was estimated that spawner escapement for naturally produced steelhead would average approximately 3,200 adults for the No Action Alternative (Table B-20). Average annual total naturally produced spawner escapement of chinook salmon (both spring and fall runs) was estimated to be approximately 5,500 adults. These spawner escapement estimates for chinook, coho, and steelhead represent approximately 8 percent of the TRRP goals of 68,000 chinook salmon; 1,400 coho salmon; and 40,000 steelhead annually. These estimates reflect the continuation of declining populations of anadromous salmonids in the Trinity River compared to existing populations. 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.

Commercial harvest of coho salmon is currently managed as a California coastal stock within the Oregon Production Index (OPI) coho stock grouping by PFMC. Significant restrictions of harvest through management actions implemented by the PFMC and NMFS of these stocks resulted in a prohibition of retention of all coho south of Cape Falcon, Oregon, in 1995. On April 25, 1997, NMFS listed this species as threatened in the California range of its distribution, including the Trinity and Klamath River Basins. Current PFMC coho salmon management of the California coastal coho stocks is consistent with NMFS's jeopardy opinion and effectively reduces harvest of Trinity River coho to near zero. For the impact analysis it was assumed that measures to protect and de-list the Northern California component of the Southern Oregon/Northern California coho salmon ESU would be successful by the year 2020, and harvest of naturally produced Trinity coho stocks would be allowed.

On February 28, 1998, NMFS announced that the Klamath Mountains Province Steelhead ESU would not be listed as threatened. In an effort to manage and recover steelhead to populations approaching historic levels, CDFG recently implemented recreational harvest restrictions to prohibit harvest of naturally produced steelhead in the Klamath and Trinity River Basins. This management effectively eliminated harvest of naturally produced steelhead in the Trinity River. Similar to coho salmon populations, it was assumed that steelhead population levels would recover through CDFG management and harvest restrictions to allow removal of sport harvest restrictions by the year 2020. Using this assumption, estimates of tribal, commercial, and sport harvest allocations for anadromous salmonids, based on spawner escapements for the No Action Alternative, are shown in Table B-20.

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.

Coastal Area.

<u>Ocean Sportfishing</u>. Under the No Action Alternative, private boat trips for salmon would be highest in the Northern/Central Oregon Region, accounting for nearly 139,000 trips annually (Table B-21). The ports at Monterey and San Francisco would have the second and third highest number of private boat trips for salmon, accounting annually for about 89,000 and 59,000 trips, respectively. The number of charter boat trips for salmon would be highest in San Francisco (about 82,300 trips), followed by Northern/Central Oregon (47,800 trips) and Monterey (43,700 trips).

Angler benefits associated with ocean sport salmon fishing would follow a pattern similar to the predicted number of trips taken. The Northern/Central Oregon Region would generate the highest benefits, with nearly $10 million in benefits to private boat salmon anglers and about $3.4 million to charter boat anglers (Table B-22). Anglers originating from ports in San Francisco and Monterey would receive the second and third highest levels of benefits. The relatively large number of charter boat trips taken out of San Francisco would generate $1.9 million in net income for charter boat operators in that port area (Table B-23).

Ocean Commercial Fishing. Under the No Action Alternative, an estimated 3,470 naturally produced Trinity River salmon would be available to the ocean commercial fishery, resulting in the projected harvest of a total of 741,800 salmon originating from all sources in 2020. Harvest levels are projected to be relatively high in the regions farthest from the Klamath River Basin and much lower in the regions near the Klamath River Basin. As Table B-14 shows, total harvest levels would range from 2,100 salmon in the KMZ-California Region to 369,100 salmon in the Northern/Central Oregon Region.

The average annual gross value of the ocean commercial harvest, or gross revenue received by salmon harvesters, generated by commercial salmon harvests in 2020 is estimated to total $19.0 million under the No Action Alternative (Table B-15). Gross revenue would range from $54,200 in the KMZ-Oregon Region to $8.0 million in the Northern/Central Oregon Region. The average annual net income (i.e., profit) received by the ocean commercial salmon harvesting sector under the No Action Alternative is estimated to range from $18,000 in the KMZ-Oregon Region to $2.7 million in the Northern/Central Oregon Region (Table B-16).

Central Valley. A summary of the estimated average annual losses of early life stages of chinook salmon from Reclamation's LSALMON2 is shown in Table B-24. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for the No Action Alternative are shown in Attachment B14. In Table B-24, estimates of average annual simulated losses of chinook salmon for the entire simulation period (1922-1990) are presented.

From this evaluation for the No Action Alternative for the entire period of simulation, annual losses of chinook early life stages averaged 11 percent for fall run and 15 percent for spring run (Table B-24). 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 up to 1-3 percent for the entire 1922-1990 simulation period (Table B-24).

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-24).

1.1.2.4 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-17. The individual scoring worksheets are shown in Attachment B12. The assumptions and rationale for scoring each attribute objective is shown in Attachment B13. A summary of the total score of the attributes for all project alternatives is shown in Table B-18. Fisheries Attachment B4 provides summaries of the analysis of temperature attribute objectives (attribute 11-objectives 1 and 2) for the mainstem Trinity River for the project alternatives.

As shown in Table B-18, the Maximum Flow Alternative was scored 60 of the total possible 74 attribute objectives points believed necessary to restore the Trinity River fluvial river system. Only 3 of the 37 attribute objectives thresholds were rated as never or nearly never exceeded (Table B-19). Eight of the 37 attributes were scored as sometimes meeting threshold criteria. Twenty-six of the 37 attribute objectives were scored as always or nearly always exceeding objective thresholds for the Maximum Flow Alternative (Table B-19). 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-24 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 917 percent under the Maximum Flow Alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-24).

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. This project alternative would result in highly beneficial improvements in river system and habitat conditions allowing naturally produced anadromous salmonid populations, including federal threatened coho salmon, to greatly increase over those expected for No Action. Table B-25 reflects this highly beneficial improvement to river system condition and anadromous salmonid populations in the mainstem Trinity River.

The estimated average annual spawner escapement of naturally produced anadromous salmonids in the mainstem Trinity River in the year 2020, under the Maximum Flow Alternative, is shown in Table B-20. Average total spawner escapement of naturally produced chinook salmon (both spring and fall runs) was estimated to be approximately 55,100 adults annually. Average annual total spawner escapements for naturally produced coho and winter steelhead were estimated to be approximately 1,100 and 32,400 adults, respectively, for the Maximum Flow Alternative (Table B-20). These estimates are approximately 81 percent of the TRRP goals of 68,000 chinook salmon; 1,400 coho salmon; and 40,000 steelhead annually. As compared to the No Action Alternative, this is an increase of over 900 percent.

The estimated tribal, commercial, and sport harvest allocations for anadromous salmonids, based on spawner escapements for the Maximum Flow Alternative, are shown in Table B-20.

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

Go To TOC

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 (Table B-25).

Coastal Area.

Ocean Sportfishing. Under the Maximum Flow Alternative, the greatest increase in private boat trips for salmon would be in the KMZ-Oregon Region, accounting for an additional 37,000 trips annually (Table B-21). The ports along Northern/Central Oregon and at Fort Bragg (Mendocino Region) would experience the second and third highest increase in the number of private boat trips for salmon, with annual increases of about 15,100 and 10,000 trips, respectively. The greatest increase in the number of charter boat trips for salmon would occur at ports along Northern/Central Oregon (about 5,200 additional trips), followed by the Mendocino (2,200 trips) and KMZ-Oregon (1,900 trips) Regions. With the exception of a slight increase in the number of charter boat trips from San Francisco, ocean sport salmon trips originating from the ports of San Francisco and Monterey are not expected to increase.

The increase in angler benefits associated with ocean sport salmon fishing would be greatest for salmon anglers originating from the KMZ-Oregon Region, with an estimated increase of nearly $2.7 million in benefits to private boat salmon anglers and about $350,000 to charter boat anglers (Table B-22). Anglers originating from ports along the Northern/Central Oregon and Mendocino Regions would receive the second and third highest increase in angler benefits. Charter boat operators out of the Mendocino Region would receive the greatest increase ($51,000) in annual net income (Table B-23).

Ocean Commercial Fishing. Under the Maximum Flow Alternative, the ocean commercial salmon harvest is estimated to be larger than under any of the other project alternatives. Relative to no action levels, the number of naturally produced Trinity River salmon available for commercial harvest is estimated to increase from 3,470 to 35,300. This change would result in the overall harvest of salmon originating from all sources increasing by a projected total of 349,300 salmon, or by 47 percent, by 2020 (Table B-14). The greatest percentage increase would occur in the regions nearest to the Klamath River Basin, including the KMZ-California, the KMZ-Oregon, and the Mendocino Regions, with increases of more than 600 percent (Table B-26). In numeric terms, the increase in the harvest would be greatest in

Go To TOC

the Northern/Central Oregon Region, where harvests are projected to increase by 211,200 salmon relative to the No Action Alternative. This increase would primarily result from increased chinook harvests in the Coos Bay port area and coho harvests elsewhere in the region. Harvests in the San Francisco and Monterey Regions are expected to be similar to no action levels in 2020.

Relative to no action levels, gross harvest revenue and net income would annually increase by a projected $8.5 million and $3.0 million, respectively, by 2020 (Table B-15 and B-16). As shown in Table B-26, increases in gross harvest revenues would range from $533,100 in the KMZ-Oregon Region to $4.6 million in the Northern/Central Oregon Region. Increases in average annual net income for the harvesting sector are projected to range from $177,000 in the KMZ-Oregon Region to $1.5 million in the Northern/Central Oregon Region. No significant changes in gross revenue and net income are expected in the San Francisco and Monterey Regions.

Because harvest levels would be higher under the Maximum Flow Alternative compared to the No Action Alternative, ocean commercial harvest effects are considered beneficial for the Northern/Central Oregon, KMZ-Oregon, KMZ-California, and Mendocino Regions.

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 LSALMON2 is shown in Table B-24. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for the Maximum Flow Alternative are shown in Attachment B14. In Table B-24, estimates of average annual simulated losses of chinook salmon for the entire simulation period (1922-1990) are presented.

From this evaluation, the Maximum Flow Alternative for the historic simulated period of 1922 through 1990 increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 13 percent (fall chinook) and 17 percent (spring chinook) early life stages, an increase over the No Action Alternative of 2 percent (Table B-27).

The estimated losses for late-fall chinook were unchanged from those estimated for this species under the No Action Alternative (1 percent). The average annual losses for endangered winter chinook were estimated to be 11 percent for the 1922-1990 simulation period (Table B-24).

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 1922-1990 period of simulation (Table B-27). Reviewing the estimated losses of winter chinook salmon in Attachment B14 revealed that the majority of estimated losses for this species, compared to the No Action Alternative, resulted from extremely high mortalities during a small number of critically dry water years (1924, 1931 through 1935, and 1977). 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 NMFS 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 this species.

Go To TOC

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-24). This estimate is unchanged from that for the No Action Alternative.

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 8 percent increase in average annual losses for the 1922-1990 period of simulation (Table B-27). These increases in losses are small as compared to the No Action Alternative, and, except for winter chinook, these estimates may be within the limits of precision of the model used to estimate them. However, these estimated losses in 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-28.

1.1.2.5 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-17. The individual scoring worksheets are shown in Attachment B12. The assumptions and rationale for scoring each attribute objective is shown in Fisheries Attachment B13. A summary of the total score of the attributes for all project alternatives is shown in Table B-18. Attachment B4 provides summaries of the analysis of temperature attribute objectives (attribute 11-objectives 1 and 2) for the mainstem Trinity River for the project alternatives.

As shown in Table B-18, the Flow Evaluation Alternative was scored 50 of the total possible 74 attribute objective points believed necessary to restore the Trinity River fluvial river system. Eight of the 37 attribute objectives were determined to never or nearly never exceed threshold criteria (Table B-19). Six of the 37 attribute objectives were found to sometimes exceed thresholds. Twenty-one of the 37 attribute objectives were scored as always or nearly always exceeding objective thresholds for the Flow Evaluation Alternative (Table B-19). While this alternative was not as effective as the Maximum Flow Alternative, 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-29 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 nearly 733 percent under the Flow Evaluation Alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-29).

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. 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-25 reflects this highly beneficial improvement to river system condition and anadromous salmonid populations in the mainstem Trinity River.

The estimated average annual spawner escapement of naturally produced anadromous salmonids in the mainstem Trinity River in the year 2020, under the Flow Evaluation Alternative, is shown in Table B-20. Average total spawner escapement of naturally produced chinook salmon (both spring and fall runs) was estimated to be approximately 45,000 adults annually. Average annual total spawner escapements for naturally produced coho and winter steelhead were estimated to be approximately 900, and 26,500 adults, respectively, for the Flow Evaluation Alternative (Table B-20). These estimates are approximately 66 percent of the TRRP goals of 68,000 chinook salmon; 1,400 coho salmon; and 40,000 steelhead annually. As compared to the No Action Alternative, this is an increase of approximately 717 percent.

The estimated tribal, commercial, and sport harvest allocations for anadromous salmonids, based on spawner escapements for the Flow Evaluation Alternative, are shown in Table B-20.

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 result in increased populations under the Maximum Flow Alternative (Table B-25).

Coastal Area.

Ocean Sportfishing. Similar to the Maximum Flow Alternative, the greatest increase in private boat trips for salmon under the Flow Evaluation Alternative would be in the KMZ-Oregon Region, accounting for an additional 35,500 trips annually (Table B-21). The ports along Northern/Central Oregon and at Fort Bragg (Mendocino Region) would experience the second and third highest increase in the number of private boat trips for salmon, with annual increases of about 14,200 and 9,300 trips, respectively. The greatest increase in the number of charter boat trips for salmon would occur at ports along Northern/Central Oregon (about 4,900 additional trips), followed by the Mendocino (2,100 trips) and KMZ-Oregon (1,900 trips) Regions. With the exception of a slight increase in the number of charter boat trips from San Francisco, ocean sport salmon trips originating from the ports of San Francisco and Monterey are not expected to increase.

The increase in angler benefits associated with ocean sport salmon fishing would be greatest for salmon anglers originating from the KMZ-Oregon Region, with an estimated increase of nearly $2.6 million in benefits to private boat salmon anglers and about $340,000 to charter boat anglers (Table B-22). Anglers originating from ports along the Northern/Central Oregon and Mendocino Region would receive the second and third highest increase in angler benefits. Charter boat operators out of the Mendocino Region would receive the greatest increase ($47,400) in annual net income (Table B-23).

<u>Ocean Commercial Fishing</u>. Ocean commercial salmon harvest levels under the Flow Evaluation Alternative would be second only to the Maximum Flow Alternative among the project alternatives. Relative to no action levels, the number of naturally produced Trinity River chinook salmon available for commercial harvest is estimated to increase from 3,470 to 29,300. This change would result in the overall harvest of salmon originating from all sources increasing by a projected total of 319,900 salmon, or by 43 percent, by 2020 (Table B-14). The greatest percentage increase would occur in the regions nearest to the Klamath River Basin, including the KMZ-California, the KMZ-Oregon, and the Mendocino Regions, with increases of more than 500 percent (Table B-26). In numeric terms, harvest increases would be greatest in the Northern/Central Oregon Region, where harvests are projected to increase by 196,400 salmon relative to the No Action Alternative. This increase would primarily result from increased chinook harvests in the Coos Bay port area and coho harvests elsewhere in the region. Harvests in the San Francisco and Monterey Regions are expected to be similar to no action levels in 2020.

Relative to no action levels, gross harvest revenue and net income would annually increase by a projected $7.7 million and $2.7 million, respectively, by 2020 (Table B-15 and B-16). As shown in Table B-26, increases in gross harvest revenues would range from $492,000 in the KMZ-Oregon Region to $4.3 million in the Northern/Central Oregon Region. Increases in average annual net income for the harvesting sector are projected to range from $163,300 in the KMZ-Oregon Region to $1.4 million in the Northern/Central Oregon Region. No significant changes in gross revenue and net income are expected in the San Francisco and Monterey Regions.

Because harvest levels would be higher under the Flow Evaluation Alternative compared to the No Action Alternative, ocean commercial harvest effects are considered beneficial for the Northern/Central Oregon, KMZ-Oregon, KMZ-California, and Mendocino Regions.

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 LSALMON2 is shown in Table B-24. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for the Flow Evaluation Alternative are shown in Attachment B14.

From this evaluation for the Flow Evaluation Alternative for the historic simulated period of 1922 through 1990, increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 12 percent (fall chinook) and 16 percent (spring chinook) early life stages; an increase over the No Action Alternative of up to 1 percent (Table B-27).

Average annual losses of late-fall and winter chinook salmon were estimated to be substantially less than those for spring chinook and averaged 1 percent for late-fall chinook for the 1928-1934 simulation period. This estimated average annual loss for late-fall chinook was unchanged from that estimated for this species under the No Action Alternative. The average annual losses for endangered winter chinook were estimated to be 5 percent for the entire 1922-1990 simulation period (Table B-24).

For endangered winter chinook salmon, these estimates represent an increase in annual average losses of only 2 percent greater than those estimated for the No Action Alternative (Table B-27). Reviewing the estimated losses of winter chinook salmon in Attachment B14 revealed that the majority of estimated losses for this species, compared to the No Action Alternative, resulted from extremely high mortalities during a small number of critically dry water years (1924, 1932 through 1934, and 1977). 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 NMFS 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 this 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 Flow Evaluation Alternative (Table B-24). This estimate is unchanged from that for the No Action Alternative.

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 2 percent increase in average annual losses for the 1922-1990 period of simulation, depending on species (Table B-27). 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 for 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-28.

1.1.2.6 Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Percent Inflow Alternative are shown in Table B-17. The individual scoring worksheets are shown in Attachment B12. The assumptions and rationale for scoring each attribute objective is shown in Attachment B13. A summary of the total score of the attributes for all project alternatives is shown in Table B-18. Attachment B4 provides summaries of the analysis

Go To TOC

of temperature attribute objectives (attribute 11-objectives 1 and 2) for the mainstem Trinity River for the project alternatives.

As shown in Table B-18, the Percent Inflow Alternative was scored 17 out of the total possible 74 attribute objective points believed necessary to restore the Trinity River fluvial river system. A majority of the attribute objectives (26 of the 37) were determined to never or nearly never exceed threshold criteria for this alternative (Table B-19). Five of the 37 attribute objectives were found to sometimes exceed objective thresholds. Only 6 of the 37 attribute objectives were scored as always or nearly always exceeding objective thresholds for this alternative (Table B-19). The objectives which were determined to always or nearly always exceed threshold criteria were those for Attribute 2: "Flows and Water Quality are Predictably Unpredictable." Because of the nature of this alternative, the inter- and intra-annual stream flows are always or nearly always variable.

This alternative was determined to provide some additional benefits in meeting river system attribute objectives compared to No Action. However, the Percent Inflow Alternative was not nearly as effective, as compared to the Maximum Flow or Flow Evaluation Alternatives, in meeting the river system and habitat requirements necessary for restoring native anadromous salmonids in the mainstem Trinity River. Table B-29 summarizes the estimated changes in river system health and habitat conditions for anadromous salmonids for the Percent Inflow Alternative compared to No Action. These results indicate that conditions would be expected to improve approximately 183 percent under the Percent Inflow Alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-29).

Compared to No Action, fishery habitat in the mainstem Trinity River in the year 2020 would be expected to improve somewhat under the Percent Inflow Alternative. Some small but beneficial improvements in river system health and function would benefit anadromous salmonid populations as compared to No Action. Table B-25 reflects the benefit to river system conditions for native anadromous salmonid populations in the mainstem Trinity River.

The estimated average annual spawner escapement of native anadromous salmonids in the mainstem Trinity River in the year 2020, under the Percent Inflow Alternative, is shown in Table B-20. Average total spawner escapement of naturally produced chinook salmon (both spring and fall runs) was estimated to be approximately 15,600 adults annually. Average annual total spawner escapements for naturally produced coho and winter steelhead were estimated to be approximately 300 and 9,200 adults, respectively, for the Percent Inflow Alternative (Table B-20). These estimates are approximately 23 percent of the TRRP goals of 68,000 chinook salmon; 1,400 coho salmon; and 40,000 steelhead annually. As compared to the No Action Alternative, this is an increase of approximately 183 percent.

The estimated tribal, commercial, and sport harvest allocations for anadromous salmonids, based on spawner escapements for the Percent Inflow Alternative, are shown in Table B-20.

Lower Klamath River Basin. The Percent Inflow Alternative would result in improved water temperature conditions and increased Trinity River flows in normal, wet, and extremely wet water years. In these years, increased annual flows (ranging from approximately 100-975 taf) and improved water temperature conditions during smolt out-migration could result in improved habitat conditions in the lower Klamath River and estuary.

Go To TOC

However, in dry and critically dry water years, annual discharges would be from 16 (in dry water years) to 175 taf (in critical water) less than those for the No Action Alternative. During these years, water temperatures in the Trinity River would be either similar or warmer, which may be detrimental to anadromous salmonids compared to those for the No Action Alternative. For dry and critical dry years, river system conditions and functions in the lower Klamath River would be less beneficial or detrimental to anadromous salmonids compared to the No Action Alternative. The benefits to anadromous salmonids resulting from improved habitat conditions during years of abundant flow and more optimal water temperatures may be more than offset by those water years in which flows are diminished and temperatures more limiting and potentially lethal. Therefore, in the long term, river system health and function and habitat conditions in the lower Klamath River and estuary would likely be unchanged from those for the No Action Alternative. Populations of anadromous salmonids in the lower Klamath River would neither benefit nor be diminished as a result of implementing this alternative.

Coastal Area.

Ocean Sportfishing. Similar to the Maximum Flow and Flow Evaluation Alternatives, the greatest increase in private boat trips for salmon under the Percent Inflow Alternative would be in the KMZ-Oregon Region, accounting for an additional 29,700 trips annually (Table B-21). The ports along Northern/Central Oregon and in the KMZ-California Region would experience the second and third highest increase in the number of private boat trips for salmon, with annual increases of about 11,200 and 6,500 trips, respectively. The greatest increase in the number of charter boat trips for salmon would occur at ports along Northern/Central Oregon (about 3,800 additional trips), followed by the KMZ-Oregon (1,600 trips) and Mendocino (1,400 trips) Regions. With the exception of a slight increase in the number of charter boat trips from San Francisco, ocean sport salmon trips originating from the ports of San Francisco and Monterey are not expected to increase.

The increase in angler benefits associated with ocean sport salmon fishing would be greatest for salmon anglers originating from the KMZ-Oregon Region, with an estimated increase of nearly $2.1 million in benefits to private boat salmon anglers and about $318,000 to charter boat anglers (Table B-22). Anglers originating from ports along the Northern/Central Oregon and Mendocino Regions would receive the second and third highest increase in angler benefits. Charter boat operators out of the Mendocino Region would receive the greatest increase ($31,100) in annual net income (Table B-23).

Ocean Commercial Fishing. Under the Percent Inflow Alternative, average annual ocean commercial salmon harvests would be smaller than under the Maximum Flow and Flow Evaluation Alternatives, but would be substantially higher than under no action conditions. Relative to no action levels, the number of naturally produced Trinity River salmon available for commercial harvest is estimated to increase from 3,470 to 10,000. This change would result in the overall harvest of salmon originating from all sources increasing by a projected total of 224,300 salmon, or by 30 percent, by 2020 (Table B-14). The greatest percentage increase would occur in the regions nearest to the Klamath River Basin, including the KMZ-California, the KMZ-Oregon, and the Mendocino Regions, with increases of approximately 300 percent or more (Table B-26). In numeric terms, harvest increases would be greatest in the Northern/Central Oregon Region, where harvests are project to increase by

148,600 salmon relative to the No Action Alternative. Harvests in the San Francisco and Monterey Regions are expected to be similar to no action levels in 2020.

Relative to no action levels, gross harvest revenue and net income would annually increase by a projected $5.3 million and $1.9 million, respectively, by 2020 (Table B-15 and B-16). As shown in Table B-26, increases in gross harvest revenues would range from $353,300 in the KMZ-Oregon Region to $3.2 million in the Northern/Central Oregon Region. Increases in average annual net income for the harvesting sector are projected to range from $117,300 in the KMZ-Oregon Region to $1.1 million in the Northern/Central Oregon Region. No significant changes in gross revenue and net income are expected in the San Francisco and Monterey Regions.

Because harvest levels would be higher under the Percent Inflow Alternative compared to the No Action Alternative, ocean commercial harvest effects are considered beneficial for the Northern/Central Oregon, KMZ-Oregon, KMZ-California, and Mendocino Regions.

Central Valley. A summary of the estimated average annual losses of early life stages of chinook salmon for the Percent Inflow Alternative from Reclamation's LSALMON2 is shown in Table B-24. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for the Percent Inflow Alternative are shown in Attachment B14.

From this evaluation for the Percent Inflow Alternative for the historic simulated period of 1922 through 1990, increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 11 percent (fall chinook) and 15 percent (spring chinook) early life stages; an increase of approximately 1 percent from the No Action Alternative (Table B-27).

Average annual losses of late-fall and winter chinook salmon were estimated to be substantially less than those for spring chinook and averaged 1 percent for late-fall chinook for the 1922-1990 simulation period. These estimated losses for late-fall chinook were unchanged from those estimated for this species under the No Action Alternative. The average annual losses for endangered winter chinook were estimated to be 3 percent for the 1922-1990 simulation period (Table B-24).

For endangered winter chinook salmon, these estimates represent no change in annual average losses from those estimated for the No Action Alternative (Table B-27).

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 Percent Inflow Alternative (Table B-24). This estimate is unchanged from that for the No Action Alternative.

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 Percent Inflow Alternative were compared to No Action. The results of this evaluation ranged from no change to a 1 percent increase in average annual losses for the 1922-1990 period of simulation, depending on species (Table B-27). 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 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 Percent Inflow Alternative on the anadromous salmonids within the Sacramento River are summarized in Table B-28.

1.1.2.7 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-17. The individual scoring worksheets are shown in Attachment B12. The assumptions and rationale for scoring each attribute objective is shown in Attachment B13. A summary of the total score of the attributes for all project alternatives is shown in Table B-18. Attachment B4 provides summaries of the analysis of temperature attribute objectives (attribute 11-objectives 1 and 2) for the mainstem Trinity River for the project alternatives.

As shown in Table B-18, the Mechanical Restoration Alternative was scored 13 out of the total possible 74 attribute objectives points believed necessary to restore the Trinity River fluvial river system. A majority of the attribute objectives (27 of the 37) were determined to never or nearly never exceed threshold criteria for this alternative (Table B-19). Seven of the 37 attribute objectives were found to sometimes exceed objective thresholds. Only 3 of the 37 attribute objectives were scored as always or nearly always exceeding objective thresholds for this alternative (Table B-19). One of the objectives which was determined to always or nearly always exceed threshold criteria was that for Attribute 9 in which periodic removal of large riparian trees would be accomplished by mechanical means.

This alternative was determined to provide some benefit in meeting river system attribute objectives compared to the No Action Alternative, but even less than that for the Percent Inflow Alternative. The Mechanical Restoration Alternative was not effective, as compared to the Maximum Flow or Flow Evaluation Alternatives, in meeting the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids in the mainstem Trinity River. Table B-29 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 117 percent under this alternative as compared to the No Action Alternative, using the TRSAAM scores as a measure of comparison (Table B-29).

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. 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. Table B-25 reflects the benefit to river system conditions for anadromous salmonid populations in the mainstem Trinity River.

The estimated average annual spawner escapement of naturally produced anadromous salmonids in the mainstem Trinity River in the year 2020, under the Mechanical Restoration Alternative, is shown in Table B-20. Average total spawner escapement of naturally produced chinook salmon (both spring and fall runs) was estimated to be approximately 11,900 adults annually. Average annual total spawner escapements for naturally produced coho and winter steelhead were estimated to be approximately 200 and 7,000 adults, respectively, for the Mechanical Restoration Alternative (Table B-20). These estimates are approximately 18 percent of the TRRP goals of 68,000 chinook salmon; 1,400 coho salmon; and 40,000 steelhead annually. As compared to the No Action Alternative, this is an increase of approximately 117 percent.

The estimated tribal, commercial, and sport harvest allocations for anadromous salmonids, based on spawner escapements for the Mechanical Restoration Alternative, are shown in Table B-20.

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 remain unchanged under this project alternative.

Coastal Area.

Ocean Sportfishing. Similar to the other alternative, the greatest increase in private boat trips for salmon under the Mechanical Restoration Alternative would be in the KMZ-Oregon Region, accounting for an additional 28,800 trips annually (Table B-21). The ports along Northern/Central Oregon and in the KMZ-California Regions would experience the second and third highest increase in the number of private boat trips for salmon, with annual increases of about 10,800 and 6,200 trips, respectively. The greatest increase in the number of charter boat trips for salmon would occur at ports along Northern/Central Oregon (about 3,700 additional trips), followed by KMZ-Oregon (1,500 trips) and the Mendocino (1,300 trips) Regions. With the exception of a slight increase in the number of charter boat trips from San Francisco, ocean sport salmon trips originating from the ports of San Francisco and Monterey are not expected to increase.

The increase in angler benefits associated with ocean sport salmon fishing would be greatest for salmon anglers originating from the KMZ-Oregon Region, with an estimated increase of nearly $2.1 million in benefits to private boat salmon anglers and about $314,000 to charter boat anglers (Table B-22). Anglers originating from ports along the Northern/Central Oregon and Mendocino Region would receive the second and third highest increase in angler benefits. Charter boat operators out of the Mendocino Region would receive the greatest increase ($28,600) in annual net income (Table B-23).

Ocean Commercial Fishing. Under the Mechanical Restoration Alternative, the ocean commercial salmon harvest is estimated to be smaller than under all other project alternatives other than the State Permit Alternative, although harvest levels would be similar to harvests under the Percent Inflow Alternative. Harvest levels under the Mechanical Restoration Alternative, however, would be higher than under the No Action Alternative. Relative to no action levels, the number of naturally produced Trinity River salmon available for commercial harvest is estimated to increase from 3,470 to 7,540. This change would result in the overall harvest of salmon originating from all sources increasing by a projected total of

212,000 salmon, or by 29 percent, by 2020 (Table B-14). The greatest percentage increase would occur in the regions nearest to the Klamath River Basin, including the KMZ-California, the KMZ-Oregon, and the Mendocino Regions, with increases of over 200 percent (Table B-26). In numeric terms, harvest increases would be greatest in the Northern/Central Oregon Region, where harvests are project to increase by 142,500 salmon relative to the No Action Alternative. Harvests in the San Francisco and Monterey Regions are expected to be similar to no action levels in 2020.

Relative to no action levels, gross harvest revenue and net income would annually increase by a projected $5.0 million and $1.8 million, respectively, by 2020 (Table B-15 and B-16). As shown in Table B-26, increases in gross harvest revenues would range from $333,700 in the KMZ-Oregon Region to $3.1 million in the Northern/Central Oregon Region. Increases in average annual net income for the harvesting sector are projected to range from $110,800 in the KMZ-Oregon Region to $1.0 million in the Northern/Central Oregon Region. No significant changes in gross revenue and net income are expected in the San Francisco and Monterey Regions.

Because harvest levels would be higher under the Mechanical Restoration Alternative compared to the No Action Alternative, ocean commercial harvest effects are considered beneficial for the Northern/Central Oregon, KMZ-Oregon, KMZ-California, and Mendocino Regions.

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.

1.1.2.8 Harvest Management Alternative

Trinity River Basin. The Harvest Management Alternative would attempt to restore anadromous salmonid populations through increased harvest restrictions. Trinity River flows would remain at the No Action levels of 340 taf annually. Because the flows and all other factors affecting inriver habitat would remain the same as No Action, the results of the TRSAAM analysis and scoring for all attribute objectives would be the same as No Action. The TRSAAM scoring results for the Harvest Management Alternative are shown in Table B-17. For comparison, the summary of the total score of the attributes for all project alternatives is shown in Table B-18.

As shown in Table B-18, the Harvest Management Alternative, like the No Action Alternative, scored only 6 of the total possible 74 attribute objective points believed necessary to restore the Trinity River fluvial river system. Thirty of the 37 attribute objective thresholds were determined to be never or nearly never exceeded (Table B-17). For only two objectives (attribute 2-objectives 3 and 4) did the Harvest Management Alternative sometimes meet the attribute objective thresholds. For only two objectives did the No Action Alternative always or nearly always meet attribute objective thresholds. Those objective thresholds that were always or nearly always met include: groundwater recharge of gravel bars (attribute 10-objective 1) and meeting SWRCB objectives for water temperatures (attribute 11-objective 2) (Table B-17).

Also like the No Action Alternative, the Harvest Management Alternative performed poorly in meeting the river system and habitat requirements necessary for restoring naturally

Go To TOC

produced anadromous salmonids in the mainstem Trinity River. These results indicate that under the Harvest Management Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would not provide the conditions necessary to allow salmonid stocks to recover to pre-dam population levels.

The estimated average annual spawner escapement and an estimated index of production of the number of adult chinook salmon for increments of harvest reduction between 0 percent (= level of harvest for No Action) and 100 percent reduction is shown in Table B-30. These estimates are for naturally produced chinook salmon (fall and spring combined) for Trinity River stocks in the year 2020 under the Harvest Management Alternative. Average annual total spawner escapements for naturally produced coho and winter steelhead were unable to be estimated for this alternative as there is no corresponding HRMs for these species. No analysis for these species was attempted.

The Klamath Harvest Management model estimated that, assuming no harvest reduction from existing levels, the average annual spawner escapement for naturally produced chinook salmon for the Harvest Management Alternative was approximately 5,500 adults (Table B-30). This spawner escapement estimate is approximately 8 percent of the TRRP goal of 68,000 chinook salmon annually. Using the model, the estimated total harvest of naturally produced chinook salmon with no harvest reduction was estimated to be 10,300 (Table B-30). It was estimated that with no harvest reduction, the chinook salmon production index would be 15,800 adults annually (Table B-30). Results of the analysis are summarized in Attachment B15.

Results of this analysis indicated that, as harvest was reduced, spawner escapement increased incrementally; and total natural production of adult chinook salmon, as predicted by the production index, decreased slightly (Table B-30). Thus, using the Ricker stock-recruit relationship assumptions and current parameters of the Klamath Harvest Management model for the chinook fishery, total chinook production decreased slightly even with the total elimination (100 percent reduction) of harvest. These results indicated that with decreased harvest rates, total adult chinook salmon production did not increase, but in fact slightly decreased, likely as a result of habitat limitations required to support ever increasing spawner escapements.

At harvest reductions of 75 percent (harvest rates of 25 percent of No Action), spawner escapement of chinook salmon was estimated to improve to approximately 12,300; and total production decreased to 15,200 adults (Table B-30). However, the spawner escapement at a 75 percent reduction of harvest is only 18 percent of the restoration goal of 68,000 chinook salmon on a yearly basis. Even with a complete elimination of harvest (100 percent reduction), spawner escapement (=Production Index) was estimated to be only 15,000 adults, approximately 22 percent of the restoration goal. Clearly, with the elimination of the majority of the harvest (75 percent reduction) or with the total elimination of harvest (100 percent reduction), the Harvest Management Alternative would fall well short of restoring adult chinook salmon populations to levels mandated for the restoration of this species in the Trinity River Basin. This alternative would not result in changes in total production of adult chinook salmon as compared to No Action.

In summary, the results of the analysis indicated that although spawner escapement increased due to increasing harvest restrictions, natural production, as indicated by the production index, actually decreased (Table 1 in Attachment B15). The lack of a positive response (i.e., increase in production) with increased harvest restrictions is most likely due to the current quantity and quality of anadromous fish habitat in the Trinity River. In other words, the analysis indicated that habitat, and not the number of spawning adults, is the limiting factor in the natural production of anadromous fish in the Trinity River. Therefore, increasing escapements above the level that is supportable under the habitat conditions of the No Action Alternative are likely to oversaturate available habitat and result in decreased production due to density-dependent mortality. Based on the results of this analysis, this alternative does not meet the purpose and need of restoring natural production of anadromous fish in the Trinity River. Hence, this alternative was eliminated from consideration and no further analysis was conducted. For specific details of all the analyses that were conducted, see Attachments B6-B9 and B15.

1.1.2.9 State Permit Alternative

Trinity River Basin. The results of the TRSAAM scoring for all attribute objectives for the State Permit Alternative are shown in Table B-17. The individual scoring worksheets are shown in Attachment B12. The assumptions and rationale for scoring each attribute objective is shown in Attachment B13. A summary of the total score of the attributes for all project alternatives is shown in Table B-18. Attachment B4 provides summaries of the analysis of temperature attribute objectives (attribute 11-objectives 1 and 2) for the mainstem Trinity River for the project alternatives.

As shown in Table B-18, the State Permit Alternative scored 0 of the total possible 74 attribute objective points believed necessary to restore the Trinity River fluvial river system. All of the 37 attribute objectives thresholds were rated as never or nearly never exceeded (Table B-19).

The State Permit Alternative performed poorly and did not meet any of the river system and habitat requirements necessary for restoring and maintaining naturally produced anadromous salmonids in the mainstem Trinity River. These results indicate that, under the State Permit Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would not provide the conditions necessary to allow salmonid stocks to recover to pre-dam population levels. The TRFCRTT determined, given the current and likely future habitat conditions as shown in the TRSAAM analysis for this alternative and the existing depressed populations of naturally produced anadromous salmonids, it was likely that there would be no distinguishable natural production of chinook and coho salmon and steelhead in the mainstem Trinity River in the year 2020. A summary of the rationale for this conclusion is provided in Attachment B9.

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. Conversely, decreased flows and increased water temperatures in the Trinity River would likely result in less favorable conditions in the lower Klamath River and estuary. Decreased flows to the Klamath River of approximately 218 taf annually would reduce habitat quantity and quality in the lower Klamath River and estuary. The temperature evaluation results (Attachment B4) indicated that the temperatures in the Trinity River from spring reservoir releases for the

Go To TOC

State Permit Alternative resulted in the same number of total weeks (1 of 12) meeting the optimal temperature requirements for smolts and fewer total weeks (8 of 12) meeting marginal temperature requirements than did the No Action Alternative (10 of 12).

These results indicate that, for the State Permit Alternative, temperatures in the lower Klamath River downstream of the confluence with the Trinity would likely be warmer than those for the No Action Alternative. Warmer temperatures and lower flows would diminish habitat conditions and increase travel time in the lower Klamath River during a critical period of out-migration of anadromous salmonid smolts.

Poorer habitat conditions, as a result of increased temperatures and decreased flows, would likely decrease survival rates of out-migrating smolts and reduce the probability of their successful passage to the ocean. An additional adverse impact to naturally produced anadromous salmonids in the lower Klamath River and estuary would result from poorer conditions for juveniles that rear in the river for an additional year before out-migrating (U.S. Fish and Wildlife Service, 1998). Coho salmon and steelhead would be particularly adversely impacted from the deterioration of 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 life. For these reasons, it is likely that naturally produced anadromous salmonids in the Klamath River and Trinity River Basin would be adversely impacted if this alternative were implemented. These adverse impacts would result in decreased populations under the State Permit Alternative.

Coastal Area.

Ocean Sportfishing. Under the State Permit Alternative, private boat trips for salmon would decrease compared to the No Action Alternative. This decrease would be highest in the Northern/Central Oregon Region, with an estimated annual reduction of 18,500 private boat trips for salmon (Table B-21). The ports along the KMZ-California and Mendocino Regions would have the second and third highest decrease in the number of private boat trips for salmon, with decreases of about 8,100 and 7,500 trips, respectively. The decline in the number of charter boat trips for salmon would be highest in the Northern/Central Oregon Region (about 6,400 trips), followed by the San Francisco (5,400 trips) and Monterey (3,100 trips) Regions.

The decline in angler benefits associated with ocean sport salmon fishing also would be highest in the Northern/Central Oregon Region, with a decline of more than $1.3 million in benefits to private boat salmon anglers and about $460,000 to charter boat anglers (Table B-22). Anglers originating from ports in Mendocino and San Francisco would experience the second and third greatest reductions in benefits. Because of the relatively large number of charter boat trips taken out of San Francisco, charter boat operators there would experience the greatest reduction in net income, approximately $123,000 annually (Table B-23).

Ocean Commercial Fishing. Under the State Permit Alternative, the ocean commercial salmon harvest is estimated to decrease relative to no action levels, making the State Permit Alternative the only alternative under which harvests would decline. Habitat conditions for naturally produced Trinity River salmon are expected to be so poor under this alternative that few salmon would be available for commercial harvest, resulting in potential listing of the anadromous fishery resources of the Trinity River under the ESA. To protect naturally produced Trinity River salmon, the ocean commercial salmon fishery in the KMZ and Mendocino regions would likely be shut down, virtually eliminating salmon harvests. In the regions farther away from the Klamath River Basin (i.e., the Northern/Central Oregon, San Francisco, and Monterey Regions), salmon harvests presumably would be permitted, but at lower levels than under no action conditions.

Compared to harvest levels under the No Action Alternative, the overall harvest is projected to decrease by a projected total of 287,300 salmon, or by 39 percent, by 2020 under the State Permit Alternative (Table B-14). Harvest restrictions would result in harvests of salmon originating from all sources decreasing by 100 percent in the KMZ-Oregon, KMZ-California, and Mendocino Regions, and by 27 percent-46 percent in the San Francisco, Monterey, and Northern/Central Oregon Regions relative to no action levels (Table B-26). In numeric terms, the decrease in harvests would be greatest in the Northern/Central Oregon Region, where harvests are projected to decrease by 171,600 salmon relative to the No Action Alternative.

Harvest restrictions would result in reduced gross harvest revenue and net income received by the salmon harvesting industry. Relative to no action levels, gross harvest revenue and net income would annually decrease by a projected $7.1 million and $2.5 million, respectively, by 2020 (Table B-15 and B-16). As shown in Table B-26, decreases in gross harvest revenues would range from $54,200 in the KMZ-Oregon Region to $3.7 million in the Northern/Central Oregon Region. Decreases in average annual net income for the harvesting sector are projected to range from $18,000 in the KMZ-Oregon Region to $1.2 million in the Northern/Central Oregon Region.

Negative commercial fishing impacts would occur in all regions under the State Permit Alternative. Although harvest levels in the San Francisco and Monterey Regions are estimated to decrease by up to 28 percent relative to no action levels, these changes would fall within the 30 percent standard deviation in harvest levels between 1970 and 1990, and are, therefore, considered adverse, but less than significant. Harvest reductions in the Northern/Central Oregon, KMZ-Oregon, KMZ-California, and Mendocino Regions would exceed the historical standard deviation in commercial harvests and are, therefore, considered significant.

Central Valley. A summary of the estimated average annual losses of early life stages of chinook salmon for the State Permit Alternative from Reclamation's LSALMON2 is shown in Table B-24. Tables of annual estimated mortalities for fall, late-fall, winter, and spring chinook salmon for the State Permit Alternative are shown in Attachment B14.

From this evaluation for the State Permit Alternative for the historic simulated period of 1922 through 1990, changes in water temperatures resulted in an estimated annual average loss of 10 percent (fall run) and 13 percent (spring run) early life stages; a decrease from the No Action Alternative of 1 percent and 3 percent, respectively (Table B-27).

Average annual losses of late-fall and winter chinook salmon were estimated to be substantially less than those for spring chinook and averaged 1 percent for late-fall chinook for the simulation period (Table B-24). These estimated losses for late-fall chinook remained unchanged from those estimated for this species as compared to the No Action Alternative.

Go To TOC

The average annual losses for endangered winter chinook were estimated to be 2 percent for the 1922-1990 water year simulation period (Table B-24). For endangered winter chinook salmon, these estimates represent a slight (1 percent) reduction in annual average losses compared to those estimated for the No Action Alternative (Table B-27).

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 State Permit Alternative, depending on the period of simulation (Table B-24). This estimate is unchanged from that for the No Action Alternative.

In summary, the estimated losses resulting from changes in water temperature on the early life stages of chinook salmon and steelhead in the Sacramento River for the State Permit Alternative were compared to No Action. The results of this evaluation ranged from no change to a 3 percent decrease in average annual losses for the 1922-1990 period of simulation, depending on species (Table B-27). These decreased 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 for chinook salmon in the Sacramento River would be significant and represent a benefit to chinook salmon from the No Action Alternative.

The results of the evaluation of the State Permit Alternative on the anadromous salmonids within the Sacramento River are summarized in Table B-28.

1.1.2.10 Existing Conditions versus Preferred 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. For CEQA purposes, the Preferred 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 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 (2vs. 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).

Coastal Area.

<u>Ocean Sportfishing</u>. Under the Preferred Alternative, ocean sportfishing for salmon would increase in response to human population growth and enhanced salmon populations. As shown in Table B-21, the increase in the number of private boat trips for salmon would range from about 12,300 trips in the San Francisco Region to about 52,700 trips in the KMZ-Oregon Region. In some regions, such as San Francisco and Monterey, human population growth accounts for nearly all of the predicted increase in activity. In other regions, such as the KMZ-Oregon Region, human population growth accounts for a much smaller proportion (32 percent) of the predicted increase in ocean sport salmon fishing activity.

Predicted changes in angler benefits and net income to charter boat operators under the Preferred Alternative are shown in Tables B-22 and B-23, respectively. Similar to sport-fishing trips, human population growth accounts for most of the increases in these measures in the San Francisco and Monterey Regions but a much smaller proportion in the other regions.

Ocean Commercial Fishing. Under the Preferred Alternative, harvest levels would be similar to, but slightly higher than, harvest levels under the Flow Evaluation Alternative. Although the restoration component of the Preferred Alternative, which would be similar to restoration efforts under the Mechanical Restoration Alternative, would likely result in somewhat higher harvest levels than under the Flow Evaluation Alternative; the TRFCRTT was unable to estimate the beneficial harvest-related effects of these actions. Consequently, harvest effects under the Preferred Alternative were assumed to be the same as under the Flow Evaluation Alternative.

Relative to harvests under modeled 1995 existing conditions, which are assumed to be similar to harvest levels under the No Action Alternative, the number of naturally produced Trinity River salmon available for commercial harvest is estimated to increase from 3,470 to 29,300. This change would result in the overall harvest of salmon originating from all sources increasing by a projected total of 349,300 salmon, or by 47 percent, by 2020 (Table B-14). The greatest percentage increase would occur in the regions nearest to the Klamath River Basin, including the KMZ-California, the KMZ-Oregon, and the Mendocino Regions, with increases exceeding 500 percent (Table B-26). In numeric terms, harvest increases would be greatest in the Northern/Central Oregon Region, where harvests are projected to increase by 196,400 salmon relative to the No Action Alternative. This increase would primarily result from increased chinook harvests in the Coos Bay port area and coho harvests elsewhere in the region. Harvests in the San Francisco and Monterey Regions are expected to be similar to no action levels in 2020.

Relative to no action levels, gross harvest revenue and net income would annually increase by a projected $7.7 million and $2.7 million, respectively, by 2020 (Table B-15 and B-16). As shown in Table B-26, increases in gross harvest revenues would range from $492,000 in the KMZ-Oregon Region to $4.3 million in the Northern/Central Oregon Region. Increases in average annual net income for the harvesting sector are projected to range from $163,300 in the KMZ-Oregon Region to $1.4 million in the Northern/Central Oregon Region. No significant changes in gross revenue and net income are expected in the San Francisco and Monterey Regions.

Because harvest levels would be higher under the Preferred Alternative compared to harvests under the No Action Alternative and modeled 1995 existing conditions, ocean commercial harvest effects are considered beneficial for the Northern/Central Oregon, KMZ-Oregon, KMZ-California, and Mendocino Regions.

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 LSALMON2 are shown in Table B-24. 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 B14.

Go To TOC

Increased water temperatures in the Sacramento River resulted in an estimated annual average loss of 12 percent (fall chinook) and nearly 16 percent (spring chinook) early life stages for the Preferred Alternative, an increase over existing conditions of 2 percent and approximately 3 percent, respectively (Table B-27).

Average annual losses of late-fall and winter chinook salmon were estimated to be substantially less than those for spring chinook and averaged 1 percent for late-fall chinook for the simulation period (Table B-24). The estimated average annual loss of late-fall chinook was unchanged from that estimated for this species under the existing conditions (Table B-27). For the Preferred Alternative, the average annual loss of winter chinook was estimated to be 5 percent for the 1922-1990 simulation period (Table B-24). For winter chinook salmon, this estimate represents an increase in annual average loss of approximately 3 percent greater than those estimated for existing conditions (Table B-27).

Reviewing the annual estimated losses of winter chinook salmon in Attachment B14 revealed that the majority of the estimated loss of this species, compared to existing conditions, resulted from extremely high mortalities during a small number of critically dry water years (1924, 1932 through 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 NMFS 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 losses to this 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-27). This estimate is less than 1 percent greater that that estimated for existing conditions.

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 ranged from no change to a 3 percent increase in average annual losses for the 1922-1990 period of simulation, depending on species (Table B-27). 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 Sacramento River for the Preferred Alternative as compared to existing conditions are summarized in Table B-28.

Go To TOC

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-2. 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-31. 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-31.

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-2), 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-31). 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.

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, 1994) (Attachment B1, Table B1-10). 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 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

Go To TOC

- 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-25. Other native anadromous species would be adversely affected by implementation of the State Permit Alternative in the Trinity and Klamath River Basins. Compared to the No Action Alternative, the Mechanical Restoration and Percent Inflow Alternatives would benefit other anadromous species in the Trinity River. However, these alternatives would not affect other anadromous species in the Klamath River Basin. The Flow Evaluation and Maximum Flow Alternatives would highly benefit other anadromous species in the Trinity River Basin. These alternatives would also result in benefits to other anadromous species in the Klamath River Basin. The Maximum Flow and Flow Evaluation Alternatives may adversely impact other anadromous species in the Central Valley.

There are no measures likely adequate to mitigate to less than significant the adverse effects to other anadromous species in the Trinity and Klamath River Basins from implementing the

Go To TOC

State Permit Alternative. There are no measures likely adequate to mitigate to less than significant the adverse effects to other anadromous species in the Central Valley from implementing the Maximum Flow and Flow Evaluation Alternatives.

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-17 and B-19). 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-17 and B-19, 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 1922-1990, the average annual discharge of the Sacramento River as estimated at Grimes and Verona was approximately 8,800 taf and 13,500 taf, respectively (Table B-32). Total average annual inflow and outflows for the Delta are approximately 22,600 taf and 14,700 taf, respectively (Tables B-33 and B-34). 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 average yearly estimates of Sacramento River discharges and Delta inflows and outflows were used to qualitatively evaluate changes in habitat for these species as there are no specific habitat/discharge relationships known for these species.

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-17 and are summarized in Table B-18. As shown in these tables, the Maximum Flow Alternative was scored 60 of the total possible 74 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. These results indicate that river system health and habitat conditions would be expected to improve approximately 900 percent under the Maximum Flow Alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-29). 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 from approximately 122 taf (critically dry water year) up to 1,800 taf (extremely wet water year) 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 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 result in increased populations under the Maximum Flow Alternative.

Central Valley. It was assumed that decreases in monthly average stream flows less 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 1922-1990, the average annual discharge of the Sacramento River at Grimes and Verona for the Maximum Flow Alternative is approximately 8,000 taf and 12,800 taf, respectively (Table B-33). For the Maximum Flow Alternative, the total average annual discharges in the middle reach of the Sacramento River decreased approximately 13 percent at Grimes and the range of monthly average flows diminished by up to 30 percent for some months compared to the No Action Alternative

(Table B-36). The total average discharges in the lower reach of the Sacramento River decreased by approximately 7 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-36). Flows at Verona decreased from 1 to 17 percent 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 21,800 and 14,300 taf, respectively (Tables B-34 and B-35). These flows are approximately 3 percent less, on average, than those for the No Action Alternative (Tables B-37 and B-38). The percentage of years in which Delta inflows for the Maximum Flow Alternative are greater than 10 percent less than the No Action Alternative ranges from 3 percent in March to 57 percent in July (Table B-39). The percentage of years in which Delta outflows for the Maximum Flow Alternative are 10 percent or less than those for No Action ranged from 1 percent in March and April to 30 percent in October (Table B-40).

There would be substantial numbers of months in which both inflows to and outflows from the Delta, and 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.

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-17 and are summarized in Table B-18. As shown in these tables, the Flow Evaluation Alternative was scored 49 of the total possible 74 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 720 percent under the Flow Evaluation Alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-28). 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 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, from approximately 28 taf (critical water year) to approximately 475 taf (extremely wet water year), would likely improve habitat conditions in the lower Klamath River and estuary in

Go To TOC

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 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 1922-1990, the average annual discharge of the Sacramento River at Grimes and Verona for the Flow Evaluation Alternative is approximately 8,600 taf and 13,300 taf, respectively (Table B-32). For this alternative, the total average annual discharges in the middle reach of the Sacramento River decreased approximately 4 percent at Grimes, and monthly average flows decreased from 1 to 12 percent compared to the No Action Alternative (Table B-35). 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-35). Average monthly flows at Verona decreased up to 6 percent compared to the No Action Alternative. Considering the magnitude of the decreases in the annual monthly discharges, except for the month of June and July at Grimes, it is unlikely that reductions in habitat quantity and quality would be sufficient to adversely affect other anadromous species in the lowermost Sacramento River.

The average annual inflow and outflow in the Delta for the Flow Evaluation Alternative is estimated to be approximately 22,400 and 14,600 taf, respectively (Tables B-34 and B-31). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-36 and B-37). The percentage of years in which Delta inflows for the Flow Evaluation Alternative are greater than 10 percent less than the No Action Alternative ranges from none for January, February, March, May, and September to 22 percent in July (Table B-38). The percentage of years in which Delta outflows for the Flow Evaluation Alternative are 10 percent or less than those for No Action ranged from none for February and March to 13 percent in November (Table B-39).

There would be only one month each in which inflows to the Delta (July) and outflows from the Delta (November) would be significantly less on the average than those for the No Action Alternative. A decrease of up to approximately 12 percent in the Grimes reach of the Sacramento River (June and July) also was significantly less than 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 Sacramento River and/or the Delta during those months.

1.2.2.7 Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Percent Inflow Alternative are shown in Table B-17 and are summarized in Table B-18. As shown in these tables, the Percent Inflow Alternative was scored 17 of the total possible 74 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 salmonids species in the mainstem Trinity River. These expected improvements would likely provide only small 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 183 percent for the Percent Inflow Alternative as compared to No Action (Table B-28). 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 Percent Inflow Alternative and would likely result in only moderate increases in other native anadromous fish populations as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The Percent Inflow Alternative would result in improved water temperature conditions and increased Trinity River flows in normal, wet, and extremely wet water years. In these years, increased annual flows (ranging from approximately 100-975 taf) and improved water temperature conditions during spring and early summer could result in improved habitat conditions in the lower Klamath River and estuary. However, in dry and critically dry water years, annual discharges would be from 16 (in dry water years) to 175 taf (in critical water) less than those for the No Action Alternative. During these years, water temperature conditions in the Trinity River would be either similar or less beneficial to other native anadromous species as compared to temperatures for No Action. For dry and critically dry years, river system conditions and functions in the lower Klamath River would be less beneficial or detrimental to other native anadromous species compared to No Action.

It is likely that the benefits resulting from improved habitat conditions during years of abundant flow and more optimal water temperatures may be offset by adverse conditions during years when flows are diminished and temperatures are less suitable. Therefore, long-term river system health, function, and habitat conditions in the lower Klamath River and estuary would likely be largely unchanged from those for the No Action Alternative. Populations of other native anadromous species in the lower Klamath River and estuary would likely neither benefit nor be adversely affected 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 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 1922-1990, the average annual discharge of the Sacramento River at Grimes and Verona for the Percent Inflow Alternative is approximately 8,600 taf and 13,400 taf, respectively (Table B-32). For this Alternative, the total average annual discharges in the middle reach of the Sacramento River decreased approximately 2 percent at Grimes, and the range of monthly average flows increased 1 percent (September) and decreased up to 7 percent (June) compared to the No Action Alternative (Table B-35).

Go To TOC

The total average annual discharges 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-35). Average monthly flows at Verona increased 1 percent (September) and decreased up to 3 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 other anadromous species in the lower Sacramento River.

The average annual inflow and outflow in the Delta for the Percent Inflow Alternative is estimated to be approximately 22,500 and 14,600 taf, respectively (Tables B-33 and B-34). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-36 and B-37). The percentage of years in which Delta inflows are greater than 10 percent less than the No Action Alternative occurs only for the months of July (3 percent) and August (1 percent) (Table B-38). The percentage of years in which Delta outflows are greater than 10 percent less than the No Action Alternative occurs for the months of February, July, August, and October through December (1 percent) and January, May, and June (3 percent) (Table B-39).

None of the annual or monthly flows in the lower Sacramento River or the Delta would be significantly less, on average, than those for the No Action Alternative. These small reductions in discharges would not result in significant reductions in habitat quality or quantity and, therefore, would not result in significant impacts to other native anadromous species in the Central Valley.

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-17 and summarized in Table B-18. As shown in these tables, the Mechanical Restoration Alternative was scored 13 out of the total possible 74 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 117 percent under this alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-28). Small and localized beneficial improvements in river system health and function would result in only small benefits to other native anadromous fish populations as compared to No Action.

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 the same as No Action for the lower Klamath River and estuary. Other native anadromous fish populations in the lower Klamath River would remain unchanged under this project alternative.

Go To TOC

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.

1.2.2.9 State Permit Alternative

Trinity River Basin. The results of the TRSAAM scoring for all attribute objectives for the State Permit Alternative are shown in Table B-17 and summarized in Table B-18. As shown in Table B-18, the State Permit Alternative scored 0 of the total possible 74 attribute objectives points believed necessary for a restored fluvial river system. All of the 37 attribute objectives thresholds were rated as never or nearly never exceeded (Table B-19). The State Permit Alternative performed poorly and did not meet any of the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids or other native anadromous fish species in the mainstem Trinity River. These results indicate that, under the State Permit Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would not provide the conditions necessary to allow other native anadromous fish species to recover to pre-dam population levels and that these conditions would adversely affect these species in the Trinity River Basin.

Lower Klamath River Basin/Coastal Area. For the State Permit Alternative, decreased flows and increased water temperatures in the Trinity River would likely result in less favorable conditions in the lower Klamath River and estuary as compared to No Action. Decreased flows to the Klamath River from reductions in Lewiston Reservoir releases (approximately 218 taf annually) would likely reduce habitat quantity and quality in the lower Klamath River and estuary. These flow reductions would likely result in water temperatures in the lower Klamath River that would be warmer than those for the No Action Alternative. Warmer water temperatures and lower flows would diminish habitat conditions and increase travel time in the lower Klamath River during migration periods of other native anadromous species.

Poorer habitat conditions would likely result in a decrease in survival rates for rearing live stages of other anadromous species in the lower Klamath River and estuary. These conditions would also result in a less likely successful passage to the estuary and ocean. As compared to the No Action Alternative, these adverse impacts would likely result in decreased populations of other native anadromous species for the State Permit 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 1922-1990, the average annual discharge of the Sacramento River at Grimes and Verona for the State Permit Alternative is approximately 9,000 taf and 13,600 taf, respectively (Table B-32). For this alternative, the total average annual discharges in the middle reach of the Sacramento River increased approximately 3 percent at Grimes, and the monthly average flows increased up to 8 percent compared to the No Action Alternative (Table B-35). The total average annual discharges in the lower reach of the Sacramento River increased by approximately 1 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-35). Average monthly flows at Verona increased up to 4 percent as compared to the No Action Alternative. Considering the magnitude of the increases for the annual and monthly average discharges, it is unlikely that significant increases in habitat quantity and quality would be sufficient to benefit other anadromous species in the lower Sacramento River.

The average annual inflow and outflow in the Delta for the State Permit Alternative is estimated to be approximately 22,800 and 14,900 taf, respectively (Tables B-33 and B-34). The Delta inflows and outflows are approximately 1 percent greater on average, compared to the No Action Alternative (Tables B-36 and B-37).

For the State Permit Alternative, none of the annual or monthly flows in the lower Sacramento River or the Delta would be significantly greater, on average, than those for the No Action Alternative. The small increases in discharges would not result in significant improvements in habitat quality or quantity and, therefore, would not result in significant benefits to other native anadromous species in the Central Valley.

1.2.2.10 Existing Conditions versus Preferred Alternative

Trinity River Basin and Lower Klamath River Basin/Coastal Area. Implementation of the Preferred 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 (see Attachment B16). 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 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 1922-1990), the average annual discharge in the Sacramento River as estimated for Grimes and Verona is approximately 8,800 taf and 13,400 taf, respectively (Table B-32). For the Preferred Alternative (Flow Evaluation Alternative), for the simulated period 1922-1990, the average annual discharge in the Sacramento River as estimated for Grimes and Verona is approximately 8,600 taf and 13,300 taf, respectively (Table B-32). The estimated changes in the average annual

Go To TOC

Sacramento River flows for Grimes and Verona for the Preferred Alternative as compared to existing conditions are shown in Table B-35. Changes in the estimated average annual Sacramento River flows at Grimes (middle reach of the river) for the Preferred Alternative averaged approximately 5 percent less and ranged from no change up to 14 percent less compared to existing conditions (Table B-35). The decreases in stream flows in June and July (decreases of 12-14 percent) may result in significant losses in habitat for other native anadromous species residing in the middle reach of the Sacramento River.

For the Preferred Alternative, the total average annual discharge (in taf) for the lower reach of the Sacramento River at Verona decreased by an average of approximately 1 percent and ranged from no change to a decrease of 3 percent compared to existing conditions (Table B-35). 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 22,600 taf and 15,100 taf, respectively (Tables B-33 and B-34). For the Preferred Alternative, the total average annual inflow and outflow for the Delta are approximately 22,400 taf and 14,600 taf, respectively (Tables B-33 and B-34). The annual average decrease in Delta inflows and outflows for the Preferred Alternative are 1 percent and 4 percent, respectively, as compared to existing conditions. The percent of years in which Delta inflows for the Preferred Alternative are 10 percent or less than existing conditions ranges from 3 percent for January to 28 percent in July (Table B-38). The percent of years in which Delta outflows for the Preferred Alternative are greater than 10 percent less than those for existing conditions ranges from 3 percent in April to 33 percent in November (Table B-39).

On average, there would be significant numbers of months in which both inflows to and outflows from the Delta would be significantly less than those for existing conditions. These changes may result in significant impacts to species in the Delta.

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-2. 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

Go To TOC

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)*, 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.

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 Section 1.3.1.4). 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 tidepool 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-2, 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. They 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, 1994).

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

Go To TOC

Wildlife Service, 1999). Peak spawning of this species occurs during March through May but can occur from January through June. Splittail populations have declined 62 percent in the last 15 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). Critical habitat for this species was not designated at the time of its listing.

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.

Go To TOC

- 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 and Delta inflow, outflow, ratio of Delta inflow to exports, and position of X2 in the Delta were evaluated. X2 refers to the X2 position, in kilometers from the Golden Gate Bridge, of a salinity (2 ppt) believed optimal for maximizing native fish species, including Delta smelt, habitats.

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 thousand acre feet (taf) 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, ratio of Delta inflow to exports, and position of X2 were compared to the No Action Alternative to determine potential changes in the habitat for native resident fish species in the Delta.

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. The results of the comparisons of the No Action Alternative to each project alternative are summarized in Table B-25. Resident native fish would be adversely affected by implementation of the State Permit Alternative in the Trinity and Klamath River Basins. Compared to the No Action Alternative, the Mechanical Restoration, Percent Inflow, Flow Evaluation, and Maximum Flow Alternatives would benefit resident native species in the Trinity River. The Mechanical Restoration and Percent Inflow Alternatives would not affect resident native species in the Klamath River Basin. The Flow Evaluation and Maximum Flow Alternatives would benefit resident native species in the Klamath River Basin. The Maximum Flow, Flow Evaluation, and Percent Inflow Alternatives would adversely affect some resident native species in the Central Valley.

There are no measures likely adequate to mitigate to less than significant the adverse effects to resident native species in the Trinity and Klamath River Basins from implementing the State Permit Alternative, and the maximum flow, flow evaluation, and percent inflow alternating to resident native species in the Central Valley.

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 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-17 and B-19). 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-17 and B-19, 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 and temperatures).

For the simulated period 1922-1990, the average annual discharge of the Sacramento River as estimated at Keswick, Grimes, and Verona was approximately 6,600 taf; 8,800 taf; and 13,500 taf, respectively (Table B-32). Total average annual inflow and outflows for the Delta are approximately 22,600 taf and 14,700 taf, respectively (Tables B-33 and B-34).

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-16 and are summarized in Table B-18. As shown in these tables, the Maximum Flow Alternative was scored 60 of the total possible 74 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 900 percent under the Maximum Flow Alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-29). 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.

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 from approximately 122 taf (critically dry water year) up to 1,800 taf (extremely wet water year) 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. These benefits would result in increased populations 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 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 were considered beneficial to these species for the maximum flow alternative. For the simulated period 1922-1990, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 5,800 taf; 8,000 taf; and 12,800 taf, respectively (Table B-32). 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-35. 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 13 percent and ranged from 6-26 percent less than the No Action Alternative (Table B-35). 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 13 percent and ranged from 3-30 percent less than the No Action Alternative (Table B-35). These changes in stream flows would likely result in significant losses of habitat for resident native species residing in these reaches of the Sacramento River.

For this alternative, the total average annual discharge (in taf) for the lower reach of the Sacramento River at Verona decreased an average of approximately 7 percent and ranged from 1-17 percent less than the discharge estimated for the No Action Alternative (Table B-35). Considering the magnitude of the decreases in annual discharges, it is likely that reductions in habitat quantity and quality may be sufficient to significantly reduce habitat and adversely affect special-status native resident 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 21,800 and 14,300 taf , respectively (Tables B-33 and B-34). These flows are approximately 3 percent less, on average, that those for the No Action Alternative (Tables B-36 and B-37). The percentage of years in which Delta inflows for the Maximum Flow Alternative are greater than 10 percent less than the No Action Alternative ranges from 3 percent (March) to 57 percent (July) (Table B-38). The percent of years in which Delta outflows for the Maximum Flow Alternative are 10 percent or less than those for No Action ranged from 1 percent in March and April to 30 percent in October (Table B-40).

For the months critical to life stages of special-status fish species in the Delta (February through June), the percentage of years in which Delta inflows are greater than 10 percent less than those for No Action ranges from 3 percent (March) to 28 percent (June). For the months critical to these species in the Delta, the percentage of years in which Delta outflows are 10 percent or less than those for No Action ranges from 1 percent (March and April) to 9 percent (June). 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 Maximum Flow Alternative. Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-40. The average monthly position of X2, the theoretical optimal salinity for Delta smelt, moved 0.9 kilometers or less for the period of simulation (approximately 1.1 percent or less relative to the No Action Alternative). 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-41).

On 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 significant numbers of months critical to sensitive Delta species in which both inflows to and outflows from the Delta would be significantly different than those for the No Action Alternative. These changes may result in significant impacts to special-status species in the Delta.

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-17 and are summarized in Table B-18. As shown in these tables, the Flow Evaluation Alternative was scored 49 of the total possible 74 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 717 percent under the Flow Evaluation Alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-29). 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 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. 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. 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. These benefits would result in increased populations 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 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 were considered beneficial to these species. For the flow evaluation alternative, the simulated period 1922-1990, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 6,400 taf; 8,500 taf; and 13,300 taf, respectively (Table B-33). 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-35. Changes in the estimated average annual Sacramento River flows at Keswick (upper reach of the river) for the Flow Evaluation Alternative decreased an average of 3 percent and ranged from 1-7 percent less than the No Action Alternative (Table B-35). 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 4 percent and ranged from 1-12 percent less than the No Action Alternative (Table B-35). These reductions in stream flows may result in significant losses of habitat (during June and July) for resident native species residing in the middle reach of the Sacramento River.

For this alternative, the total average annual discharge (in taf) for the lower reach of the Sacramento River at Verona decreased an average of approximately 2 percent and ranged from no change to a decrease of 6 percent compared to the average annual discharge estimated for the No Action Alternative (Table B-35). 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 22,400 and 14,600 taf, respectively (Tables B-33 and B-34). These flows are approximately 1 percent less, on average, that those for the No Action Alternative (Tables B-36 and B-37). The percentage of years in which Delta inflows for the

Flow Evaluation Alternative are greater than 10 percent less than the No Action Alternative ranges from 0 percent for January, February, May, and September to 22 percent in July (Table B-38). The percentage of years in which Delta outflow for the Flow Evaluation Alternative is 10 percent or less than those for the No Action Alternative ranges from 0 percent in February and March to 13 percent in November (Table B-39).

For the months critical to life stages of special-status fish species in the Delta (February through June), the percentage of years in which Delta inflows are greater than 10 percent less than those for No Action ranges from no change in February and May to 6 percent (June). For the months critical to these species in the Delta, the percentage of years in which Delta outflows are greater than 10 percent less than those for No Action ranges from 0 percent (February and March) to 9 percent (June). The 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-40. The average monthly position of X2 moved 0.3 kilometers or less for the period of simulation (approximately 0.4 percent relative to the No Action Alternative) (Table B-43). During the months of February through June, X2 moved 0.2 kilometers or less for the years simulated (a change of 0.3 percent or less relative to that for No Action) (Table B-41).

On average, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly changed for the Flow Evaluation Alternative. However, there would be significant numbers of months critical to sensitive Delta species in which both inflows to and outflows from the Delta would be significantly less than those for the No Action Alternative. These changes may result in significant impacts to special-status species in the Delta.

1.3.2.7 Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Percent Inflow Alternative are shown in Table B-17 and are summarized in Table B-18. As shown in these tables, the Percent Inflow Alternative was scored 17 of the total possible 74 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 salmonids species in the mainstem Trinity River. These expected improvements would also provide only small benefits to habitat conditions for resident native fish species in the Trinity Basin. The TRSAAM analysis indicated that river system health and habitat conditions improved approximately 183 percent for the Percent Inflow Alternative as compared to No Action (Table B-29). 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 Percent Inflow Alternative and would likely result in only moderate increases in resident native fish populations as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The Percent Inflow Alternative would result in improved water temperature conditions and increased Trinity River flows in normal, wet, and extremely wet water years. In these years, increased annual flows (ranging from approximately 100-975 taf) and improved water temperature conditions during spring and early summer could result in improved habitat conditions in the lower Klamath River and estuary.

Go To TOC

However, in dry and critically dry water years, annual discharges would be from 16 (in dry water years) to 175 taf (in critically dry water years) less than those for the No Action Alternative. During these 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. For dry and critical dry years, river system conditions and functions in the lower Klamath River would be less beneficial or detrimental to resident native species compared to No Action.

It is likely that the benefits resulting from improved habitat conditions during years of abundant flow and more optimal water temperatures may be offset by adverse conditions during years when flows are diminished and temperatures are less suitable. Therefore, long-term river system health, function, and habitat conditions in the lower Klamath River and estuary would likely be largely unchanged from those for the No Action Alternative. Populations of resident native species in the lower Klamath River and estuary would likely neither benefit nor be adversely affected by this alternative.

Central Valley. It was assumed that decreases in monthly average flows greater than 10 percent of those for the No Action Alternative 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 were considered beneficial to these species. For the simulated period 1922-1990, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 6,500 taf; 8,600 taf; and 13,400 taf, respectively (Table B-32). The estimated changes in the average annual Sacramento River flows for Keswick and Grimes for the Percent Inflow Alternative as compared to No Action are shown in Table B-35. Changes in the estimated average annual Sacramento River flows at Keswick (upper reach of the river) for the Percent Inflow Alternative decreased an average of 2 percent and ranged from an increase of approximately 1 percent to a decrease of approximately 5 percent compared to the No Action Alternative (Table B-35). Changes in the estimated average annual Sacramento River flows at Grimes (middle reach of the river) for the Flow Evaluation Alternative decreased an average of 2 percent and ranged from an increase of approximately 1 percent to a decrease of approximately 7 percent compared to the No Action Alternative (Table B-35). 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.

For this alternative, the total average annual discharge (in taf) for the lower reach of the Sacramento River at Verona decreased approximately 1 percent and ranged from an increase of 1 percent to a decrease of 3 percent compared to the average annual discharge estimated for the No Action Alternative (Table B-35). 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 Percent Inflow Alternative is estimated to be approximately 22,500 and 14,600 taf, respectively (Tables B-33 and B-34). These flows are approximately 1 percent less, on average, that those for the No Action Alternative (Tables B-36 and B-37). The percentage of years in which Delta inflows for the Percent Inflow Alternative are 10 percent or less than the No Action Alternative ranges from

0 percent for September through June to 3 percent in July (Table B-38). The percentage of years in which Delta outflows for the Percent Inflow Alternative are greater than 10 percent less than those for the No Action Alternative ranges from 0 percent in March, April, and September to 3 percent in May and June (Table B-39).

For the months critical to life stages of special-status fish species in the Delta (February through June), there are no months in which Delta inflows are 10 percent or less than those for No Action (Table B-38). For the months critical to these species in the Delta, there are 2 months in which the percentage of years that Delta outflows are greater than 10 percent less than those for No Action (3 percent each for the months of May and June). The maximum ratio of Delta inflows to exports were not violated for any year simulated for the Percent Inflow Alternative. Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-40. The average monthly position of X2 moved 0.2 kilometers or less for the period of simulation (approximately 0.3 percent or less relative to the No Action Alternative). During the months of February through June, X2 moved 0.2 kilometers or less for the years simulated (a change of 0.1 percent or less relative to that for No Action) (Table B-41).

On average, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Percent Inflow Alternative. However, there would be a number of months critical to sensitive Delta species in which outflows from the Delta would be significantly less than those for the No Action Alternative. These changes may result in significant impacts to special-status species in the Delta.

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-17 and summarized in Table B-18. As shown in these tables, the Mechanical Restoration Alternative was scored 13 out of the total possible 74 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 117 percent under this alternative as compared to No Action, using the TRSAAM scores as a measure of comparison (Table B-29). 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. 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.

1.3.2.9 State Permit Alternative

Trinity River Basin. The results of the TRSAAM scoring for all attribute objectives for the State Permit Alternative are shown in Table B-17 and summarized in Table B-18. As shown in Table B-18, the State Permit Alternative scored 0 of the total possible 74 attribute objectives points believed necessary for a restored fluvial river system. All of the 37 attribute objectives thresholds were rated as never or nearly never exceeded (Table B-19). The State Permit Alternative performed poorly and did not meet any of the river system and habitat requirements necessary for restoring naturally produced anadromous salmonids or resident native fish species in the mainstem Trinity River. These results indicate that, under the State Permit Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would not provide the conditions necessary to allow resident native fish species to recover to pre-dam population levels and that these conditions would adversely affect these species in the Trinity River Basin.

Lower Klamath River Basin/Coastal Area. For the State Permit Alternative, decreased flows and increased water temperatures in the Trinity River would likely result in less favorable conditions in the lower Klamath River and estuary as compared to No Action. Decreased flows to the Klamath River from reductions in Lewiston Reservoir releases (approximately 218 taf annually) would likely reduce habitat quantity and quality in the lower Klamath River and estuary. These flow reductions would likely result in warmer water temperatures in the lower Klamath River compared to the No Action Alternative. Warmer water temperatures and lower flows would diminish habitat conditions.

Poorer habitat conditions would likely result in a decrease in survival rates for rearing live stages of resident native species in the lower Klamath River and estuary. As compared to the No Action Alternative, these adverse impacts would likely result in decreased populations of resident native species for the State Permit 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 resident native species in the Central Valley. Increases in stream flows greater than 10 percent of those for No Action were considered beneficial to these species. For the simulated period 1922-1990, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 6,800 taf; 9,000 taf; and 13,600 taf, respectively (Table B-32). The estimated changes in the average annual Sacramento River flows for Keswick and Grimes for the State Permit Alternative as compared to No Action are shown in Table B-35. Changes in the estimated average annual Sacramento River flows at Keswick (upper reach of the river) for the State Permit Alternative increased an average of 3 percent and ranged from increases of approximately 1 percent to 8 percent compared to the No Action Alternative (Table B-35). Changes in the estimated average annual Sacramento River flows at Grimes (middle reach of the river) for the State Permit Alternative increased an average of 3 percent and ranged from no change to an increase of approximately 8 percent compared to the No Action Alternative (Table B-35).

These increases in stream flows would not likely result in significant benefits in habitat for resident native species residing in these reaches of the Sacramento River.

For this alternative, the total average annual discharge (in taf) for the lower reach of the Sacramento River at Verona increased approximately 1 percent and ranged from no change to an increase of 4 percent compared to the average annual discharge estimated for the No Action Alternative (Table B-35). Considering the magnitude of this increase in annual discharges, it is not likely that habitat quantity and quality would be sufficiently benefited, nor would they increase populations of resident native species in the lower Sacramento River.

The average annual inflow and outflow in the Delta for the State Permit Alternative is estimated to be approximately 22,800 and 14,900 taf, respectively (Tables B-33 and B-34). These flows are approximately 1 percent more, on average, than those for the No Action Alternative (Tables B-36 and B-37).

The maximum ratio of Delta inflows to exports were not violated for any year simulated for the State Permit Alternative. Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-40. The average monthly position of X2 moved 0.2 kilometers or less for the period of simulation (approximately 0.3 percent or less relative to the No Action Alternative). During the months of February through June, X2 moved 0.1 kilometers or less for the years simulated (a change of 0.2 percent or less relative to that for No Action) (Table B-41).

On average, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the State Permit Alternative. There would be no significant impacts or benefits to Sacramento River or Delta species.

1.3.2.10 Existing Conditions versus Preferred Alternative

Trinity River Basin and Lower Klamath River Basin/Coastal Area. Trinity River impacts of the Preferred 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 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 were considered beneficial to these species. For existing conditions (for the simulated period 1922-1990), the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 6,600 taf; 8,800 taf; and 13,400 taf, respectively (Table B-32). For the Preferred Alternative (Flow Evaluation Alternative), for the simulated period 1922-1990, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona is approximately 6,400 taf; 8,600 taf; and 13,300 taf, respectively (Table B-32). 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-35. Changes in the

Go To TOC

estimated average annual Sacramento River flows at Keswick (upper reach of the river) for the Preferred Alternative averaged approximately 4 percent less and ranged from no change to 7 percent less compared to existing conditions (Table B-35). Changes in the estimated average annual Sacramento River flows at Grimes (middle reach of the river) for the Preferred Alternative averaged approximately 5 percent less and ranged from no change to 14 percent less compared to existing conditions (Table B-35). The decreases in stream flows in June and July (decreases of 12-14 percent) may result in significant losses in habitat for resident native species residing in the middle reach of the Sacramento River.

For the Preferred Alternative, the total average annual discharge (in taf) for the lower reach of the Sacramento River at Verona decreased by an average of approximately 1 percent and ranged from no change to a increase of 4 percent compared to existing conditions (Table B-35). 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 22,600 taf and 15,100 taf, respectively (Tables B-33 and B-34). For the Preferred Alternative, the total average annual inflow and outflow for the Delta are approximately 22,400 taf and 14,600 taf, respectively (Tables B-33 and B-34). The annual average change in Delta inflows and outflows for the Preferred Alternative are 1 percent and 4 percent, respectively, as compared to existing conditions. The percent of years in which Delta inflows for the Preferred Alternative are 10 percent or less than existing conditions ranges from 3 percent for January to 28 percent in July (Table B-38). The percent of years in which Delta outflows for the Preferred Alternative are greater than 10 percent less than those for existing conditions ranges from 3 percent in April to 33 percent in November (Table B-40).

For the months critical to life stages of special-status fish species in the Delta (February through June), the percentage of years that Delta inflows are greater than 10 percent less than those for existing conditions ranges from 4 percent (April) to 17 percent (June). For the months critical to these species in the Delta, the percentage of years that Delta outflows are 10 percent or less than those for No Action ranged from 3 percent (April) to 17 percent (February). However, the maximum 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-40. The average monthly position of X2, the theoretical optimal salinity for Delta smelt, moved 0.7 kilometers or less for the period of simulation (approximately 0.9 percent or less relative to existing conditions). During the months of February through June, X2 moved 0.5 kilometers or less for the years simulated (a change of 0.8 percent or less relative to that for existing conditions) (Table B-41).

On average, 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 significant numbers of months critical to sensitive Delta species in which both inflows to and outflows from the Delta would be significantly different than those for existing conditions. These changes may result in significant impacts to special-status Delta species.

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-2. 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 Reservoir, 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 the fall months prior to spawning which occurs in March through June.

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 taf 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, and position of X2 in the Delta were compared to the No Action Alternative to determine potential changes in habitat for non-native fish species.

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-25. Non-native fish species would be adversely affected by implementation of the State Permit Alternative in the Trinity and Klamath River Basins. Compared to the No Action Alternative, the Mechanical Restoration, Percent Inflow, Flow Evaluation, and Maximum Flow Alternatives would benefit non-native species in the Trinity River. The Mechanical Restoration and Percent Inflow Alternatives would not affect non-native species in the Klamath River Basin. The Flow Evaluation and Maximum Flow Alternatives would benefit non-native species in the Klamath River Basin. The maximum flow and the flow evaluation alternative would adversely affect some non-native fish species in the Central Valley.

There are no measures likely adequate to mitigate to less-than-significant the adverse effects to non-native species in the Trinity and Klamath River Basins from implementing the State Permit Alternative or the Central Valley from implementing the maximum flow or flow evaluation 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-17 and B-19). 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 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-17 and B-19, 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 provide the 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 1922-1990, the average annual discharge of the Sacramento River as estimated at Keswick, Grimes, and Verona was approximately 6,700 taf; 8,800 taf; and 13,500 taf, respectively (Table B-32). Total average annual inflow and outflows for the

Go To TOC

Delta are approximately 22,600 taf and 14,700 taf, respectively (Tables B-33 and B-34). 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-17 and are summarized in Table B-18. As shown in these tables, the Maximum Flow Alternative was scored 60 of the total possible 74 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. 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 species within the lower Klamath River and estuary. Increases in flows to the Trinity River from approximately 122 taf (critically dry water year) up to 1,800 taf (extremely wet water year) 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. 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. These benefits would 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 1922-1990, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Maximum Flow Alternative are approximately 5,800; 8,000; and 12,800 taf, respectively (Table B-32). For the Maximum Flow Alternative, the total average annual discharges in the upper and middle reaches of the Sacramento River decreased approximately 13 percent at both Keswick and Grimes. The range of monthly average flows diminished from 6 to 26 percent and Keswick and 3 to 30 percent at Grimes (Table B-35). These average monthly flows included reductions of up to 17 percent (Keswick) and 24 percent (Grimes) for the months of May and June, important months for spawning runs of striped bass and American shad (Table B-35).

The total average annual discharges in the lower reach of the Sacramento River decreased by approximately 7 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-35). Average monthly flows at Verona decreased from 1 to 17 percent compared to the No Action Alternative and included a reduction of an 11 percent average in June. Considering the magnitude of the decreases in some of the monthly average discharges important to striped bass and American shad, it is likely that reductions in habitat quantity and quality would be sufficient to potentially impact non-native species in the Sacramento River.

The average annual inflow and outflow in the Delta for the Maximum Flow Alternative is estimated to be approximately 21,800 and 14,300 taf, respectively (Tables B-33 and B-34). These flows are approximately 3 percent less, on average, than those for the No Action Alternative (Tables B-36 and B-37). The percent of years in which Delta outflows for the Maximum Flow Alternative are 10 percent or less than those for No Action ranged from 1 percent in March and April to 30 percent in October (Table B-39).

For the months important for recreationally important striped bass in the Delta (February through June), the percentage of years that Delta outflows are 10 percent or less than those for No Action ranged from 1 percent (March and April) to 9 percent (June). However, the 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-40. The average monthly position of X2 moved 0.9 kilometers or less for the period of simulation (approximately 1.1 percent or less relative to the No Action Alternative). 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-41). These changes are likely insufficient to adversely impact non-native fish, including striped bass and American shad, in the Delta.

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 potentially significant reductions in flows in the Sacramento River that may adversely affect striped bass and American shad, particularly during May and June when these species are migrating and spawning.

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-17 and are summarized in Table B-18. As shown in these tables, this alternative was scored 49 of the total possible 74 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 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. 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 species within the lower Klamath River and estuary. Increases in flows to the Trinity River, from approximately 28 taf (critically dry water year) to approximately 475 taf (extremely wet water year), 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. 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. These benefits would likely 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 1922-1990, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Flow Evaluation Alternative are approximately 6,400; 8,600; and 13,300 taf, respectively (Table B-32). For this alternative, the total average annual discharges in the upper and middle reaches of the Sacramento River decreased approximately 3 percent (Keswick) and 4 percent (Grimes). The average monthly flows decreased 1 to 7 percent at Keswick and 1 to 12 percent at Grimes (Table B-35). These average monthly flows included a reduction of 12 percent at Grimes during June, an important month for spawning runs of striped bass and American shad (Table B-35).

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-35). The average monthly flows at Verona decreased up to 6 percent compared to the No Action Alternative. Considering the magnitude of the decrease in average June discharge at Grimes, significant reductions in habitat quantity and quality may potentially impact non-native species, including striped bass and American shad, in the Sacramento River.

The average annual inflow and outflow in the Delta for the Flow Evaluation Alternative is estimated to be approximately 22,400 and 14,600 taf, respectively (Tables B-33 and B-34). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-36 and B-37). The percent of years in which Delta outflows for the Flow Evaluation Alternative are 10 percent or less than those for No Action ranged from none (February and March) to 13 percent in November (Table B-39).

For the months important for recreationally important striped bass in the Delta (February through June), the percentage of years that Delta outflows are 10 percent or less than those for No Action ranged from none (February and March) to 9 percent (June). 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 Flow Evaluation Alternative. Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-40. The average monthly position of X2 moved 0.3 kilometers or less for the period of simulation (approximately 0.4 percent relative to the No Action Alternative). During the months of February through June, X2 moved 0.2 kilometers or less for the years simulated (a change of 0.3 percent or less relative to that for No Action) (Table B-41). These changes are likely insufficient to adversely impact non-native fish, including striped bass and American shad, in the Delta.

On average, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Flow Evaluation Alternative. However, there would be a potentially significant reduction in flows in the middle reach of Sacramento River that may adversely affect striped bass and American shad during June when these species are migrating and spawning.

1.4.2.7 Percent Inflow Alternative

Trinity River Basin. The results of the TRSAAM analysis for all attribute objectives for the Percent Inflow Alternative are shown in Table B-17 and are summarized in Table B-18. As shown in these tables, the Percent Inflow Alternative was scored 17 of the total possible 74 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 salmonids species in the mainstem Trinity River. These expected improvements would also provide only small benefits to habitat conditions for most non-native fish species 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 improve somewhat under the Percent Inflow Alternative and would likely result in only moderate increases in populations of non-native species as compared to the No Action Alternative.

Lower Klamath River Basin/Coastal Area. The Percent Inflow Alternative would result in cooler water temperature conditions and increased Trinity River flows in normal, wet, and extremely wet water years. In these years, increased annual flows (ranging from approximately 100-975 taf) 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 dry and critically dry water years, annual

Go To TOC

discharges would be from 16 (in dry water years) to 175 taf (in critically dry water years) 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 compared to conditions for the No Action Alternative.

It is likely that the benefits resulting from improved habitat conditions during years of abundant flow and more optimal water temperatures for some species, may be offset by adverse conditions during years when flows are diminished and temperatures are less suitable for other species. Therefore, long-term river system health, function, and habitat conditions in the lower Klamath River and estuary would likely be largely unchanged from those for the No Action Alternative. Populations of non-native species in the lower Klamath River and estuary would likely neither benefit nor be adversely affected 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 percent inflow alternative. For the simulated period 1922-1990, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the Percent Inflow Alternative are approximately 6,500; 8,600; and 13,400 taf, respectively (Table B-33). For this alternative, the total average annual discharges in the upper and middle reaches of the Sacramento River decreased approximately 2 percent at both Keswick and Grimes (Table B-35). The average monthly flows ranged from an increase of 1 percent to a decrease of 5 percent at Keswick and an increase of 1 percent to a decrease of 7 percent at Grimes (Table B-35).

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-35). The average monthly flows at Verona decreased up to 3 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 be no significant reduction in habitat quantity and quality nor impact non-native species, including striped bass and American shad, in the Sacramento River.

The average annual inflow and outflow in the Delta for the Percent Inflow Alternative is estimated to be approximately 22,500 and 14,600 taf, respectively (Tables B-33 and B-34). These flows are approximately 1 percent less, on average, than those for the No Action Alternative (Tables B-36 and B-37). The percent of years in which Delta outflows for the Flow Evaluation Alternative are 10 percent or less than those for No Action ranged from none (March, April, and September) to 3 percent (January, May, and June) (Table B-39).

For the months important for recreationally important striped bass in the Delta (February through June), the percentage of years that Delta outflows are 10 percent or less than those for No Action ranged from none (March and April) to 3 percent (May and June). 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 Percent Inflow Alternative. Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-40. The average monthly position of X2 moved 0.2

kilometers or less for the period of simulation (approximately 0.3 percent or less relative to the No Action Alternative). During the months of February through June, X2 moved 0.2 kilometers or less for the years simulated (a change of 0.3 percent or less relative to that for No Action) (Table B-41). These changes in the Delta are likely insufficient to adversely impact non-native fish, including striped bass and American shad.

On average, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the Percent Flow Alternative. There also would be insufficient reductions in flows in the Sacramento River to adversely affect non-native species, including striped bass and American shad. There would be no significant impacts to non-native fish 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-17 and summarized in Table B-18. As shown in these tables, the Mechanical Restoration Alternative was scored 13 out of the total possible 74 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 State Permit Alternative

Trinity River Basin. The results of the TRSAAM scoring for all attribute objectives for the State Permit Alternative are shown in Table B-17 and summarized in Table B-18. As shown in Table B-18, the State Permit Alternative scored 0 of the total possible 74 attribute objectives points believed necessary for a restored fluvial river system. The State Permit Alternative performed poorly and did not provide benefits to the river system and or habitats necessary for non-native fish species in the mainstem Trinity River. These results indicate that, under the State Permit Alternative, fishery habitat in the mainstem Trinity River in the year 2020 would not provide the conditions necessary to allow populations of non-native fish species to flourish. These habitat conditions would adversely affect these species in the Trinity River Basin.

Lower Klamath River Basin/Coastal Area. For the State Permit Alternative, decreased flows and increased water temperatures in the Trinity River would likely result in less favorable conditions in the lower Klamath River and estuary as compared to No Action. Decreased flows to the Klamath River from reductions in Lewiston Reservoir releases (approximately 218 taf annually) would likely reduce habitat quantity and quality in the lower Klamath River and estuary. These flow reductions would likely result in warmer water temperatures in the lower Klamath River compared to the No Action Alternative. Diminished habitat conditions would likely result in a decrease in survival rates for rearing life stages of coldwater non-native species in the lower Klamath River and estuary. As compared to the No Action Alternative, these adverse impacts would likely result in decreased populations of species such as brown trout for the State Permit Alternative. Warmer water temperatures may affect species such as American shad, but it is not known if this would result in adverse or beneficial conditions for this species.

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 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 1922-1990, the average annual discharge of the Sacramento River at Keswick, Grimes, and Verona for the State Permit Alternative are approximately 6,800; 9,000; and 13,600 taf, respectively (Table B-32). For this alternative, the total average annual discharge in the upper and middle reach of the Sacramento River increased approximately 3 percent at Keswick and Grimes. The monthly average flows increased up to 8 percent at both Keswick and Grimes compared to the No Action Alternative (Table B-35).

The total average annual discharge in the lower reach of the Sacramento River increased by approximately 1 percent at Verona compared to those discharges estimated for the No Action Alternative (Table B-35). Average monthly flows at Verona increased up to 4 percent as compared to the No Action Alternative. Considering the magnitude of the increases for the annual and monthly average discharges, it is unlikely that significant increases in habitat quantity and quality would be sufficient to benefit non-native species, including striped bass and American shad, in the Sacramento River.

The average annual inflow and outflow in the Delta for the State Permit Alternative is estimated to be approximately 22,800 and 14,900 taf, respectively (Tables B-33 and B-34). These flows are approximately 1 percent more, on average, that those for the No Action Alternative (Tables B-36 and B-37). The maximum ratio of Delta inflows to exports were not violated for any year simulated for the State Permit Alternative. Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-40. The average monthly position of X2 moved 0.2 kilometers or less for the period of simulation (approximately 0.3 percent or less relative to the No Action Alternative). During the months of February through June, X2 moved 0.1 kilometers or less for the years simulated (a change of 0.2 percent or less relative to that for No Action) (Table B-41).

On average, the monthly ratio of Delta inflows to exports, and the position of X2 in the Delta would not significantly change for the State Permit Alternative. There would be no significant impacts or benefits to Sacramento River or Delta species.

1.4.2.10 Existing Conditions versus Preferred Alternative

Trinity River Basin and Lower Klamath River Basin/Coastal Area. Trinity River impacts of the Preferred 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 1922-1990), the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona are approximately 6,600; 8,800; and 13,400 taf, respectively (Table B-32). For the Preferred Alternative, for the simulated period 1922-1990, the average annual discharge in the Sacramento River as estimated for Keswick, Grimes, and Verona are approximately 6,400; 8,600, and 13,300 taf, respectively (Table B-32). 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-35. 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 averaged approximately 4 and 5 percent less, respectively. Flows ranged from no change up to 7 percent less (Keswick) and no change up to 14 percent less (Grimes) compared to existing conditions (Table B-35). The decreases in stream flows in June (12 percent) may result in significant reduction in habitat for striped bass and American shad migration and spawning within the middle reach of the Sacramento River during that month.

For the Preferred Alternative, the total average annual discharge (in taf) for the lower reach of the Sacramento River at Verona decreased by an average of approximately 1 percent and ranged from no change to a decrease of 6 percent compared to existing conditions (Table B-35). Considering the magnitude of these decreases in annual discharges, it is not likely that the quantity and quality of non-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 22,600 taf and 15,100 taf, respectively (Tables B-33 and B-34). For the Preferred Alternative, the total average annual inflow and outflow for the Delta are approximately 22,400 taf and 14,600 taf, respectively (Tables B-33 and B-34). The annual average change in Delta inflows and outflows for the Preferred Alternative are 1 percent and 4 percent, respectively, as compared to existing conditions.

For the months important for recreationally important striped bass in the Delta (February through June), the percentage of years that Delta outflows are 10 percent or less than those for existing conditions ranged from 3 percent (April) to 17 percent (February). 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 Flow

Go To TOC

Evaluation Alternative. Calculated positions of X2 in the Delta, as measured from the Golden Gate Bridge, are shown in Table B-40. The average monthly position of X2 moved 0.7 kilometers or less for the period of simulation (approximately 0.9 percent relative to the No Action Alternative). During the months of February through June, X2 moved 0.5 kilometers or less for the years simulated (a change of 0.8 percent or less relative to that for No Action) (Table B-41).

The changes in the percentage of years that Delta outflows are larger than 10 percent greater than existing condition would potentially impact non-native fish, including striped bass and American shad, in the Delta. There would be a potentially significant reduction in flows in the middle reach of Sacramento River that may adversely affect striped bass and American shad during June when these species are migrating and spawning.

1.5 RESERVOIRS

1.5.1 Affected Environment

1.5.1.1 Trinity River Basin (Trinity and Lewiston Reservoirs)

Fish species found in the Lewiston Reservoirs and Trinity Reservoir 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 Reservoir and Lewiston Reservoir.

1.5.1.2 Reservoir Fish Populations and Habitat Conditions

Trinity Reservoir 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 Reservoir include both coldwater and warmwater species. Trinity Reservoir 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 Reservoir 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 Reservoir 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 Reservoir 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 Reservoir 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 Reservoir appear to be nearly ideal. The cool water and the high percentage of gravel-rubble bottom found in Trinity Reservoir 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 Reservoir, 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 Reservoir (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 and Lewiston Reservoirs. 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 and Lewiston Reservoirs 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.

Go To TOC

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 the Trinity Reservoir 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 Reservoir may not have been optimal for largemouth bass (Frederiksen, Kamine, and Associates, 1980). Cold water in Trinity Reservoir, resulting in low zooplankton production and competition for food with Trinity Reservoir 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 Reservoir 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 Reservoir. Waters from the McCloud, Pit, and Sacramento Rivers and tributaries are impounded by Shasta Dam. Discharges from Shasta Reservoir greatly influence temperatures in the upper Sacramento River below the dam. Shasta Reservoir 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.

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. CDFG has periodically stocked catfish and bass into this reservoir, but the principal gamefish has been striped bass.

Folsom Reservoir. Folsom Reservoir contains a warmwater fishery consisting of large-mouth and smallmouth bass, sunfish, and catfish. The coldwater fishery in Folsom is for rainbow trout stocked by CDFG on an annual basis. Lake Oroville’s warmwater sport fishery is for largemouth, spotted, and smallmouth bass and catfish. The coldwater fishery consists of rainbow and brown trout and chinook salmon.

1.5.2 Environmental Consequences

1.5.2.1 Methodology

Trinity River Basin.

Reservoir Habitat Assessment Model. A spreadsheet model was developed to evaluate the changes in reservoir habitat resulting in fluctuation of surface elevations and area. This assessment model was referred to as the Reservoir Habitat Assessment Model (RHAM) (Jones and Stokes Associates, 1999). A summary of the methods and assumptions for this model are shown in Attachment B17.

Reservoir operations affect reservoir fish populations by changing reservoir water surface elevations and reservoir surface areas. The impacts of operations and the effects of fluctuating reservoirs on warmwater fish communities in Trinity Reservoir were evaluated by calculating a spawning habitat index and a rearing habitat index for largemouth and smallmouth bass. These physical habitat indices are measures that could be expected to predict a biological response from a simulated change in environmental conditions. These changes are assumed to directly affect fish abundance and production. Changes in habitat indices therefore reflect expected changes in relative population, abundance, and production. In the RHAM model, each habitat impact assessment index value ranged from 0-1, where 0 represents unfavorable conditions and 1 represents favorable conditions. When comparing indices between an alternative and No Action, the difference in an mechanism index corresponds to the relative magnitude of an adverse or beneficial impact to the habitat of the species evaluated.

Go To TOC

The quantity of habitat available to young bass is dependent on each reservoir's geomorphology, the reservoir's surface elevation, and the window of depths these fish can utilize for spawning and rearing. Surface area of the reservoir correlates to the amount of shallow water habitat that can be used by bass. These factors were used to develop a tool, the RHAM—a spreadsheet model, used to evaluate changes in reservoir conditions on bass populations. These species represent an important warmwater sport fishery in Trinity Reservoir.

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 assessment, it was assumed that it required 3 years for revegetation of exposed substrate to occur.

The RHAM calculated either a spawning or rearing habitat index based on the relationship between changes in reservoir elevation and available habitat for bass species. For each project alternative, the reservoir assessment model imported 69 years of simulated monthly reservoir storage data from Reclamation's monthly operations model PROSIM (project simulation model). Within the RHAM model, the monthly average reservoir storage values from PROSIM were combined with elevation-storage-area relationships reflective of the geomorphology of the reservoir. The assessment model then calculated monthly values for water surface area, water surface fluctuation (elevation changes), and habitat exposure (or time length of habitat de-watering).

Spawning and rearing habitat indices were calculated from monthly water storage for Trinity Reservoir simulated over the 1922-1990 period. Known elevation-storage-area relationships for Trinity Reservoir were used in combination with simulated reservoir storage data to calculate water surface area, water elevation fluctuation, and periods of habitat exposure. The product of these three factors were weighted by a species timing factor (i.e., monthly importance) to give a monthly habitat index for each of the species evaluated. The sum of the 12 monthly habitat indices produced an annual mechanism index for each water year analyzed for each species.

The relationship between impact mechanisms and biological responses as measured by the habitat indices identified potential changes in a population parameter in response to an impact mechanism. Although the relationships were based on the best available information, a numerical estimate of biological response (e.g., actual change in population numbers) was not possible in the impact assessment because relationships occur in complex conditions and during variable periods that cannot be precisely characterized and incorporated into simulated monthly conditions. For the impact assessment, the mechanism index is an estimate that portrays the magnitude and direction of a particular response that can be evaluated relative to conditions simulated for the No Action Alternative.

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 Lewiston and Trinity Reservoirs was determined based on knowledge of these species' habitat requirements.

Central Valley. To qualitatively assess effects on reservoir species in the Central Valley, a comparison of changes in surface areas of Shasta, Oroville, Whiskeytown, Folsom, 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 1922-1990 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 the annual spawning and rearing indices. To provide a means for assessing the significance of a change in these indices, a target range was calculated for the No Action Alternative. The target range is the mean index for the 70-year simulation of the No Action Alternative ± 1 standard deviation. If a skewed distribution results in a standard deviation that exceeds the minimum or maximum index, the minimum or maximum index for the No Action Alternative is used as the lower or upper boundary of the target range.

For Trinity Basin Reservoirs, under the No Action Alternative, some of the calculated indices for the 70-year simulation fall outside the target range. The frequency with which the indices are outside the target range for the No Action Alternative is compared to the frequency with which the indices are outside the target range for each of the action alternatives. If the frequency with which the indices fall below the target range for an alternative is greater (i.e., 10 percent) than the frequency with which the indices fall below the target range for the No Action Alternative, a significant adverse impact was identified. Conversely, if the frequency with which the indices are above the high end of the target range is greater than the frequency for the No Action Alternative, a beneficial impact was identified.

To assess the changes in hydrology and reservoir operations for 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 Central Valley 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-25. For coldwater reservoir species, none of the project alternatives would affect those species in Lewiston Reservoir or Trinity Reservoir. The warmwater reservoir species in Trinity Reservoir were not affected by the State Permit, Mechanical, Percent Inflow, and Flow Evaluation Alternatives as compared to the No Action Alternative. The Maximum Flow Alternative would adversely affect both largemouth and smallmouth bass in Trinity Reservoir. Mitigation would reduce these adverse effects to less than significant.

None of the project alternatives would significantly affect reservoir fisheries in the Central Valley.

Comparing the Preferred Alternative to existing conditions resulted in no significant differences and no impacts to reservoir fisheries in either the Trinity/Klamath River Basins or the Central Valley.

1.5.2.4 No Action Alternative

Trinity Reservoir/Trinity River Basin.

Warmwater Species. On the average, spawning and rearing habitat for largemouth and smallmouth bass in Trinity Reservoir are approximately half of that which could be available if reservoirs always operated to maximize fish habitat. The average annual spawning indices for largemouth and smallmouth bass under the No Action Alternative are 0.41 and 0.54, respectively (Figures 1 and 2, Attachment B17). The average annual rearing index for both species is 0.55 (Figure 3, Attachment B17).

Coldwater Species. Because coldwater fish generally do not spawn in Trinity Reservoir, rearing life stages are most affected by reservoir operations. For the No Action Alternative, the average water surface elevations are lower than the reservoir maximum, indicating that surface area and rearing habitat availability are lower than they could be under reservoir operations that would maximize fish habitat. The average monthly reservoir-level elevation over the 70-year hydrologic period for Trinity Reservoir under the No Action Alternative is shown in Table B-42.

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 for the period 1922-1990 are shown in Tables B-43 through B-47.

1.5.2.5 Maximum Flow Alternative

Trinity Reservoir.

Warmwater Species. Under the Maximum Flow Alternative, Trinity Reservoir would be drawn down more frequently and to lower levels than under the No Action Alternative (Table B-42). The resulting reservoir fluctuations and reduced surface area would generally result in a decrease in habitat availability for warmwater species.

Conditions for largemouth bass spawning under the Maximum Flow Alternative would decline during May and June and would improve slightly for this life stage during April, July, and August. Smallmouth bass spawning would decline during May and June and improve slightly during April and August. Conditions for rearing for both species would decline from April to June and improve slightly in August.

Compared to the No Action Alternative, indices for smallmouth bass spawning and rearing for both species would fall below the target range 10 percent or more of the time than under the No Action Alternative (Figures 1-3, Attachment B17). The analysis of the alternative indicated that the frequency of occurrence in which spawning and rearing indices fell below the target range for No Action Alternative exceeded 10 percent of the 70 years of simulation, a significant adverse impact.

The change in operations under this alternative would result in significant adverse impacts (Table B-25) on both largemouth and smallmouth bass populations because these species support an important sport fishery in Trinity Reservoir 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 Reservoir elevations would frequently be lower than those of the No Action Alternative, reducing the amount of habitat available to coldwater fish (Table B-42). Adverse impacts on coldwater fish would occur from February through December, whereas increased reservoir levels in January would lead to improved conditions. Although coldwater fish species may be adversely affected, this impact would likely be less than significant (Table B-25) because trout populations are currently supported by hatchery production. The stocking frequency and intensity would be determined on the basis of creel census surveys conducted by the CDFG.

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 (Table B-25).

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-43 through B-47. Summaries of the expected changes in reservoir area, as compared to No Action on a monthly basis, are shown in Tables B-48 through B-52.

There would be no 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-53). The change in monthly surface area of Shasta Reservoir would range from a decrease of 466 to 829 acres during March through July compared to the No Action Alternative, a decrease of 2 to 3 percent (Table B-53). The monthly surface area for Oroville Reservoir range from an increase of 16 to 31 acres during March through July compared to No Action, an increase of less than 1 percent (Table B-53). The change in monthly surface area of Folsom Reservoir would range, on average, from a decrease of 163 to 517 acres during March through July compared to the No Action Alternative, a decrease of 2 to 6 percent (Table B-53). Finally, the changes in average monthly San Luis Reservoir surface area would range, on average, from an increase of 114 to a decrease of 121 acres during March through July compared to the No Action Alternative. These changes represent a difference of approximately plus or minus 1 percent of the reservoir surface area compared to No Action (Table B-53).

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

1.5.2.6 Flow Evaluation Alternative

Trinity Reservoir/Trinity River Basin.

Warmwater Species. Conditions for largemouth bass spawning under the Flow Evaluation Alternative would improve slightly in May and July compared to the No Action Alternative. Conditions for smallmouth bass spawning would improve in April and May and be the same as those under the No Action Alternative for the remainder of the period. Rearing habitat for both species would improve slightly in August and decline in September.

Impacts on largemouth bass are considered less than significant because the spawning indices for largemouth bass and the rearing indices for both species would not fall below the target range 10 percent or more of the time (Figures 1-3, Attachment B17).

Coldwater Species. Under this alternative, Trinity Reservoir elevations would frequently be higher than those under the No Action Alternative (Table B-42), increasing the amount of habitat area available for fish year round. Coldwater fish are likely to benefit under this alternative (Table B-25).

Lewiston Reservoir. Coldwater fish habitat conditions at Lewiston Reservoir under the Flow Evaluation 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 Flow Evaluation Alternative (Table B-25).

Central Valley. The average monthly reservoir surface areas in acres for the Flow Evaluation Alternative for Whiskeytown, Shasta, Oroville, Folsom, and San Luis Reservoirs are shown in Tables B-43 through B-47. Summaries of the expected changes in reservoir area, as compared to No Action on a monthly basis, are shown in Tables B-48 through B-52.

There would be no change in the average monthly surface area of Whiskeytown Reservoir, in acres, for the Flow Evaluation Alternative during March through July compared the No Action Alternative (Table B-53). The changes in average monthly surface area of Shasta Reservoir would decrease on the average from 172 to 540 acres during March through July compared to the No Action Alternative, a reduction of 1 to 2 percent (Table B-53). The average monthly changes in Oroville Reservoir’s surface area for the Flow Evaluation Alternative would range from an increase of 2 acres to a decrease of 7 acres during March through July compared to No Action, a change of less than 1 percent (Table B-53). The decrease in monthly Folsom Reservoir areas would range from 18 to 150 acres during March through July compared to No Action, a decrease of up to 2 percent (Table B-56). Finally, the changes in average monthly San Luis Reservoir area would range, on average, from an increase of 29 acres to a decrease of 147 acres during March through July compared to the No Action Alternative. These changes represent a difference of approximately less than 1 percent of the reservoir surface area compared to No Action (Table B-53).

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

1.5.2.7 Percent Inflow Alternative

Trinity Reservoir/Trinity River Basin.

Warmwater Species. Under the Percent Inflow Alternative, conditions for largemouth bass spawning would improve slightly during July compared to the No Action Alternative. Conditions for both largemouth and smallmouth bass spawning would improve slightly during April and July. Conditions for both smallmouth and largemouth bass rearing would decline slightly during April but improve slightly in August relative to those under No Action. The impacts on largemouth and smallmouth bass are considered less than significant because the indices for each species would not fall below the target level 10 percent or more of the time compared to the No Action Alternative (Figures 1-3, Attachment B17) (Table B-25).

Coldwater Species. Because changes in surface area would be small under this alternative relative to the No Action Alternative, impacts on coldwater fish would be less than significant (Tables B-42 and B-25).

Lewiston Reservoir. Coldwater fish habitat conditions at Lewiston Reservoir under the 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 Percent Inflow Alternative (Table B-25).

Central Valley. The average monthly reservoir surface areas in acres for the Percent Inflow Alternative for Whiskeytown, Shasta, Oroville, Folsom, and San Luis Reservoirs are shown in Tables B-43 through B-47. Summaries of the expected changes in reservoir area, as compared to No Action on a monthly basis, are shown in Tables B-48 through B-52.

There would be no change in the average monthly surface area of Whiskeytown Reservoir, in acres, for the Percent Inflow Alternative during March through July compared the No Action Alternative (Table B-53). The changes in average monthly surface area of Shasta Reservoir would decrease on average from 38 to 316 acres during March through July compared to the No Action Alternative, a reduction of less than 1 percent (Table B-53). The average monthly changes in Oroville Reservoir's surface area for the Percent Inflow Alternative would range from a decrease of 3 to 21 acres during March through July compared to No Action, a change of less than 1 percent (Table B-53). The changes in monthly Folsom Reservoir areas would range from an increase of 3 to a decrease of 36 acres during March through July compared to No Action, a change of up to 1 percent (Table B-53). Finally, the changes in average monthly San Luis Reservoir area would range, on average, from a decrease of 2 to 8 acres during March through July compared to the No Action Alternative. These changes represent a difference of approximately less than 1 percent of the reservoir surface area compared to No Action (Table B-53).

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

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 Reservoir and coldwater fish species at Lewiston Reservoir would be the same as under the No Action Alternative (Table B-25).

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 State Permit Alternative

Trinity Reservoir/ Trinity River Basin.

<u>Warmwater Species</u>. Under this alternative, Trinity Reservoir would be drawn down less frequently than under the No Action Alternative. Conditions for largemouth bass spawning would improve between May and July, and conditions for smallmouth bass spawning would improve during May and June. However, because the spawning and rearing indices for both species would not be above the target frequency 10 percent or more of the time compared to the No Action Alternative, the changes in conditions would not result in a significant beneficial impact on warmwater species (Figures 1-3, Attachment B17) (Table B-25).

<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 (Table B-25).

Lewiston Reservoir. Coldwater fish habitat conditions at Lewiston Reservoir under the State Permit 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 State Permit Alternative (Table B-25).

Central Valley. The average monthly reservoir surface areas in acres for the State Permit Alternative for Whiskeytown, Shasta, Oroville, Folsom, and San Luis Reservoirs are shown in Tables B-43 through B-47. Summaries of the expected changes in reservoir area, as compared to No Action on a monthly basis, are shown in Tables B-48 through B-52.

There would be no change in the average monthly surface area of Whiskeytown Reservoir, in acres, for the Percent Inflow Alternative during March through July compared the No Action Alternative (Table B-53). The changes in average monthly surface area of Shasta Reservoir would range from an increase 116 acres to a decrease of 6 acres during March through July compared to the No Action Alternative, a change of less than 1 percent (Table B-53). The average monthly changes of Oroville Reservoir's surface area for the State Permit Alternative would range from an increase of 53 to 76 acres during March through July compared to No Action, a change of approximately 1 percent (Table B-53). The changes in monthly Folsom Reservoir areas would range from an increase of 169 acres to a decrease of 14 acres during March through July compared to No Action, an increase of approximately

2 percent (Table B-53). Finally, the changes in average monthly San Luis Reservoir area would range, on average, from an increase of 2 acres to a decrease of 29 acres during March through July compared to the No Action Alternative. These changes represent a difference of approximately less than 1 percent of the reservoir surface area compared to No Action (Table B-53).

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

1.5.2.10 Existing Conditions versus Preferred Alternative

Trinity Reservoir/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. This is because the other components of the Preferred Alternative (i.e., watershed protection) would not affect reservoirs, and there is little expected change in reservoir conditions between existing conditions and the No Action Alternative.

Warmwater Species. Trinity Reservoir would rarely be lower under the Preferred Alternative than under existing conditions. Conditions for largemouth bass spawning would improve slightly during May and July relative to existing conditions. Smallmouth bass spawning would decrease slightly from February through April and also in August, but would increase from May through July compared to existing conditions. Rearing conditions would not differ between the Preferred Alternative and existing conditions.

Impacts on largemouth and smallmouth bass are considered less than significant because the spawning and rearing indices for both species would not fall below the target range of 10 percent or more of the time (Figures 4-6 in Fisheries Attachment 17).

Coldwater Species. Under the Preferred Alternative, Trinity Reservoir elevations would typically be higher than those under existing conditions, increasing the amount of habitat area available for fish year round. Coldwater fish are likely to benefit under 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 Whiskeytown, Shasta, Oroville, Folsom, and San Luis Reservoirs are shown in Tables B-43 through B-47. Summaries of the expected changes in reservoir area, as compared to existing conditions on a monthly basis, are shown in Tables B-48 through B-52.

The surface area of Whiskeytown Reservoir for the Preferred Alternative during March through July would range from an increase of 2 to 34 acres, on average, compared the No Action Alternative (Table B-53). The ranges in average monthly surface area of Shasta Reservoir would decrease on the average approximately 277 to 746 acres during March through July compared to the No Action Alternative, a reduction of 1 to 3 percent

Go To TOC

(Table B-53). The average monthly decreases in Oroville Reservoir's surface area for the Preferred Alternative would range from 292 to 553 acres during March through July compared to No Action, a change of 2 to 4 percent (Table B-53). The decreases in monthly Folsom Reservoir areas would range from 115 to 224 acres during March through July compared to No Action, a decrease of up to 2 percent (Table B-53). Finally, the changes in average monthly San Luis Reservoir area would range, on average, from a decrease of 6 to 225 acres March through July compared to the No Action Alternative. These changes represent a difference of up to 3 percent of the reservoir surface area compared to No Action (Table B-53).

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

1.5.2.11 Fisheries Cumulative Effects

Impacts Relative to the No Action Alternative. Implementation of the Preferred Alternative, the CVPIA Preferred Alternative, and full CVP water rights deliveries ("cumulative effects") would result in modeled increased losses of early lifestages (eggs and sac-fry) of some runs of Sacramento River chinook salmon compared to the No Action Alternative. These impacts are attributable to mortality of chinook salmon eggs and sac-fry from increases of Sacramento River water temperature. On an annual average basis, losses of fall and spring chinook salmon would increase approximately 1 percent over that of the No Action Alternative (Table B-27). Losses of late-fall chinook and steelhead would likely remain unchanged from No Action. Losses of winter chinook salmon eggs and fry would increase approximately 6 percent beyond that estimated for No Action. The modeled increases in mortality occurred during the critically dry waters years of 1924, 1931 through 1935, and 1977 (Attachment B-14). For those years, increased water temperatures resulted in very large mortality increases (up to nearly 70 percent greater than those for No Action) of incubating and developing sac-fry. For the entire simulated period (1922-1990), the losses are slightly greater than assumed for the No Action condition, but they would be significant.

The cumulative effects of the implementation of preferred alternatives and full CVP deliveries on Delta species would likely be minor compared to No Action. The average absolute change in the position of X2 (in kilometers [km]) in the Delta during February through June would be less than 1.7 km, a relative change of less than 3 percent (Table B-41). These changes in geographic position of X2 may not be sufficiently large enough to effect transport of larvae and juveniles into areas in the Delta where they could be entrained into the Delta pumps. However, reductions in outflows in the Delta greater than 10 percent less than those for No Action occurred in up to 14 percent of the years modeled (Table B-39). These reductions may adversely affect Delta species by relocating them in less productive areas or areas of lower habitat value within the Delta. These changes may adversely effect these species.

Impacts Relative to Existing Conditions. Implementation of the Preferred Alternative, the CVPIA Preferred Alternative, and full CVP water rights deliveries ("cumulative effects") would result in even greater losses of early lifestages (eggs and sac-fry) of fall, winter, and spring chinook salmon compared to existing conditions. This would result from increased water temperatures in the upper Sacramento River. Losses of late-fall chinook and steelhead

Go To TOC

would likely remain unchanged from No Action. On an annual average basis, losses of fall, winter, and spring chinook salmon would increase approximately 2, 6, and 4 percent, respectively, over those under existing conditions (Table B-27). These losses would be significant.

The cumulative effects of the implementation of preferred alternatives and full CVP deliveries on Delta species would also be minor compared to No Action. The average absolute change in the position of X2 (in km) in the Delta during February through June would be less than 1.6 km, a relative change of approximately 2 percent (Table B-41). These changes may not be sufficient in magnitude to result in the transport of Delta smelt and other native or important gamefish into areas where they could be entrained by the Delta pumps. However, reductions in outflows in the Delta greater than 10 percent less than those for No Action occurred. These reductions may adversely affect Delta species by relocating them in less productive areas or areas of lower habitat value within the Delta. These changes may result in adverse affects to these species.

Impacts Relative to the Preferred Alternative. Compared to the Preferred Alternative alone, and except for winter chinook, the cumulative effects of the implementation of the preferred alternatives and full CVP water right deliveries 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 winter 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-27). These additional losses would be significant.

The cumulative effects of the implementation of preferred alternatives and full CVP deliveries on Delta species would also be minor compared to the 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 1.8 km, a relative change of less than 3 percent (Table B-41). 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 be sufficiently large enough to transport larvae and juvenile smelt and other species into areas where they would be subject to increased entrainment. These reductions may however, adversely affect Delta species by relocating them in less productive areas or areas of lower habitat value within the Delta. These changes may result in adverse effects to these species.

Go To TOC

1.6 BIBLIOGRAPHY

AWAC, 1995. Association of California Water Agencies (ACWA). 1995. The Status of Steelhead Populations in California in Regards to the Endangered Species Act. Special Report, February, 1995. Submitted to the National Marine Fisheries Service on Behalf of the Association of California Water Agencies. Prepared by S. P. Cramer and Associates, Inc. Gresham, OR. 190 pp.

BLM (Bureau of Land Management). 1995. *Mainstem Trinity River Watershed Analysis*. U.S. Department of the Interior, Bureau of Land Management, Redding Resource Area, Redding, CA. 237 pp.

Boles, G.L. 1976. Effects of riffle degradation on aquatic invertebrate populations in the Trinity River, California Department of Water Resources, Northern District.

Boles, G.L. 1980.Macroinvertebrates Abundance and Diversity as Influenced by Substrate Size in the Trinity River. Department of Water Resources, Northern District. January, 1980. 9 pp.

Boles, G. 1988. Water temperature effects on chinook salmon (*Oncorhynchus tshawytscha*) with an emphasis on the Sacramento River - a literature review. California Department of Water Resources publication, Northern District. 43 pp.

California Department of Fish and Game. 1965 Annual Report Trinity River Salmon and Steelhead Hatchery Sixth Year of Operation 1963-1964. Inland Fisheries Administrative Report No. 65-5.

California Department of Fish and Game. 1966 Annual Report Trinity River Salmon and Steelhead Hatchery Seventh Year of Operation 1964-1965. Inland Fisheries Administrative Report No. 66-1.

California Department of Fish and Game. 1970 Annual Report Trinity River Salmon and Steelhead Hatchery Twelfth Year of Operation 1969-1970. Anadromous Fisheries Branch Administrative Report No. 70-19.

California Department of Fish and Game. 1971 Annual Report Trinity River Salmon and Steelhead Hatchery Thirteenth Year of Operation 1970-1971. Anadromous Fisheries Branch Administrative Report No. 72-4.

California Department of Fish and Game. 1972 Annual Report Trinity River Salmon and Steelhead Hatchery Fourteenth Year of Operation 1972-1973. Anadromous Fisheries Branch Administrative Report No. 72-14.

California Department of Fish and Game. 1974 Annual Report Trinity River Salmon and Steelhead Hatchery 1972-1973. Anadromous Fisheries Branch Administrative Report No. 74-4.

California Department of Fish and Game. 1974 Annual Report Trinity River Salmon and Steelhead Hatchery 1973-1974. Anadromous Fisheries Branch Administrative Report No. 75-4.

California Department of Fish and Game. 1976 Annual Report Trinity River Salmon and Steelhead Hatchery 1974-1975. Anadromous Fisheries Branch Administrative Report No. 76-6.

California Department of Fish and Game. 1976 Annual Report Trinity River Salmon and Steelhead Hatchery 1975-1976. Anadromous Fisheries Branch Administrative Report No. 78-1.

California Department of Fish and Game. 1977 Annual Report Trinity River Salmon and Steelhead Hatchery 1976-1977. Anadromous Fisheries Branch Administrative Report No. 78-2.

California Department of Fish and Game. 1978 Annual Report Trinity River Salmon and Steelhead Hatchery 1977-1978. Anadromous Fisheries Branch Administrative Report No. 79-2.

California Department of Fish and Game. 1979 Annual Report Trinity River Salmon and Steelhead Hatchery 1978-1979. Anadromous Fisheries Branch Administrative Report No. 80-14.

California Department of Fish and Game. 1980 Annual Report Trinity River Salmon and Steelhead Hatchery 1979-1980. Anadromous Fisheries Branch Administrative Report No. 82-3.

California Department of Fish and Game. 1983 Annual Report Trinity River Salmon and Steelhead Hatchery 1980-1981. Anadromous Fisheries Branch Administrative Report No. 83-3.

California Department of Fish and Game. 1982 Annual Report Trinity River Salmon and Steelhead Hatchery 1981-1982. Anadromous Fisheries Branch Administrative Report No. 82-39.

California Department of Fish and Game. 1983 Annual Report Trinity River Salmon and Steelhead Hatchery 1982-1983. Anadromous Fisheries Branch Administrative Report No. 83-11.

California Department of Fish and Game. 1984 Annual Report Trinity River Salmon and Steelhead Hatchery 1983-1984. Anadromous Fisheries Branch Administrative Report No. 84-05.

California Department of Fish and Game. 1985 Annual Report Trinity River Salmon and Steelhead Hatchery 1984-1985. Inland Fisheries Administrative Report No. 87-5.

California Department of Fish and Game. 1986 Annual Report Trinity River Salmon and Steelhead Hatchery 1985-1986. Inland Fisheries Administrative Report No. 87-13.

California Department of Fish and Game. 1990 Annual Report Trinity River Salmon and Steelhead Hatchery 1986-1987. Inland Fisheries Administrative Report No. 90-17.

California Department of Fish and Game. 1990 Annual Report Trinity River Salmon and Steelhead Hatchery 1987-1988. Inland Fisheries Administrative Report No. 90-11.

CDFG (California Department of Fish and Game). 1992a. Annual Report, Trinity River Basin salmon and steelhead monitoring project, 1989 - 1990 season. Inland Fisheries Division, Sacramento, CA. 140 pp.

California Department of Fish and Game. 1992a. Utilization of the Klamath River Estuary by Juvenile Salmonids. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Project No. F-51-R-4; Subproject No. IX; Study No. 10; Job No. 3; 8 pp.

CDFG (California Department of Fish and Game). 1992b. Annual Report, Trinity River Basin salmon and steelhead monitoring project, 1990 - 1991 season. Inland Fisheries Division, Sacramento, CA. 186 pp.

California Department of Fish and Game. 1992b. Assessment of Fish Habitat Types in the Klamath River Estuary. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Project No. F-51-R-4; Subproject No. IX; Study No. 22; Job No. 1; 7 pp.

California Department of Fish and Game. 1993a. Utilization of the Klamath River Estuary by Juvenile Salmonids. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Project No. F-51-R-5; Subproject No. IX; Study No. 10; Job No. 3; 7 pp.

California Department of Fish and Game. 1993b. Assessment of Fish Habitat Types in the Klamath River Estuary. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Project No. F-51-R-5; Subproject No. IX; Study No. 22; Job No. 1; 9 pp.

CDFG (California Department of Fish and Game). 1994. Annual Report, Trinity River Basin salmon and steelhead monitoring project, 1991 - 1992 season. Inland Fisheries Division, Sacramento, CA. 235 pp.

California Department of Fish and Game. 1994a. Length of Residency of Juvenile Chinook Salmon in the Klamath River Estuary. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Project No. F-51-R-6; Project No. 32; Job No. 4; 11 pp.

California Department of Fish and Game. 1994b. Seasonal Water Quality Monitoring in the Klamath River Estuary. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Project No. F-51-R-6; Category: Surveys and Inventories; Project No. 33; Job No. 2; 6 pp.

CDFG (California Department of Fish and Game). 1995. Annual Report, Trinity River Basin salmon and steelhead monitoring project, 1992 - 1993 season. Inland Fisheries Division, Sacramento, CA. 235 pp.

California Department of Fish and Game. 1995. Seasonal Water Quality Monitoring in the Klamath River Estuary. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Project No. F-51-R-6; Category: Surveys and Inventories; Project No. 33; Job No. 2; 6 pp.

CDFG (California Department of Fish and Game). 1996a. Annual Report, Trinity River Basin salmon and steelhead monitoring project, 1993 - 1994 season. Inland Fisheries Division, Sacramento, CA. 266 pp.

CDFG (California Department of Fish and Game). 1996b. Annual Report, Trinity River Basin salmon and steelhead monitoring project, 1994 - 1995 season. Inland Fisheries Division, Sacramento, CA. 197 pp.

California Department of Fish and Game. 1997. Klamath River Basin Fall Chinook Salmon Run-Size, In-River Harvest and Spawner Escapement—1997 Season. December 16, 1997. CDFG Klamath-Trinity Program. 9 pp.

CDFG (California Department of Fish and Game). 1998. Klamath River Basin Fall Chinook Salmon Run-Size, Harvest, and Spawner Escapement - 1998 Season.

CDFG/USFWS (California Department of Fish and Game/ U.S. Fish and Wildlife Service). 1956. A plan for the protection of fish and wildlife resources affected by the Trinity River Division, Central Valley Project. Prepared jointly by California Department of Fish and Game and U.S. Fish and Wildlife Service. 76 pp.

CRWQCB-NCR (California Regional Water Quality Control Board - North Coast Region). 1994. Water Quality Control Plan for the north coast region. Santa Rosa, CA.

California Resources Agency, 1980.

Coleman, M.E. 1978. Composition and Horizontal Distribution of Net Zooplankton and Their Association with Environmental Variables In Clair Engle Reservoir, California. Master’s Thesis. Humboldt State University, Arcata, CA.

Conte, F.S. Doroshov, S.I., Lutes, P.B., and Strange, E.M. 1988. Hatchery Manual for the White Sturgeon *Acipenser transmontanus* with Applications to Other North American Acipenseridae; (Publication 3322) Davis, University of California Cooperative Extension, Division of Agriculture and Natural resources.

Coon, John, Pacific Fishery Management Council, Portland, OR. 1998. Telephone conversation on February 24 with Thomas Wegge.

Dixon, Rich, California Department of Fish and Game, Sacramento, CA. 1997. Facsimile transmittal of unpublished tagged Trinity River salmon harvest data in July to Thomas Wegge.

Fitch, J. E., and R. J. Lavenberg. 1975. Tidepool and Nearshore Fishes of California. California Natural History Guides: 38. University of California Press, Berkeley, California. 156 pp.

Foott, J.S., and R.L. Walker. 1992. Disease survey of Trinity River salmonid smolt populations. U.S. Fish and Wildlife Service, California-Nevada Fish Health Center, Anderson, CA. 35 pp.

Fredericksen, Kamine, and Associates. October 1980. Proposed Trinity River Basin Fish and Wildlife Management Program, Appendix B - sediment and related analysis. Report prepared for Bureau of Reclamation by Trinity River Basin Fish and Wildlife Task Force, Sacramento, CA.

Free, D., J.S. Foott, W. Talo, and J.D. Williamson. 1997. Physiological effects of *Nanophyetus* Metacercaria Infection in Chinook Salmon Smolts (Trinity River). U.S. Fish and Wildlife Service, California-Nevada Fish Health Center, Anderson, CA. 35 pp.

Galbreath, J.L. 1979. Columbia River Colossus, The White Sturgeon: Oregon Wildlife, March 1979.

Gall, G.A.E.; Bartley, D.; Brodziak, J.; Gomulkiewicz, R.; and Mangel, M. 1992. "Geographic Variation in Population Genetic Structure of Chinook Salmon from California and Oregon." *Fishery Bulletin 90(1)*: 77-100.

Gallagher, S. P. 1995. Evaluation of the feathered edge restoration projects on the Trinity River: Fish use and physical habitat. U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, California. 28 pp.

Gard, M. 1996. Simulation of physical habitat for anadromous salmonids in the Trinity River. U.S. Fish and Wildlife Service, Ecological Services, Sacramento, California. 55 pp.

Gard, M. 1997. Simulation of physical habitat for anadromous salmonids in the lower Trinity River. U.S. Fish and Wildlife Service, Ecological Services, Sacramento, California. 30 pp.

Gibbs, E.D. 1956. A report on the King Salmon, *Oncohynchos tshawytscha*, in the upper Trinity River, 1955. California Department of Fish and Game, Inland Fishery Administrative Report No. 56-10 13 pp.

Glase, J. D. 1994a. Monitoring juvenile salmon and steelhead outmigrants produced in the upper Trinity River, Northern California, 1991-1993 progress report. U.S. Fish and Wildlife Service, Trinity River Restoration Program, progress report. 27 pp.

Glase, J. D. 1994b. Progress Report, Evaluation of Artificially Constructed Side Channels as Habitat for Salmonids in the Trinity River, Northern California, 1991-1993. U.S. Fish and Wildlife Service, Trinity River Fishery Resource Office, Weaverville, CA. pp. 46.

Gray, Ann, U.S. Fish and Wildlife Service, Arcata, CA. 1998. Facsimile transmittal of fish harvest estimates on March 6 and April 3 to Thomas Wegge.

Hallock, R. J. 1989. Upper Sacramento River Steelhead, *Oncorhynchus mykiss*, 1952-1988. Prepared for the U.S. Fish and Wildlife Service. Sacramento, CA. September 15, 1989.

Hamaker, T. June 19, 1997. Memorandum to Mark Hampton of U.S. Fish and Wildlife Service, Weaverville, CA. Subject: chinook salmon run size review; Project SWW33785.36.TH.

Hampton, M. 1992. Evaluation of the Junction City Side Channels, U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, CA. 12 pp.

Hanemann, M. and C. Dumas. 1996. *CVPIA Impact Assessment Methodology for Fish, Wildlife and Recreation Economics.* University of California at Berkeley, Berkeley, CA. Prepared for Jones & Stokes Associates, Inc., Sacramento, CA.

Hilborn, R. 1992. Can Fisheries Agencies Learn from Experience? Fisheries, Vol. 17, No. 4 pp. 6-14.

Holmberg, J.J. 1972. Salmon in California. U.S. Bureau of Reclamation. Sacramento, CA. 73 pp.

Hubbel, P. 1973. A program to identify and correct salmon and steelhead problems in the Trinity River Basin. California Department of Fish and Game.

KRTAT (Klamath River Technical Advisory Team). 1986. Recommended spawner escapement policy for Klamath River fall-run chinook. 73pp.

Jones and Stokes Associates. 1998.

Jones & Stokes Associates Inc., 1999. Trinity River Restoration Project Reservoir Fisheries Evaluation. Prepared for CH2MHILL Redding, CA. May 25, 1999.

Kohlhorst, D.W. 1976. Sturgeon Spawning in the Sacramento River in 1973, as Determined by Distribution of Larvae. California Fish and Game, Vol. 62, No. 1, pp. 32-40.

La Faunce, D. A. 1965. A steelhead spawning survey of the upper Trinity River System. California Department of Fish and Game, Marine Resources Administration Report No. 65-4. 5 pp.

Leidy R.A., and G.R. Leidy. 1984. Life stage periodicities of anadromous salmonids in the Klamath River Basin, northwestern California. U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, CA. 21 pp.

Lestelle, L.C., L.E. Mobrand, J.A. Lichatowich, and T.S. Vogel. 1996. Ecosystem Diagnosis and Treatment (EDT), Applied Ecosystem Analysis - A Primer. Prepared for US Deptment of Energy, Bonneville Power Administration, Environmental Fish and Wildlife. Portland, OR. 95 pp.

Ligon, F.K., W.E. Deitrich, and W.J. Trush. 1995. Downstream ecological effects of dams: a geomorphic perspective. BioScience 45(3): 183-192.

Mangum, 1995.

McBain, S.M., and W.J. Trush. 1995. Channel bed mobility and scour on a regulated gravel bed river. pp1941-1950 in J.J. Cassiday, (ed.) International Conference on Hydropower ASCE, San Francisco, CA.

McBain, S., and W. Trush. 1997. *Trinity River Channel Maintenance Flow Study Final Report*. Prepared for the Hoopa Valley Tribe, Trinity River Task Force.

Mills, T. J. and F. Fisher. 1994. Central Valley Anadromous Sport Fish Annual Rin-Size, Harvest Estimates and Population Trends, 1967 through 1991. 3rd Draft. (Inland Fisheries Technical Report). Sacramento , CA., California Department of Fish and Game. August, 1994.

Minnesota IMPLAN Group. 1993. Micro IMPLAN, version 91-F, open data file. St. Paul, MN.

Moffett, J.W., and S.H. Smith. 1950. Biological Investigations of the fishery resources of the Trinity River, California. Special Scientific Report No. 12. U.S. Fish and Wildlife Service. 71 pp.

Moyle, P.B. 1976. Inland Fishes of California. Berkeley, University of California Press.

Moyle, P.B., r. M. Yoshiyama, J.E. Williams, and E.D. Wikramanyake. 1995. Fish Species of Special Concern in California. Second Edition. Prepared for the /department of Fish and Game, Inland Fisheries Division, Rancho Cordova, CA. June, 1995. 272 pp.

NMFS (National Marine Fisheries Service). 1994. Status review for Klamath Mountains Province. NOAA Technical Memorandum NMFS-NWFSC-19. 130 pp.

National Marine Fisheries Service. 1997. NMFS Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. August, 1997NMFS Southwest Region, Long Beach California.

Niskikawa, V. 1998. Summary of simulated Trinity River diversion patterns, Sacramento River temperatures, and salmon mortality model assumptions. Attachment B9.

Oscar Larson and Associates. 1984. Trinity Lake Hydroelectric Projects Cumulative Environmental Impact Report. Eureka, CA. Prepared for Trinity County Planning Department, Weaverville, CA.

Pacific Fishery Management Council. 1998. Review of 1997 ocean salmon fisheries. Portland, OR.

Pacific Fishery Management Council. 1997. Review of 1996 ocean salmon fisheries. Portland, OR.

PFMC (Pacific Fishery Management Council). 1995. Review of 1994 Ocean Salmon Fisheries.

Pacific Fishery Management Council. 1993. Historical ocean salmon fishery data for Washington, Oregon, and California. Portland, OR.

PFMC (Pacific Fishery Management Council). 1988. Review of 1987 Ocean Salmon Fisheries.

Pacific Fishery Management Council. 1983. Proposed plan for managing the 1983 salmon fisheries off the coasts of California, Oregon, and Washington. Portland, OR.

Polos, Joe, fishery biologist, U.S. Fish and Wildlife Service, Arcata, CA. 1997. Telephone conversation on July 16 with Thomas Wegge.

Rogers, D.W. 1972. King Salmon (*Oncorhynchus tshawytscha*) and Silver Salmon (*Oncorhynchus kitsuch*) Spawning Escapement and Spawning Habitat in the Upper Trinity River, 1970. Anadromous Fisheries Branch Administrative Report No. 73-10. July 1997. California Department of Fish and Game. 14 pp.

Rogers, D. W. 1973. A steelhead spawning survey of the tributaries of the upper Trinity River and upper Hayfork Creek drainage, 1972. California Department of Fish and Game, Anadromous Fisheries Administrative Report No. 73-5A. 8 pp.

Rogers, D.W. 1982. A Spawning Escapement Survey in the Trinity River, 1971. Anadromous Fisheries Branch Administrative Report No. 82-2. California Department of Fish and Game. 11 pp.

Rowell. J. 1997. Memorandum Subject: *Model Update: USBR Sacramento River Basin Temperature Model-Sacramento River Salmon Model*. Dated March 6, 1997. To Walter Bourez et al. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA. 5 pp.

Smith, G. 1975. Anadromous salmonid escapement in upper Trinity River, California. 19679. California Department of Fish and Game, Anad. Fish. Br. Admin Rep. 75-7.

Stemple, M. 1988. Chinook Salmon Spawning Survey in the Upper Trinity River During the Fall of 1987. Trinity River Restoration Office. U.S. Fish and Wildlife Service. Weaverville, CA.

Stuber, R. J. G. Gebhart, and O.E. Maughan. 1982. Habitat Suitability Index Models: Largemouth Bass. (FWS/OBS-8210.16) U.S. Fish and Wildlife Service. Fort Collins, CO.

TRBFWTF (Trinity River Basin Fish and Wildlife Task Force). 1977. Framework guide for Trinity River Basin Fish and Wildlife Management Program. 87 pp.

Theurer F.D., K.A. Voos, and W.J. Miller. 1984. Instream Water Temperature Model. Instream Flow Information Paper No. 16. Washington, DC: US Fish and Wildlife Service (FWS/OBS-84/15). 200 pp.

Thomson, C.J., and D.D. Huppert. 1987. Results of Bay Area Sportfish Economic Study (BASES). (NOAA-TM-NMSF-SWFC-78.) U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Center.

Trinity Restoration Associates, Inc. 1993. Trinity River Maintenance Report, Evaluation of the 6000-cfs Release. February 1993. Prepared for the Hoopa Valley Tribe, Fisheries Department. 294 pp.

USBOR (U.S. Bureau of Reclamation). 1952. Trinity River Division, Central Valley Project Ultimate Plan. Washington D.C. 184 pp+Appendixes.

USBOR (U.S. Bureau of Reclamation). 1991. Appendixes to Shasta Outflow Temperature Control: Planning Report/Environmental Statement: Appendix A. USDI/BOR/Mid-Pacific Region. November 1990, Revised May 1991. v.p.

USBOR. (U.S. Bureau of Reclamation). 1997. Draft Programmatic Environmental Impact Statement: Implementation of the Central Valley Project Improvement Act of 1992. Prepared by the U.S. Bureau of Reclamation for the Department of the Interior. USBOR Mid-Pacific Region, Sacramento CA. September, 1997.

USFWS (U.S. Fish and Wildlife Service). 1980a. Trinity River Instream Flow Study, Lewiston Dam to the North Fork, June/July 1978. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. 48 pp.

USFWS (U.S. Fish and Wildlife Service). 1980b. Environmental Impact Statement on the Management of River Flows to Mitigate the Loss of the Anadromous Fishery of the Trinity

River, California. Volumes I and II. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA.

USFWS (U.S. Fish and Wildlife Service). 1983. Final environmental impact statement: Trinity River Basin fish and wildlife management program. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, CA. INT/FES 83-53.

USFWS (U.S. Fish and Wildlife Service). 1985. Trinity River Flow Evaluation-Annual Report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. 45 pp.

USFWS (U.S. Fish and Wildlife Service). 1986. Trinity River Flow Evaluation-Annual Report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. 104 pp.

USFWS (U.S. Fish and Wildlife Service). 1987. Trinity River Flow Evaluation-Annual Report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. 157 pp.

USFWS (U.S. Fish and Wildlife Service). 1988. Trinity River Flow Evaluation-Annual Report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. 146 pp.

USFWS (U.S. Fish and Wildlife Service). 1989. Trinity River Flow Evaluation-Annual Report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. 116 pp.

USFWS (U.S. Fish and Wildlife Service). 1990. Trinity River Flow Evaluation-Annual Report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. 63 pp.

USFWS (U.S. Fish and Wildlife Service). 1991. Trinity River Flow Evaluation-Annual Report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. 57 pp.

USFWS (U.S. Fish and Wildlife Service). 1993. Biological opinion for the Sacramento River winter-run chinook.

USFWS (U.S. Fish and Wildlife Service). 1994. *Restoration of the mainstem Trinity River, background report*, Trinity River Fishery Resource Office, Weaverville, California. 14 pp.

USFWS (U.S. Fish and Wildlife Service). 1996. Trinity River Flow Evaluation hydraulic modeling procedures and calibration details: Feather edge studies, 1995. USFWS, Division of Ecological Services, Instream Flow Branch, Sacramento, California. 7 pp.

USFWS (U.S. Fish and Wildlife Service). 1997. Physical Habitat and Fish Use of Channel Rehabilitation Projects on the Trinity River. Coastal California Fish and Wildlife Service, Arcata, California. 19 pp.

USFWS (U.S. Fish and Wildlife Service). 1998. Juvenile salmonid monitoring on the main-stem Trinity River at Willow Creek and mainstem Klamath River at Big Bar, 1992-1995.

Annual Report of the Klamath River Fisheries Assessment Program. U.S. Fish and Wildlife Service, Coastal California Fish and Wildlife Office, Arcata, CA.

USFWS/CDFG (U.S. Fish and Wildlife Service and California Department of Fish and Game). 1956. A plan for the protection of fish and wildlife resources affected by the Trinity River Division, Central Valley Project. Prepared jointly by California Department of Fish and Game and U.S. Fish and Wildlife Service. 76 pp.

USFWS (U.S. Fish and Wildlife Service). 1995. Working Paper on Restoration Needs: Habitat Restoration Actions to Double Natural Production of Anadromous fish in the Central Valley of California. Volume 3. May 5, 1995. Prepared for the U.S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group. Stockton, CA.

USFWS (U.S. Fish and Wildlife Service) and the Hoopa Valley Tribe. 1999. Trinity River Flow Evaluation Final Report. May 1999.

VTN Environmental Studies. October 1979. Fish and Wildlife Management Options, Trinity River Basin. Trinity River Basin Fish and Wildlife Task Force.

Vogel, D. A. and K.R. 1991. .U.S. Bureau of Reclamation, Central Valley Project Guide to Upper Sacramento River Chinook Salmon Life History. CH2MHILL, Redding, CA.

Wallace, M., and B.W. Collins. 1997. Variation in use of the Klamath River estuary by juvenile chinook salmon. California Department of Fish and Game 83 (4): 132-143.

Wilcock, P.R., G.M. Kondolf, A.F. Barta, W.V.G. Matthews, and C.C. Shea. 1995. Spawning gravel flushing during trial reservoir releases on the Trinity River: Field observations and recommendations for sediment maintenance flushing flows. Prepared for the U.S. Fish Wildlife Service, Sacramento, CA., Cooperative Agreements 14-16-0001-91514 and 14-16-0001-91515. 96 pp.

Williamson, S.C., J.M. Bartholow, and C.B. Stalnaker. 1993. Conceptual model for quantifying pre-smolt production from flow-dependent physical habitat and water temperature. *Regulated Rivers: Research & Management*. 8(1&2): 15-28.

Zedonis, P. 1997. A water temperature model of the Trinity River. Prepared for the U.S. Bureau of Reclamation. U.S. Fish and Wildlife Service, Coastal California Fish and Wildlife Office, Arcata, California. 97 pp.

Zedonis, P.A, and T. J. Newcomb. 1997. Flow and water temperatures for protection of spring salmon and steelhead smolts in the Trinity River, California. U.S. Fish and Wildlife Service, Arcata, CA. 20 pp.

Zuspan and Sinnen, 1996 as cited by Service and HVT, 1999

Table B-1
Summary of Impact Analysis for Fisheries Resources (Comparing Each Alternative to the No Action Alternative)

Resource Concern	Geographical Area	Alternative: No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions Compared to Preferred Alternative
Native anadromous salmonids	Trinity River Basin	--	HB	HB	B	B	A	HB
	Lower Klamath Basin	--	B	B	nc	nc	A	B
	Central Valley	--	A	A	A	nc	B	A
Other native anadromous species	Trinity River Basin	--	HB	HB	B	B	A	HB
	Lower Klamath Basin	--	B	B	nc	nc	A	B
	Central Valley	--	A	A	nc	nc	nc	A
Resident native species	Trinity River Basin	--	B	B	B	B	A	B
	Lower Klamath Basin	--	B	B	nc	nc	A	B
	Central Valley	--	A	A	A	nc	nc	A
Non-native species	Trinity River Basin	--	B	B	B	B	A	B
	Lower Klamath Basin	--	B	B	nc	nc	A	B
	Central Valley	--	A	A	nc	nc	nc	A
Reservoir species-Trinity Basin	Warmwater species	--	A[1]	nc	nc	nc	nc	A
	Coldwater species	--	nc	nc	nc	nc	nc	nc
Reservoir species-Central Valley	All species	--	nc	nc	nc	nc	nc	nc

A = adverse change
A[1] = adverse change (large and smallmouth bass)
nc = no change
B = benefical change
HB = highly beneficial change

Table B-2
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 NMFS 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 have been proposed for "threatened species" listing (U.S. National Marine Fisheries Service, 1995).
[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 Clair Engle Reservoirs by CDFG and since transported downstream into Trinity River.

Table B-3
Life History and Habitat Characteristics of Non-salmonid Native Anadromous Fish in the Trinity River and/or Klamath River Basins

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
Post-dam Chinook and Coho Salmon and Winter Steelhead Run-size, Spawning Escapement, and Angler Harvest Estimates for the Mainstem Trinity River

Species	Run-size Estimate	Total Basin Escapement	Inriver Spawner Escapement	TRSSH Hatchery Escapement	Inriver Angler Harvest	Naturally Produced Inriver Spawner Escapement[a]	Hatchery-produced Inriver Spawner Escapement[a]
Years	**1977-1997**					**1982-1997**	
Fall Chinook	44,100	40,280	31,970	8,300	3,820	12,230	34,170
Years	**1978-1982, 1984-1994, 1996, 1997**			**1977-1997**		**1982-1997**	
Spring Chinook	16,500	14,450	10,400	4,160	2,050	1,550	13,830
Years	**1977-1997**					**1991-1995**	
Coho	16,620	16,040	10,370	5,670	580	200	15,820
Years	**0,1982-1984,1988-1997**			**1977-1997**	**1980,1982-1984,1988-1997**	**1980,1982-1984,1988-1996**	
Winter Steelhead	10,670	9,380	8,150	1,280	1,370	4,290	2,010
Years	**1992-1997**					**1992-1996**	
Winter Steelhead	5,080	4,640	3,500	1,150	440	1,600	1,740

[a]Zuspan and Sinnen (1996) as cited by Service (1998)
[b]Stemple (1988); Zuspan and Sinnen (1996) as cited by U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999

Table B-5
Fall Chinook Salmon Inriver Spawner Escapement for the Trinity River

	Pre-dam (<1964)		Post-dam (1982-1997)	
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	34,670[c]	5,250-113,000[c]
Total	45,600[d]	19,000-75,600	34,670	5,250 113,000
Total of naturally produced fish (total minus hatchery-produced fish spawning inriver)[c]	N/A	N/A	12,230	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

Go To TOC

Table B-6
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-7

Trinity River Salmon and Steelhead Hatchery Operational Rearing and Stocking Goals and Constraints 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.

Go To TOC

Table B-8
Annual Ocean Sport Salmon Fishing Effort
by Region and Vessel Type
(Thousands of Angler Trips)

	Oregon Coast			California Coast		
	Charter	**Private**	**Total**	**Charter**	**Private**	**Total**
1976-1980	76.4[a]	203.3[a]	279.7	71.3	95.2	166.5
1981-1985	45.7	187.9	233.6	66.6	77.2	143.8
1986-1990	56.5	184.5	241.0	96.5	144.8	241.3
1991-1995	17.9	81.7	99.6	81.7	131.8	213.5

[a]Data available for 1979 and 1981 only.

Source: Pacific Fishery Management Council, 1998.

Table B-9
Ocean Commercial Salmon Harvest for Califonria and Oregon:
Average Annual, 1971-1990

Coastal Areas	Salmon Landed (1,000)	Pounds Landed (1,000)
Northern/Central Oregon		
1971-1975	1,010.2	7,221.2
1976-1980	844.3	5,932.7
1981-1985	403.3	2,701.0
1986-1990	762.3	5,436.7
Average 1971-1990	755.0	5,322.9
KMZ-Oregon		
1971-1975	177.2	922.0
1976-1980	134.1	725.3
1981-1985	52.9	336.4
1986-1990	34.2	260.7
Average 1971-1990	99.6	561.1
KMZ-California		
1971-1975	388.6	2,823.7
1976-1980	372.7	2,547.4
1981-1985	122.8	956.9
1986-1990	56.1	464.7
Average 1971-1990	235.0	1,698.2
Mendocino		
1971-1975	221.2	1,982.5
1976-1980	194.9	1,725.4
1981-1985	125.4	1,230.9
1986-1990	278.4	2,582.9
Average 1971-1990	205.0	1,880.4
San Francisco		
1971-1975	223.7	2,270.2
1976-1980	195.5	1,842.2
1981-1985	187.7	1,860.4
1986-1990	360.5	3,700.4
Average 1971-1990	241.8	2,418.3
Monterey		
1971-1975	83.6	878.0
1976-1980	99.0	936.6
1981-1985	85.5	750.4
1986-1990	146.5	1,601.0
Average 1971-1990	103.6	1,041.5

Source: Pacific Fishery Management Council, 1993.

Table B-10
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 component
		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 component
		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 component
		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 component
		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 component
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	Bed scour (> 2 D_{84} particle thickness) on face of alternate bar surfaces occurs at > 8,500 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 > 6,000 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 of 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
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 in June and July
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
11	Water temperature and microhabitat	1	Flows sufficient to meet smolt outmigration temperature criteria (April 22-July 14)	Temperatures were assessed based on data presented in tables in Attachment B2 using criteria as shown in Table B-11
		2	Flow sufficient (450 cfs or greater) to meet State Water Resources Control Board temperature objectives under all conditions	Temperatures assessed on the ability of flow schedule to provide 450 cfs during outmigration period (tables in Attachment B2)
		3	Provides adequate fry and juvenile rearing flows	There was insufficient information to evaluate these items as no data is available for change in channel configuration
		4	Provides adequate adult spawning flows	There was insufficient information to evaluate these items as no data is available for change in channel configuration

Table B-11

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-12
Spawner Escapement Goals of the Trinity River Restoration Program

Species	Spawner Escapment Goal (Adults)
Fall-run chinook	62,000
Spring-run chinook	6,000
Coho	1,400
Steelhead	40,000

Table B-13
Fish Harvest Estimates by Alternative

	Alternatives					
	No Action	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**Mechanical Restoration**	**State Permit**
Ocean Salmon Commercial Fishery[a]						
Northern /Central Oregon						
Trinity River naturally produced	1,390	21,520	17,330	4,810	3,440	0
Total	369,100	580,300	565,500	517,700	511,600	197,500
KMZ-Oregon						
Trinity River naturally produced	50	1,280	990	220	150	0
Total	2,300	27,100	25,200	18,800	17,900	0
KMZ-California						
Trinity River naturally produced	50	1,070	860	190	120	0
Total	2,100	23,800	22,100	16,500	15,800	0
Mendocino						
Trinity River naturally produced	150	3,480	2,710	630	430	0
Total	13,700	96,600	85,600	49,800	45,200	0
San Francisco						
Trinity River naturally produced	1,030	4,470	4,170	2,330	1,910	0
Total	199,300	208,200	208,200	208,200	208,200	144,700
Monterey						
Trinity River naturally produced	800	3,480	3,240	1,820	1,490	0
Total	155,100	155,100	155,100	155,100	155,100	112,300
All Regions						
Trinity River naturally produced	3,470	35,300	29,300	10,000	7,540	0
Total	741,600	1,091,100	1,061,700	966,100	953,800	454,500
Ocean Salmon Sport Fishery[b]						
Northern/Central Oregon	99,200	156,000	152,100	139,200	137,600	53,100
KMZ-Oregon	3,600	38,700	36,000	26,900	25,600	3,600
KMZ-California	4,000	45,200	42,000	31,300	30,000	4,000
Mendocino	2,200	15,600	13,800	8,000	7,300	2,200
San Francisco	73,800	77,100	77,100	77,100	77,100	53,600
Monterey	50,000	50,000	50,000	50,000	50,000	36,200
All Regions	232,800	382,600	371,000	332,500	327,600	152,700

[a]Estimates of Trinity River naturally produced salmon were developed by the Trinity River Fish Team; total harvest estimates were provided by the U.S. Fish & Wildlife Service (Polos, pers. comm.)

[b]Harvest numbers were estimated based on the ratio of the ocean sport to commercial salmon harvest in each region, as derived from the 10-year average between 1987and 1996.

Table B-14
Estimated Regional Ocean Commercial Harvest of Salmon under No Action and with-Project Conditions

	No Action		Maximum Flow		Flow Evaluation		Percent Inflow		Mechanical Restoration		State Permit	
Region of Harvest (Port Areas)	**Trinity Harvest[a]**	**Total Harvest[b]**	**Trinity Harvest[a]**	**Total Harvest[b]**	**Trinity Harvest[a]**	**Total Harvest[b]**	**Trinity Harvest[a]**	**Total Harvest[b]**	**Trinity Harvest[a]**	**Total Harvest[b]**	**Trinity Harvest[c]**	**Total Harvest[b]**
Northern/Central Oregon (Columbia River/Tillamook/ Newport/Coos Bay)	1,390	369,100	21,520	580,300	17,330 •		4,810	517,700	3,440	511,600	0	197,500
KMZ-Oregon (Brookings)	50	2,500	1,280	27,100	990	25,200	220	18,800	150	17,900	0	0
KMZ-California (Crescent City/Eureka)	50	2,100	1,070	23,800	860	22,100	190	16,500	120	15,800	0	0
Mendocino (Fort Bragg)	150	13,700	3,480	96,600	2,710	85,600	630	49,800	430	45,200	0	0
San Francisco	1,030	199,300	4,470	208,200	4,170	208,200	2,330	208,200	1,910	208,200	0	144,700
Monterey	800	155,100	3,480	155,100	3,240	155,100	1,820	155,100	1,490	155,100	0	112,300
Total	**3,470**	**741,800**	**35,300**	**1,091,100**	**29,300**	**1,061,700**	**10,000**	**966,100**	**7,540**	**953,800**	**0**	**454,500**

[a] Number of naturally produced chinook and coho salmon available to the ocean commercial fishery estimated to be landed in each region.
[b] Total number of salmon landed in each region.
[c] Assumes no harvest of naturally produced Trinity River chinook or coho under the State Permit Alternative.

Source: U.S. Fish and Wildlife Service staff estimate (Polos, pers. comm.). See Methodology section of text for a description of estimation methods.

Table B-15
Estimated Average Annual Harvesting Sector Gross Revenues under No Action and With-project Conditions

Region of Harvest (Port Areas)	Ex-Vessel Price per Pound[a]	No Action		Maximum Flow		Flow Evaluation		Percent Inflow		Mechanical Restoration		State Permit	
		Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)
Northern/Central Oregon (Columbia River/Tillamook/ Newport/Coos Bay)	$3.01	$30.1	$7,999.1	$466.4	$12,576.3	$375.6	$12,255.5	$104.2	$11,219.6	$74.6	$11,087.4	$0.0	$4,280.2
KMZ-Oregon (Brookings)	$3.01	1.1	54.2	27.7	587.3	21.5	546.1	4.8	407.4	3.3	387.9	0.0	0.0
KMZ-California (Crescent City/Eureka)	$3.04	1.5	61.9	31.6	701.8	25.4	651.7	5.6	486.6	3.5	465.9	0.0	0.0
Mendocino (Fort Bragg)	$3.04	4.4	404.0	102.6	2,848.5	79.9	2,524.2	18.6	1,468.5	12.7	1,332.9	0.0	0.0
San Francisco	$3.04	30.4	5,877.0	131.8	6,139.4	123.0	6,139.4	68.7	6,139.4	56.3	6,139.4	0.0	4,266.9
Monterey	$3.04	23.6	4,573.6	102.6	4,573.6	95.5	4,573.6	53.7	4,573.6	43.9	4,573.6	0.0	3,311.5
Total	**NA**	**$91.1**	**$18,969.8**	**$862.7**	**$27,426.9**	**$720.8**	**$26,690.5**	**$255.6**	**$24,295.1**	**$194.3**	**$23,987.1**	**$0.0**	**$11,858.6**

[a] Represents average ex-vessel prices for Oregon and California salmon over the 1981-1990 period (Pacific Fishery Management Council, 1997) adjusted to 1997 dollars using the Producer Price Index.

[b]Represents the gross value of the salmon harvest. Derived by multiplying price by pounds of salmon landed based on an average dressed weight per salmon of 9.7 pounds for California and 7.2 pounds for Oregon.

Notes:
Prices and revenues are expressed in dollars adusted to a 1997 base year.
N/A = not applicable.

Table B-16
Estimated Average Annual Net Income Generated by Ocean Commercial Salmon Harvests under No-Action and With-Project Conditions

Region of Harvest (Port Areas)	Net Income Factor[a]	No Action		Maximum Flow		Flow Evaluation		Percent Inflow		Mechanical Restoration		State Permit	
		Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)	Trinity Harvest[b] ($1,000)	Total Harvest[b] ($1,000)
Northern/Central Oregon (Columbia River/Tillamook/ Newport/Coos Bay)	0.332	$10.0	$2,655.7	$154.8	$4,175.3	$124.7	$4,068.8	$34.6	$3,724.9	$24.8	$3,681.0	$0.0	$1,421.0
KMZ-Oregon (Brookings)	0.332	0.4	18.0	9.2	195.0	7.1	181.3	1.6	135.3	1.1	128.8	0.0	0.0
KMZ-California (Crescent City/Eureka)	0.390	0.6	24.2	12.3	273.7	9.9	254.2	2.2	189.8	1.4	181.7	0.0	0.0
Mendocino (Fort Bragg)	0.390	1.7	157.6	40.0	1,110.9	31.2	984.4	7.2	572.7	4.9	519.8	0.0	0.0
San Francisco	0.392	11.9	2,303.8	51.7	2,406.6	48.2	2,406.6	26.9	2,406.6	22.1	2,406.6	0.0	1,672.6
Monterey	0.353	8.3	1,614.5	36.2	1,614.5	33.7	1,614.5	18.9	1,614.5	15.5	1,614.5	0.0	1,169.0
Total	**NA**	**$32.9**	**$6,773.7**	**$304.3**	**$9,776.1**	**$254.8**	**$9,509.9**	**$91.5**	**$8,643.8**	**$69.7**	**$8,532.4**	**$0.0**	**$4,262.6**

[a] Represents estimated average proprietary income (i.e., profits) per dollar of revenue. Derived from the IMPLAN model (Minnesota IMPLAN Group, 1993).
[b] Derived by multiplying salmon harvesting gross revenue by the net income factor. Represents estimated total net income within the salmon harvesting sector.

Notes:
Net income is expressed in dollars adjusted to a 1997 base year.
NA = not applicable.

Table B-17
Scoring Results of the Trinity River System Attribute Analysis (TRSAAM) Evaluation

Attribute Number	Objective Number	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
		Alternative						
1	1	NS	NS	NS	NS	NS	NS	NS
	2	NS	NS	NS	NS	NS	NS	NS
	3	NS	NS	NS	NS	NS	NS	NS
	4	NS	NS	NS	NS	NS	NS	NS
	5	NS	NS	NS	NS	NS	NS	NS
	subtotal score	NS	NS	NS	NS	NS	NS	NS
2	1	0	0	0	2	0	0	0
	2	0	0	0	2	0	0	0
	3	0	0	0	1	0	0	0
	4	1	2	2	2	1	0	1
	5	1	2	2	2	1	0	1
	subtotal score	2	4	4	9	2	0	2
3	1	0	2	2	1	0	0	0
	2	0	2	2	0	0	0	0
	3	0	2	2	2	1	0	0
	subtotal score	0	6	6	3	1	0	0
4	1	0	2	2	0	0	0	0
	2	0	1	2	0	0	0	0
	3	0	2	2	0	0	0	0
	4	0	1	2	0	0	0	0
	subtotal score	0	6	8	0	0	0	0
5	1	0	2	2	0	1	0	0
	2	0	2	2	0	0	0	0
	3	0	2	2	0	0	0	0
	4	0	2	1	0	0	0	0
	subtotal score	0	8	7	0	1	0	0
6	1	0	1	1	0	0	0	0
	2	0	2	2	0	0	0	0
	3	0	2	0	0	0	0	0
	subtotal score	0	5	3	0	0	0	0
7	1	0	2	2	0	0	0	0
	2	0	1	2	0	0	0	0
	3	0	2	2	0	0	0	0
	subtotal score	0	5	6	0	0	0	0
8	1	0	2	0	0	0	0	0
	2	0	2	0	0	0	0	0
	3	0	2	0	0	0	0	0
	4	0	2	1	1	1	0	0
	5	0	2	1	0	0	0	0
	subtotal score	0	10	2	1	1	0	0

Table B-17
Scoring Results of the Trinity River System Attribute Analysis (TRSAAM) Evaluation

Attribute Number	Objective Number	Alternative: No Action	Alternative: Maximum Flow	Alternative: Flow Evaluation	Alternative: Percent Inflow	Alternative: Mechanical Restoration	Alternative: State Permit	Existing Conditions
9	1	0	1	1	1	0	0	0
	2	0	2	2	0	1	0	0
	3	0	2	1	0	1	0	0
	4	0	2	0	0	2	0	0
	5	0	2	2	1	0	0	0
	subtotal score	0	9	6	2	4	0	0
10	1	2	2	2	2	2	0	2
	2	0	2	2	0	0	0	0
	3	0	1	1	0	0	0	0
	subtotal score	2	5	5	2	2	0	2
11	1	0	1	0	0	0	0	0
	2	2	1	2	0	2	0	2
	3	NS	NS	NS	NS	NS	NS	NS
	4	NS	NS	NS	NS	NS	NS	NS
	subtotal score	2	2	2	0	2	0	2

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

Table B-18
Summary of Trinity River System Attribute Scoring from TRSAAM Evaluation

Attribute Number	Ecosystem Attribute Description	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
1	Spatially complex channel geomorphology	NS	NS	NS	NS	NS	NS	NS
2	Flows and water quality are predictably unpredictable	2	4	4	9	2	0	2
3	Frequently mobilized channelbed surface	0	6	6	3	1	0	0
4	Periodic channelbed scour and fill	0	6	8	0	0	0	0
5	Balanced fine and coarse sediment budgets	0	8	7	0	1	0	0
6	Periodic channel migration	0	5	3	0	0	0	0
7	Functional floodplain	0	5	6	0	0	0	0
8	Infrequent channel resetting floods	0	10	2	1	1	0	0
9	Self-sustaining diverse riparian plant communities	0	9	6	2	4	0	0
10	Naturally fluctuating groundwater table	2	5	5	2	2	0	2
11	Water temperature and microhabitat	2	2	3	0	2	0	2
	Total Score	**6**	**60**	**50**	**17**	**13**	**0**	**6**

NS = Not scored

Table B-19
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	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
Spatially complex channel geomorphology	Restore alluvial channel (self-forming bed particle and bank dimensions)	NS	NS	NS	NS	NS	NS	NS
	Create and/or maintain structural complexity of alternate bar sequences	NS	NS	NS	NS	NS	NS	NS
	Create and maintain functional floodplains	NS	NS	NS	NS	NS	NS	NS
	Increase diversity of channelbed particle size	NS	NS	NS	NS	NS	NS	NS
	Greater topographic complexity in side channels	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
	Provide inter- and intra-annual flow variation for winter baseflows (January 1-April 1)	N	N	N	A	N	N	N
	Provide inter- and intra-annual flow variation for winter flood (October 1-April 30)	N	N	N	S	N	N	N
	Provide inter- and intra-annual flow variation for snowmelt peak floods (April 1-June 30)	S	A	A	A	S	N	S
	Provide inter- and intra-annual flow variation for snowmelt recession (May 1-July 31)	S	A	A	A	S	N	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	S	N	N	N
	Achieve incipient motion for most of channelbed surface (riffles, face of point bars) every 2 of 3 years	N	A	A	N	N	N	N
	Exceed threshold for transporting sand through most pools every 2 of 3 years	N	A	A	A	S	N	N
Periodic channelbed scour and fill	Scour/redeposit spawning gravel deposits (at least 2 D_{84} thicknesses) every 2-3 years	N	A	A	N	N	N	N
	Scour/redeposit faces of alternate bars (at least 2 D_{84} thicknesses) every 3-5 years	N	S	A	N	N	N	N
	Deposit fine sediment onto upper alternate bar and floodplain surfaces	N	A	A	N	N	N	N
	Maintain scour channels on alternate bar surfaces every 3-5 years	N	S	A	N	N	N	N
Balanced fine and coarse sediment budgets	Reduce fine sediment storage in mainstem	N	A	A	N	S	N	N
	Maintain coarse sediment budget in the mainstem	N	A	A	N	N	N	N
	Route mobilized D_{84} gravel through alternate bar sequences every 2 of 3 years	N	A	A	N	N	N	N
	Prevent excessive aggradation of tributary-derived material in the mainstem	N	A	S	N	N	N	N
Periodic channel migration	Channel migrates in alluvial reaches	N	S	S	N	N	N	N
	Maintain channel geometry as channel migrates	N	A	A	N	N	N	N
	Create channel avulsions every 10 years	N	A	N	N	N	N	N
Functional floodplain	Inundate the floodplain on average every 2 of 3 years	N	A	A	N	N	N	N
	Encourage local floodplain surface scour and deposition by infrequent (every 3-5 years) but larger floods	N	S	A	N	N	N	N
	Floodplain construction keeps pace with floodplain loss on opposite bank	N	A	A	N	N	N	N
Infrequent channel resetting floods	Major reorganization of alternate bar sequences every 10-20 years	N	A	N	N	N	N	N
	Remove upstream bedload impedance by distributing tributary delta materials	N	A	N	N	N	N	N
	Infrequent (once every 5-10 years) deep scour on floodplain surfaces	N	A	N	N	N	N	N
	Construct and maintain/rejuvenate side channels	N	A	S	S	S	N	N
	Deposit fine sediment on lower terrace surfaces	N	A	S	N	N	N	N
Self-sustaining diverse riparian plant communities	Prevent seedling germination on lower bar surfaces	N	S	S	S	N	N	N
	Scour of most initiating seedlings (0- to 1-year old plants)	N	A	A	N	S	N	N
	Scour of most established seedling (2- to 3-year old plants)	N	A	S	N	S	N	N
	Periodic removal of individual mature riparian trees at least every 10 years	N	A	N	S	A	N	N
	Seed deposition on floodplains every 2-3 years	N	A	A	N	N	N	N
Naturally fluctuating groundwater table	Groundwater recharge of gravel bars	A	A	A	A	A	N	A
	Groundwater recharge of floodplains and off-channel wetland habitats	N	A	A	N	N	N	N
	Groundwater recharge of terraces and associated wetland habitats	N	S	S	N	N	N	N
Water temperature and microhabitat	Flows sufficient to meet smolt outmigration temperature criteria (April 22-July 14)	N	S	S	N	N	N	N
	Flow sufficient (450 cfs or greater) to meet State Water Resources Control Board temperature objectives under all conditions	A	S	A	N	A	N	A
	Provides adequate fry and juvenile rearing flows	NS	NS	NS	NS	NS	NS	NS
	Provides adequate adult spawning flows	NS	NS	NS	NS	NS	NS	NS

NS = Not scored
A = Always or nearly always exceeds thresholds
S = Sometimes exceeds thresholds
N = Never or rarely exceeds thresholds

Table B-20
Estimated Average Annual Number of Anadromous Salmonids for the Mainstem Trinity River in the Year 2020

Species	Estimated Number	Alternative: No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
Chinook	**Escapement**	5,500	55,100	45,900	15,600	11,900	***	5,500
	Total Harvest	10,100	101,400	84,500	28,700	21,900	***	10,100
	Tribal Harvest	5,100	50,700	42,300	14,400	11,000	***	5,000
	Commercial Ocean	3,400	34,500	28,700	9,800	7,400	***	3,400
	Ocean Sport	900	8,600	7,200	2,400	1,900	***	900
	Inriver Sport	800	7,600	6,300	2,200	1,600	***	800
	Harvest and Escapement	15,600	156,500	130,400	44,300	33,800	***	15,600
Coho	**Escapement**	100	1,100	900	300	200	***	100
	Total Harvest	200	2,200	1,800	600	400	***	200
	Tribal Harvest	100	1,100	900	300	200	***	100
	Commercial Ocean	70	700	600	200	140	***	70
	Ocean Sport	20	190	200	50	30	***	20
	Inriver Sport	20	200	100	50	30	***	20
	Harvest and Escapement	300	3,300	2,700	900	600	***	300
Steelhead	**Escapement**	3,200	32,400	27,000	9,200	7,000	***	3,200
	Total Harvest	1,000	10,400	8,700	3,000	2,200	***	1,000
	Tribal Harvest	not assessed	not assessed	not assessed	not assessed	not assessed	***	not assessed
	Commercial Ocean	0	0	0	0	0	***	0
	Ocean Sport	0	0	0	0	0	***	0
	Inriver Sport	1,000	10,400	8,700	3,000	2,200	***	1,000
	Harvest and Escapement	4,200	42,800	35,700	12,000	9,200	***	4,200

Table B-21
Estimated Ocean Salmon Sport Fishing Activity under the No Action and With-project Conditions

Region	No Action Alternative	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions	Preferred Alternative
Northern/Central Oregon								
Private boat trips	138,884	154,011	153,102	150,044	149,636	120,414	112,711	153,102
Net change in private boat trips[a]		15,127	14,218	11,160	10,752	-18,470		40,391
Percent change in private boat trips[a]		11%	10%	8%	8%	-13%		36%
Charter boat trips	47,829	53,040	52,727	51,674	51,535	41,470	38,033	52,727
Net change in charter boat trips[a]		5,211	4,898	3,845	3,706	-6,359		14,694
Percent change in charter boat trips[a]		11%	10%	8%	8%	-13%		39%
KMZ-Oregon								
Private boat trips	54,125	91,168	89,667	83,865	82,930	46,864	37,012	89,667
Net change in private boat trips[a]		37,043	35,542	29,740	28,805	-7,261		52,655
Percent change in private boat trips[a]		68%	66%	55%	53%	-13%		142%
Charter boat trips	2,849	4,798	4,719	4,414	4,365	2,467	1,948	4,719
Net change in charter boat trips[a]		1,949	1,870	1,565	1,516	-382		2,771
Percent change in charter boat trips[a]		68%	66%	55%	53%	-13%		142%
KMZ-California								
Private boat trips	40,926	50,084	49,535	47,428	47,128	32,876	27,724	49,535
Net change in private boat trips[a]		9,158	8,609	6,502	6,202	-8,050		21,811
Percent change in private boat trips[a]		22%	21%	16%	15%	-20%		79%
Charter boat trips	1,294	2,246	2,210	2,066	2,050	1,168	1,020	2,210
Net change in charter boat trips[a]		952	916	772	756	-126		1,190
Percent change in charter boat trips[a]		74%	71%	60%	58%	-10%		117%
Mendocino								
Private boat trips	29,695	39,682	38,967	35,973	35,444	22,172	21,064	38,967
Net change in private boat trips[a]		9,987	9,272	6,278	5,749	-7,523		17,903
Percent change in private boat trips[a]		34%	31%	21%	19%	-25%		85%

Table B-21
Estimated Ocean Salmon Sport Fishing Activity under the No Action and With-project Conditions

Region	No Action Alternative	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions	Preferred Alternative
Charter boat trips	4,032	6,271	6,109	5,394	5,286	2,576	2,860	6,109
Net change in charter boat trips[a]		2,239	2,077	1,362	1,254	-1,456		3,249
Percent change in charter boat trips[a]		56%	52%	34%	31%	-36%		114%
San Francisco								
Private boat trips	57,095	57,095	57,095	57,095	57,095	54,332	44,800	57,095
Net change in private boat trips[a]		0	0	0	0	-2,763		12,295
Percent change in private boat trips[a]		0%	0%	0%	0%	-5%		27%
Charter boat trips	82,312	83,388	83,388	83,388	83,388	76,933	64,600	83,388
Net change in charter boat trips[a]		1,076	1,076	1,076	1,076	-5,379		18,788
Percent change in charter boat trips[a]		1%	1%	1%	1%	-7%		29%
Monterey								
Private boat trips	89,066	89,066	89,066	89,066	89,066	84,886	56,045	89,066
Net change in private boat trips[a]		0	0	0	0	-4,180		33,021
Percent change in private boat trips[a]		0%	0%	0%	0%	-5%		59%
Charter boat trips	43,708	43,708	43,708	43,708	43,708	40,615	27,501	43,708
Net change in charter boat trips[a]		0	0	0	0	-3,093		16,207
Percent change in charter boat trips[a]		0%	0%	0%	0%	-7%		59%

[a] Represents the net change as compared to levels under the No Action Alternative for all alternatives except the Preferred Alternative, which is compared to the existing condition levels.

Table B-22 Estimated Angler Benefits of Ocean Salmon Sportfishing Activity								
	NEPA Analysis						CEQA Analysis	
Region of Activity	No Action Alternative	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	1995 Existing Conditions	Preferred Alternative
Northern/Central Oregon								
Private boat benefits	$9,999,360	$11,088,720	$11,023,200	$10,803,240	$10,773,720	$8,669,880	$8,115,120	$11,023,200
Net change in private boat benefits [a]		$1,089,360	$1,023,840	$803,880	$774,360	-$1,329,480		$2,908,080
Percent change in private boat benefits [a]		11%	10%	8%	8%	-13%		29%
Charter boat benefits	$3,443,760	$3,818,880	$3,796,200	$3,720,600	$3,710,520	$2,985,840	$2,738,520	$3,796,200
Net change in charter boat benefits [a]		$375,120	$352,440	$276,840	$266,760	-$457,920		$1,057,680
Percent change in charter boat benefits [a]		11%	10%	8%	8%	-13%		31%
KMZ-Oregon								
Private boat benefits	$3,897,000	$6,564,240	$6,455,880	$6,038,280	$5,970,960	$3,374,280	$2,664,864	$6,455,880
Net change in private boat benefits [a]		$2,667,240	$2,558,880	$2,141,280	$2,073,960	-$522,720		$3,791,016
Percent change in private boat benefits [a]		68%	66%	55%	53%	-13%		97%
Charter boat benefits	$205,200	$345,600	$339,840	$317,880	$314,280	$177,480	$140,400	$339,840
Net change in charter boat benefits [a]		$140,400	$134,640	$112,680	$109,080	-$27,720		$199,440
Percent change in charter boat benefits [a]		68%	66%	55%	53%	-14%		97%
KMZ-California								
Private boat benefits	$2,516,400	$3,605,760	$3,566,880	$3,414,960	$3,393,360	$2,367,360	$1,879,200	$3,566,520
Net change in private boat benefits [a]		$1,089,360	$1,050,480	$898,560	$876,960	-$149,040		$1,687,320
Percent change in private boat benefits [a]		43%	42%	36%	35%	-6%		67%
Charter boat benefits	$92,880	$162,000	$159,120	$149,040	$147,600	$84,240	$73,440	$159,120
Net change in charter boat benefits [a]		$69,120	$66,240	$56,160	$54,720	-$8,640		$85,680
Percent change in charter boat benefits [a]		74%	71%	60%	59%	-9%		92%
Mendocino								
Private boat benefits	$2,137,680	$2,856,960	$2,805,840	$2,589,840	$2,551,680	$1,596,240	$1,516,320	$2,805,840
Net change in private boat benefits [a]		$719,280	$668,160	$452,160	$414,000	-$541,440		$1,289,520
Percent change in private boat benefits [a]		34%	31%	21%	19%	-25%		60%
Charter boat benefits	$290,160	$451,440	$439,920	$388,080	$380,880	$185,760	$205,920	$439,920
Net change in charter boat benefits [a]		$161,280	$149,760	$97,920	$90,720	-$104,400		$234,000
Percent change in charter boat benefits [a]		56%	52%	34%	31%	-36%		81%
San Francisco								
Private boat benefits	$4,110,480	$4,110,480	$4,110,480	$4,110,480	$4,110,480	$3,911,760	$3,225,600	$4,110,480
Net change in private boat benefits [a]		$0	$0	$0	$0	-$198,720		$884,880
Percent change in private boat benefits [a]		0%	0%	0%	0%	-5%		22%
Charter boat benefits	$5,926,320	$6,004,080	$6,004,080	$6,004,080	$6,004,080	$5,538,960	$4,651,200	$6,004,080
Net change in charter boat benefits [a]		$77,760	$77,760	$77,760	$77,760	-$387,360		$1,352,880

Table B-22
Estimated Angler Benefits of Ocean Salmon Sportfishing Activity

	NEPA Analysis						CEQA Analysis	
Region of Activity	**No Action Alternative**	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**Mechanical Restoration**	**State Permit**	**1995 Existing Conditions**	**Preferred Alternative**
Percent change in charter boat benefits [a]		1%	1%	1%	1%	-7%		23%
Monterey								
Private boat benefits	$6,413,040	$6,413,040	$6,413,040	$6,413,040	$6,413,040	$6,112,080	$4,034,880	$6,413,040
Net change in private boat benefits [a]		$0	$0	$0	$0	-$300,960		$2,378,160
Percent change in private boat benefits [a]		0%	0%	0%	0%	-5%		37%
Charter boat benefits	$3,147,120	$3,147,120	$3,147,120	$3,147,120	$3,147,120	$2,923,920	$1,980,000	$3,147,120
Net change in charter boat benefits [a]		$0	$0	$0	$0	-$223,200		$1,167,120
Percent change in charter boat benefits [a]		0%	0%	0%	0%	-7%		37%

[a]Represents the net change as compared to levels under the No Action Alternative for the NEPA analysis or as compared to levels under the 1995 existing conditions for the CEQA analysis.
Note: All monetary values are expressed in 1997 dollars.

Table B-23

Estimated Benefits (Net Income) to Charter Boat Operators of Ocean Salmon Sportfishing Activity under the No Action and With-project Conditions

Region	No Action Alternative	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions	Preferred Alternative
Northern/Central Oregon								
Charter boat operator benefits	$239,910	$266,049	$264,479	$259,197	$258,500	$208,014	$190,774	$264,479
Net change in benefits[a]		$26,138	$24,568	$19,287	$18,589	-$31,897		$73,705
Percent change[a]		11%	10%	8%	8%	-13%		39%
KMZ-Oregon								
Charter boat operator benefits	$3,897	$6,564	$6,456	$6,038	$5,971	$3,375	$2,665	$6,456
Net change in benefits[a]		$2,666	$2,558	$2,141	$2,074	-$523		$3,791
Percent change[a]		68%	66%	55%	53%	-13%		142%
KMZ-California								
Charter boat operator benefits	$29,503	$51,209	$50,388	$47,105	$46,740	$26,630	$23,256	$50,388
Net change in benefits[a]		$21,706	$20,885	$17,602	$17,237	-$2,873		$27,132
Percent change[a]		74%	71%	60%	58%	-10%		117%
Mendocino								
Charter boat operator benefits	$91,930	$142,979	$139,285	$122,983	$120,521	$58,733	$65,208	$139,285
Net change in benefits[a]		$51,049	$47,356	$31,054	$28,591	-$33,197		$74,077
Percent change[a]		56%	52%	34%	31%	-36%		114%
San Francisco								
Charter boat operator benefits	$1,876,714	$1,901,246	$1,901,246	$1,901,246	$1,901,246	$1,754,072	$1,472,880	$1,901,246
Net change in benefits[a]		$24,533	$24,533	$24,533	$24,533	-$122,641		$428,366
Percent change[a]		1%	1%	1%	1%	-7%		29%
Monterey								
Charter boat operator benefits	$996,542	$996,542	$996,542	$996,542	$996,542	$926,022	$627,023	$996,542
Net change in benefits[a]		$0	$0	$0	$0	-$70,520		$369,520
Percent change[a]		0%	0%	0%	0%	-7%		59%

[a] Represents the net change as compared to levels under the No Action Alternative for all alternatives except the Preferred Alternative, which is compared to the existing condition levels.

Table B-24
Summary of Estimated Average Annual Losses of Early Life Stages of Chinook Salmon and Steelhead in the Upper Sacramento River

	Simulated Average Loss (Percent)						
Species	**No Action**	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**State Permit**	**Existing Conditions**	**Cumulative**
Fall chinook	11	13	12	11	10	10	12
Late-fall chinook	1	1	1	1	1	1	1
Winter chinook	3	11	5	3	2	2	9
Spring chinook	15	17	16	15	13	12	16
Steelhead	1	1	1	1	1	0	1

Table B-25
Summary of Impact Analysis for Fisheries Resources (Comparing Each Alternative to the No Action Alternative)

Resource Concern	Geographical Area	Alternative					
		Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions Compared to Preferred Alternative
Native anadromous salmonids	Trinity River Basin	**HB**	**HB**	**B**	**B**	**A**	**HB**
	Lower Klamath Basin	**B**	**B**	**nc**	**nc**	**A**	**B**
	Central Valley	**A**	**A**	**A**	**nc**	**B**	**A**
Other native anadromous species	Trinity River Basin	**HB**	**HB**	**B**	**B**	**A**	**HB**
	Lower Klamath Basin	**B**	**B**	**nc**	**nc**	**A**	**B**
	Central Valley	**A**	**A**	**nc**	**nc**	**nc**	**A**
Resident native species	Trinity River Basin	**B**	**B**	**B**	**B**	**A**	**B**
	Lower Klamath Basin	**B**	**B**	**nc**	**nc**	**A**	**B**
	Central Valley	**A**	**A**	**A**	**nc**	**nc**	**A**
Non-native species	Trinity River Basin	**B**	**B**	**B**	**B**	**A**	**B**
	Lower Klamath Basin	**B**	**B**	**nc**	**nc**	**A**	**B**
	Central Valley	**A**	**A**	**nc**	**nc**	**nc**	**A**
Reservoir species-Trinity Basin	Warmwater Species	**A[1]**	**nc**	**nc**	**nc**	**nc**	**nc**
	Coldwater Species	**nc**	**nc**	**nc**	**nc**	**nc**	**nc**
Reservoir species-Central Valley	All Species	**nc**	**nc**	**nc**	**nc**	**nc**	**nc**

A = adverse change
A[1] = adverse change (large and smallmouth bass)
nc = no change
B = benefical change
HB = highly beneficial change

Table B-26
Summary of Total Ocean Commercial Salmon Harvest Effects Compared to No Action Conditions

Region of Harvest	No Action Alternative[a]	Maximum Flow Net Change[b]	Maximum Flow Percent Change[b]	Flow Evaluation Net Change[b]	Flow Evaluation Percent Change[b]	Percent Inflow Net Change[b]	Percent Inflow Percent Change[b]	Mechanical Restoration Net Change[b]	Mechanical Restoration Percent Change[b]	State Permit Net Change[b]	State Permit Percent Change[b]
Northern/Central Oregon											
Salmon landed	369,100	211,200	57%	196,400	53%	148,600	40%	142,500	39%	-171,600	-46%
Pounds landed (1,000)	3,469.5	1,985.3	57%	1,846.2	53%	1,396.8	40%	1,339.5	39%	-1,613.0	-46%
Gross harvest revenue ($1,000)	$7,999.1	$4,577.1	57%	$4,256.4	53%	$3,220.5	40%	$3,088.3	39%	-3,718.9	-46%
Net harvest income ($1,000)	$2,655.7	$1,519.6	57%	$1,413.1	53%	$1,069.2	40%	$1,025.3	39%	-1,234.7	-46%
KMZ-Oregon											
Salmon landed	2,500	24,600	984%	22,700	908%	16,300	652%	15,400	616%	-2,500.0	-100%
Pounds landed (1,000)	23.5	231.2	984%	213.4	908%	153.2	652%	144.8	616%	-23.5	-100%
Gross harvest revenue ($1,000)	$54.2	$533.1	984%	$492.0	908%	$353.3	652%	$333.7	616%	-54.2	-100%
Net harvest income ($1,000)	$18.0	$177.0	984%	$163.3	908%	$117.3	652%	$110.8	616%	-18.0	-100%
KMZ-California											
Salmon landed	2,100	21,700	1033%	20,000	952%	14,400	686%	13,700	652%	-2,100.0	-100%
Pounds landed (1,000)	20.6	212.7	1033%	196.0	952%	141.1	686%	134.3	652%	-20.6	-100%
Gross harvest revenue ($1,000)	$61.9	$639.9	1033%	$589.8	952%	$424.6	686%	$404.0	652%	-61.9	-100%
Net harvest income ($1,000)	$24.2	$249.6	1033%	$230.0	952%	$165.6	686%	$157.6	652%	-24.2	-100%
Mendocino											
Salmon landed	13,700	82,900	605%	71,900	525%	36,100	264%	31,500	230%	-13,700.0	-100%
Pounds landed (1,000)	134.3	812.4	605%	704.6	525%	353.8	264%	308.7	230%	-134.3	-100%
Gross harvest revenue ($1,000)	$404.0	$2,444.6	605%	$2,120.2	525%	$1,064.5	264%	$928.9	230%	-404.0	-100%
Net harvest income ($1,000)	$157.6	$953.4	605%	$826.9	525%	$415.2	264%	$362.3	230%	-157.6	-100%
San Francisco											
Salmon landed	199,300	8,900	4%	8,900	4%	8,900	4%	8,900	4%	-54,600.0	-27%
Pounds landed (1,000)	1,953.1	87.2	4%	87.2	4%	87.2	4%	87.2	4%	-535.1	-27%
Gross harvest revenue ($1,000)	$5,877.0	$262.4	4%	$262.4	4%	$262.4	4%	$262.4	4%	-1,610.0	-27%
Net harvest income ($1,000)	$2,303.8	$102.9	4%	$102.9	4%	$102.9	4%	$102.9	4%	-631.1	-27%
Monterey											
Salmon landed	155,100	0	0%	0	0%	0	0%	0	0%	-42,800.0	-28%
Pounds landed (1,000)	1,520.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	-419.4	-28%
Gross harvest revenue ($1,000)	$4,573.6	$0.0	0%	$0.0	0%	$0.0	0%	$0.0	0%	-1,262.1	-28%
Net harvest income ($1,000)	$1,614.5	$0.0	0%	$0.0	0%	$0.0	0%	$0.0	0%	-445.5	-28%

[a] Represents estimated harvest, revenue, and income levels under the No Action Alternative associated with total ocean commercial salmon harvests.

[b] Represents the net change relative to levels under the No Action Alternative.

Notes:

Gross harvest levels and net harvest income are expressed in dollars adjusted to a 1997 base year.

Table B-27
Percent Change in Temperature-related Losses to Early Life Stages of Salmonids in the Sacramento River
(Compared to the No Action Alternative)

Species	Estimated Change In Average Annual Loss[a]					Preferred Alternative Compared to Existing Conditions	Cumulative Effects Comapred to No Action	Cumulative Effects Compared to Existing Conditions	Cumulative Effects Compared to Preferred Alternative
	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit				
Fall chinook	+2	+1	+1	0	-1	+2	+1	+2	+1
Late-fall chinook	0	0	0	0	0	0	0	0	0
Winter chinook	+8	+2	0	0	-1	+3	+6	+6	+3
Spring chinook	+2	0	0	0	-3	+3	+1	+4	0
Steelhead	0	0	0	0	0	0	0	0	0

[a] Estimated average annual losses rounded to the nearest percentile for the 1922-1990 simulation period.

Table B-28
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 (Compared to the No Action Alternative)

Species	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Condition[a]
Fall chinook						
Percent loss change[b]	2	1	1	0	-1	2
Results[c]	A	A	A	NC	B	A
Late-fall chinook						
Percent loss change[b]	0	0	0	0	0	0
Results[c]	NC	NC	NC	NC	NC	NC
Winter chinook						
Percent loss change[b]	8	2	0	0	-1	3
Results[c]	A	A	NC	NC	B	A
Spring chinook						
Percent loss change[b]	2	0	0	0	-3	3
Results[c]	A	NC	NC	NC	B	A
Steelhead						
Percent loss change[b]	0	0	0	0	0	0
Results[c]	NC	NC	NC	NC	NC	NC

[a] Compared to the preferred alternative.
[b] Average annual losses estimated for the entire 1922-1990 simulation period (negative value = lower losses than No Action).
[c] NC = no change; A = significantly adverse effect; B = beneficial effect.

Table B-29
Summary of Change in Trinity River Fluvial River System Health from No Action for Each Project Alternative

Parameter	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
	Alternative						
Total Score	**6**	**60**	**50**	**17**	**13**	**0**	**6**
Possible Score	74	74	74	74	74	74	74
Percent of Maximum	8	81	68	23	18	0	8
Percent Change from No Action	0	900	733	183	117	-100	--
Qualitative Rating[a]	**--**	**A**	**HB**	**B**	**B**	**A**	**--**

[a] Rating based on following scale:
A = adverse change (< the No Action attribute score)
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-30
Estimated Harvest, Escapement, and Total Production for Trinity River Chinook Salmon at Varying Reductions of Ocean and Inriver Harvest Rates (numbers rounded to the nearest 100[a])

Harvest Reduction Level (percent)	Tribal Harvest	Non-tribal Harvest	Total Harvest	Spawning Escapement	Estimated Production Index[b]
0	5,500	6,300	11,800	5,500	17,300
25	4,400	4,800	9,200	7,700	16,900
50	3,200	3,200	6,400	10,300	16,700
75	1,700	1,700	3,400	13,100	16,500
90	700	600	1,300	15,000	16,300
100	0	0	0	16200	16,200

[a] Reductions in ocean and inriver harvest rates were calculated without adjusting for equal sharing of the numbers of harvested chinook between tribal and non-tribal fisheries.
[b] Total production calculated by adding total harvest and spawning escapement, and not as estimate of recruits at a specific age.

Table B-31
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-32
Monthly Average Sacramento River Flows at Keswick (taf)

	Alternative																	
	No Action			Maximum Flow			Flow Evaluation			Percent Inflow			State Permit			Existing Conditions		
Location	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**	**Keswick**	**Grimes**	**Verona**
Month																		
October	331	388	603	245	303	518	329	386	601	328	384	599	357	412	627	341	395	600
November	377	572	832	310	501	761	354	548	805	369	564	823	389	585	848	379	564	829
December	479	966	1,328	439	921	1,299	463	950	1,318	473	960	1,325	498	986	1,341	487	966	1,321
January	566	1,309	1,685	532	1,268	1,655	557	1,299	1,675	558	1,301	1,679	574	1,317	1,690	569	1,307	1,693
February	649	1,592	2,008	604	1,540	1,979	637	1,580	1,999	635	1,577	1,997	655	1,599	2,017	653	1,594	2,019
March	501	1,215	1,739	470	1,178	1,714	495	1,208	1,732	486	1,199	1,730	517	1,232	1,752	502	1,210	1,747
April	459	748	1,243	390	692	1,193	435	727	1,224	448	738	1,238	471	758	1,251	459	739	1,211
May	579	439	983	480	358	913	544	408	956	552	413	961	604	462	1,003	574	444	979
June	707	391	811	592	296	718	656	344	765	679	363	785	728	408	821	693	393	775
July	851	434	758	698	302	626	799	387	710	831	415	742	888	468	791	841	450	730
August	752	365	773	657	289	712	744	361	771	748	361	771	762	371	775	752	391	741
September	395	359	718	365	334	683	390	355	716	399	363	722	406	369	724	391	377	716
Total	**6,646**	**8,778**	**13,483**	**5,782**	**7,981**	**12,773**	**6,404**	**8,553**	**13,273**	**6,507**	**8,638**	**13,372**	**6,848**	**8,968**	**13,639**	**6,642**	**8,829**	**13,361**

Table B-33
Average Delta Inflow (taf) for Each Month of the Year (1922-1990)

Month	No Action Monthly Inflow	Maximum Flow Monthly Inflow	Flow Evaluation Monthly Inflow	Percent Inflow Monthly Inflow	State Permit Monthly Inflow	Existing Conditions Monthly Inflow
October	951	859	948	945	975	959
November	1,276	1,201	1,248	1,264	1,296	1,274
December	2,181	2,144	2,173	2,179	2,204	2,176
January	3,067	3,013	3,055	3,056	3,084	3,097
February	3,402	3,352	3,388	3,383	3,417	3,432
March	3,267	3,225	3,255	3,249	3,285	3,274
April	2,162	2,132	2,146	2,154	2,171	2,149
May	1,683	1,620	1,657	1,660	1,702	1,690
June	1,335	1,237	1,297	1,310	1,348	1,322
July	1,169	1,035	1,113	1,155	1,176	1,143
August	1,120	1,053	1,118	1,115	1,118	1,086
September	1,011	969	1,007	1,014	1,024	1,002
Total	**22,624**	**21,838**	**22,404**	**22,484**	**22,800**	**22,604**

Table B-34
Average Delta Outflow (taf) for Each Month of the Year (1922-1990)

Month	No Action Monthly Outflow	Maximum Flow Monthly Outflow	Flow Evaluation Monthly Outflow	Percent Inflow Monthly Outflow	State Permit Monthly Outflow	Existing Conditions Monthly Outflow
October	356	314	348	354	365	387
November	629	579	605	619	646	666
December	1,413	1,372	1,398	1,407	1,434	1,452
January	2,332	2,264	2,318	2,319	2,348	2,405
February	2,783	2,733	2,767	2,762	2,797	2,852
March	2,607	2,578	2,600	2,590	2,623	2,683
April	1,609	1,593	1,600	1,601	1,615	1,619
May	1,121	1,086	1,102	1,101	1,139	1,146
June	711	684	686	691	714	720
July	446	426	438	443	447	459
August	387	370	387	385	387	391
September	345	323	341	348	354	369
Total	**14,739**	**14,321**	**14,591**	**14,621**	**14,869**	**15,149**

Table B-35
Comparison of the Average Sacramento River Flows Inflow (taf) for Each Month of the Year (1922-1990)

Month	Maximum Flow: Average Absolute Change from No Action Alternative[a] (percent)			Flow Evaluation: Average Absolute Change from No Action Alternative[a] (percent)			Flow Evaluation: Average Absolute Change from Existing Conditions[b] (percent)			Percent Inflow: Average Absolute Change from No Action Alternative[a] (percent)			State Permit: Average Absolute Change from No Action Alternative[a] (percent)		
	Keswick	Grimes	Verona	Keswick	Grimes	Verona	Keswick	Grimes	Verona	Keswick	Grimes	Verona	Keswick	Grimes	Verona
October	-26	-22	-14	-1	-1	0	-4	-2	0	-1	-1	-1	8	6	4
November	-18	-12	-9	-6	-4	-3	-7	-3	-3	-2	-1	-1	3	2	2
December	-8	-5	-2	-3	-2	-1	-5	-2	0	-1	-1	0	4	2	1
January	-6	-3	-2	-2	-1	-1	-2	-1	-1	-1	-1	0	1	1	0
February	-7	-3	-1	-2	-1	0	-2	-1	-1	-2	-1	-1	1	0	0
March	-6	-3	-1	-1	-1	0	-1	0	-1	-3	-1	-1	3	1	1
April	-15	-8	-4	-5	-3	-2	-5	-2	1	-2	-1	0	3	1	1
May	-17	-18	-7	-6	-7	-3	-5	-8	-2	-5	-6	-2	4	5	2
June	-16	-24	-11	-7	-12	-6	-5	-12	-1	-4	-7	-3	3	4	1
July	-18	-30	-17	-6	-11	-6	-5	-14	-3	-2	-4	-2	4	8	4
August	-13	-21	-8	-1	-1	0	-1	-7	4	-1	-1	0	1	2	0
September	-8	-7	-5	-1	-1	0	0	-6	0	1	1	1	3	3	1
Average	-13	-13	-7	-3	-4	-2	-4	-5	-1	-2	-2	-1	3	3	1

[a] Change for Flow Evalution recommendation relative to the No Action Alternative. Values represent the average change for the 69 years modeled, rather than the difference between the 69-year average flow values for each month under these two cases.

[b]Changes for the preferred alternative relative to existing conditions. Values represent the average change for the 69 years modeled, rather than the difference between the 69-year average flow values for each month under these two cases..

Table B-36
Percent Change in the Average Monthly Inflows (taf) in the Delta (1922-1990) [a]

	Compared to No Action Alternative				Compared to Existing Conditions
Month	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**StatePermit**	**Preferred Alternative**
October	-10	0	-1	3	-1
November	-6	-2	-1	2	-2
December	-2	0	0	1	0
January	-2	0	0	1	-1
February	-1	0	-1	0	-1
March	-1	0	-1	1	-1
April	-1	-1	0	0	0
May	-4	-2	-1	1	-2
June	-7	-3	-2	1	-2
July	-12	-5	-1	1	-3
August	-6	0	0	0	3
September	-4	0	0	1	0
Average	-3	-1	-1	1	-1

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

Table B-37 Percent Change in the Average Monthly Outflows (taf) in the Delta (1922-1990) [a]					
	Compared to No Action Alternative				Compared to Existing Conditions
Month	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**StatePermit**	**Preferred Alternative**
October	-12	-2	-1	2	-10
November	-8	-4	-2	3	-9
December	-3	-1	0	2	-4
January	-3	-1	-1	1	-4
February	-2	-1	-1	1	-3
March	-1	0	-1	1	-3
April	-1	-1	0	0	-1
May	-3	-2	-2	2	-4
June	-4	-4	-3	0	-5
July	-5	-2	-1	0	-5
August	-4	0	-1	0	-1
September	-6	-1	1	3	-8
Average	-3	-1	-1	1	-4

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

Table B-38
Percent of Years with Delta Inflows Greater than 10 Percent Less than the No Action Alternative (1922-1990) [a]

	Compared to No Action Alternative				Compared to Existing Conditions
Month	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**State Permit**	**Preferred Alternative**
October	45	4	0	0	7
November	23	4	0	0	9
December	13	3	0	0	7
January	4	0	0	1	3
February	4	0	0	0	9
March	3	1	0	0	7
April	7	3	0	0	4
May	12	0	0	0	6
June	28	6	0	0	17
July	57	22	3	1	28
August	29	3	1	3	9
September	20	0	0	0	12

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

Table B-39
Percent of Years with Delta Outflows Greater than 10 Percent Less than the No Action Alternative (1922-1990)[a]

	Compared to No Action Alternative				Compared to Existing Conditions	Cumulative Effects Compared to No Action Alternative
Month	Maximum Flow	Flow Evaluation	Percent Inflow	State Permit	Preferred Alternative	
October	30	7	1	0	19	12
November	29	13	1	0	33	26
December	14	6	1	0	22	16
January	10	6	3	0	17	10
February	4	0	1	0	17	9
March	1	0	0	0	13	10
April	1	1	0	0	3	1
May	4	1	3	0	9	0
June	9	9	3	0	16	14
July	19	9	1	0	26	20
August	19	1	1	0	19	16
September	17	3	0	0	29	17

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

Table B-40
Summary of Impact Analysis on Fisheries Resources (Comparing Each Alternative to the No Action Alternative)

		Alternative					
Geographical Area	**Resource Concern**	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**Mechanical Restoration**	**State Permit**	**Existing Condtions[a]**
Trinity River Basin	Anadromous salmonids	HB	HB	B	B	A	HB
	Other anadromous species	HB	HB	B	B	A	HB
	Resident native species	B	B	B	B	A	B
	Non-native species	B	B	B	B	A	B
Lower Klamath Basin	Anadromous salmonids	B	B	nc	nc	A	B
	Other anadromous species	B	B	nc	nc	A	B
	Resident native species	B	B	nc	nc	A	B
	Non-native species	B	B	nc	nc	A	B
Central Valley	Anadromous salmonids	A^1	A	A	nc	B	A
	Other anadromous species	A	A	nc	nc	nc	A
	Resident native species	A	A	A	nc	nc	A
	Non-native species	A	A	nc	nc	nc	A
Riverine Summary	**All (Trinity/Klamath/Central Valley)**	**HB/B/A^1**	**HB/B/A**	**B/nc/A**	**B/nc/nc**	**A/B/nc**	**HB/B/A**
Lewiston/Trinity Reservoirs	Warmwater species	A^2	nc	nc	nc	nc	nc
	Coldwater species	nc	nc	nc	nc	nc	nc
Reservoir Summary		**A^2/nc**	**nc/nc**	**nc/nc**	**nc/nc**	**nc/nc**	**nc/nc**

[a] Compared to existing conditions
A = adverse change
A^1 = adverse change (native anadromous salmonids only)
A^2 = adverse change (largemouth and smallmouth bass)
nc = no change
B = benefical change
HB = highly beneficial change

Table B-41
Changes in Delta X2 Position (in km) for the Period 1922-1990

Month	No Action Compared to Maximum Flow		No Action Compared to Flow Evaluation		No Action Compared to Percent Inflow		No Action Compared to State Permit		Existing Conditions Compared to Preferred Alternative		Cumulative Effects Compared to Existing Conditions		Cumulative Effects Compared to Preferred Alternative	
	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	-0.8	-0.9	-0.1	-0.1	0.0	0.0	0.1	0.1	-0.6	-0.7	0.8	1.0	0.2	0.2
November	-0.9	-1.1	-0.3	-0.4	-0.1	-0.1	0.1	0.1	-0.7	-0.9	1.1	1.4	0.4	0.5
December	-0.4	-0.5	-0.2	-0.3	0.0	0.0	0.2	0.3	-0.5	-0.7	0.7	0.9	0.2	0.3
January	-0.4	-0.6	-0.1	-0.1	-0.1	-0.1	0.1	0.1	-0.4	-0.6	0.6	0.9	0.2	0.3
February	-0.2	-0.3	-0.1	-0.2	0.0	0.0	0.1	0.2	-0.5	-0.8	0.5	0.8	0.0	0.0
March	-0.1	-0.2	0.0	0.0	0.0	0.0	0.1	0.2	-0.4	-0.6	0.2	0.3	-0.2	-0.3
April	-0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.1	-0.1	-0.1	-0.9	-1.3	-1.0	-1.5
May	-0.3	-0.4	-0.1	-0.1	-0.2	-0.3	0.1	0.1	-0.2	-0.3	-1.6	-2.2	-1.8	-2.5
June	-0.2	-0.3	-0.2	-0.3	-0.1	-0.1	0.1	0.1	-0.3	-0.4	-0.5	-0.7	-0.8	-1.1
July	-0.4	-0.5	-0.2	-0.3	-0.1	-0.1	0.1	0.1	-0.4	-0.5	0.2	0.3	-0.2	-0.3
August	-0.5	-0.6	-0.1	-0.1	-0.1	-0.1	0.1	0.1	-0.3	-0.4	0.3	0.4	0.0	0.0
September	-0.5	-0.6	-0.1	-0.1	0.0	0.0	0.2	0.2	-0.5	-0.6	0.8	1.0	0.3	0.4
Mean Annual Change (km)	-0.4	-0.5	-0.1	-0.2	-0.1	-0.1	0.1	0.1	-0.4	-0.5	0.2	0.2	-0.2	-0.3

Table B-42
Average Monthly Surface Elevations (msl) for Trinity Reservoir Under the No Action and With-project Alternatives

	Alternative					
Month	**No Action**	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**State Permit**	**Existing Conditions**
October	2,280	2,276	2,282	2,283	2,289	2,282
November	2,281	2,280	2,284	2,285	2,291	2,283
December	2,285	2,287	2,289	2,289	2,295	2,287
January	2,290	2,287	2,295	2,294	2,301	2,293
February	2,299	2,288	2,304	2,301	2,309	2,302
March	2,309	2,290	2,314	2,308	2,319	2,312
April	2,319	2,292	2,325	2,316	2,330	2,323
May	2,319	2,286	2,323	2,321	2,335	2,325
June	2,311	2,284	2,319	2,317	2,330	2,319
July	2,298	2,279	2,307	2,306	2,317	2,306
August	2,287	2,275	2,295	2,294	2,303	2,293
September	2,282	2,273	2,284	2,286	2,293	2,287

Table B-43
Average Monthly Surface Area in Whiskeytown Reservoir (Acres) for the Period 1922-1990

	Alternative					
Month	**No Action**	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**State Permit**	**Existing Conditions**
October	3,039	3,039	3,039	3,039	3,039	3,034
November	2,946	2,946	2,946	2,946	2,946	2,946
December	2,946	2,946	2,945	2,946	2,946	2,939
January	2,946	2,946	2,946	2,946	2,946	2,945
February	2,946	2,946	2,946	2,946	2,946	2,945
March	3,039	3,039	3,039	3,039	3,039	3,037
April	3,199	3,201	3,197	3,197	3,199	3,163
May	3,201	3,201	3,201	3,201	3,201	3,182
June	3,201	3,201	3,201	3,201	3,201	3,181
July	3,201	3,201	3,201	3,201	3,201	3,172
August	3,201	3,201	3,201	3,201	3,201	3,154
September	3,178	3,178	3,178	3,178	3,178	3,133

Table B-44
Average Monthly Surface Area in Shasta Reservoir (Acres) for the Period 1922-1990

Month	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	State Permit	Existing Conditions
	Alternative					
October	21,262	19,971	20,787	21,171	21,512	21,458
November	21,365	20,315	20,973	21,299	21,573	21,553
December	21,928	20,971	21,595	21,867	22,072	22,081
January	22,857	22,026	22,575	22,789	22,995	23,004
February	24,085	23,403	23,840	24,033	24,236	24,207
March	25,757	25,149	25,551	25,719	25,865	25,871
April	27,052	26,585	26,879	26,969	27,136	27,157
May	27,108	26,605	26,794	26,968	27,226	27,216
June	26,091	25,354	25,551	25,827	26,172	26,244
July	23,906	23,077	23,377	23,590	23,901	24,122
August	21,797	20,700	21,233	21,580	21,905	22,015
September	21,156	19,846	20,854	21,120	21,505	21,390

Table B-45
Average Monthly Surface Area in Oroville Reservoir (Acres) for the Period 1922-1990

Month	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	State Permit	Existing Conditions
	Alternative					
October	10,458	10,479	10,458	10,437	10,584	11,336
November	10,638	10,665	10,648	10,623	10,748	11,435
December	10,850	10,864	10,839	10,829	10,958	11,549
January	11,345	11,371	11,332	11,327	11,438	11,876
February	11,952	11,974	11,943	11,948	12,015	12,340
March	12,541	12,570	12,539	12,538	12,595	12,831
April	13,345	13,374	13,341	13,338	13,402	13,647
May	13,618	13,634	13,611	13,607	13,669	13,918
June	13,198	13,217	13,195	13,187	13,274	13,591
July	12,192	12,224	12,195	12,171	12,274	12,748
August	11,122	11,107	11,123	11,096	11,223	11,881
September	10,463	10,491	10,459	10,439	10,577	11,315

Table B-46 Average Monthly Surface Area in Folsom Reservoir (Acres) for the Period 1922-1990						
	Alternative					
Month	**No Action**	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**State Permit**	**Existing Conditions**
October	21,262	19,971	20,787	21,171	21,512	21,458
November	21,365	20,315	20,973	21,299	21,573	21,553
December	21,928	20,971	21,595	21,867	22,072	22,081
January	22,857	22,026	22,575	22,789	22,995	23,004
February	24,085	23,403	23,840	24,033	24,236	24,207
March	25,757	25,149	25,551	25,719	25,865	25,871
April	27,052	26,585	26,879	26,969	27,136	27,157
May	27,108	26,605	26,794	26,968	27,226	27,216
June	26,091	25,354	25,551	25,827	26,172	26,244
July	23,906	23,077	23,377	23,590	23,901	24,122
August	21,797	20,700	21,233	21,580	21,905	22,015
September	21,156	19,846	20,854	21,120	21,505	21,390

Table B-47
Average Monthly Surface Area in San Luis Reservoir (Acres) for the Period 1922-1990

	Alternative					
Month	**No Action**	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**State Permit**	**Existing Conditions**
October	7,842	7,564	7,811	7,799	7,877	8,072
November	8,708	8,395	8,650	8,666	8,733	8,802
December	10,071	9,924	10,075	10,052	10,097	10,141
January	11,134	11,092	11,147	11,125	11,147	11,182
February	11,631	11,634	11,661	11,631	11,646	11,692
March	11,905	11,929	11,923	11,901	11,914	11,929
April	11,569	11,651	11,589	11,567	11,581	11,672
May	11,063	11,176	11,089	11,058	11,065	11,179
June	9,997	10,069	10,026	9,988	10,018	10,086
July	8,509	8,388	8,362	8,479	8,538	8,586
August	7,164	7,088	7,031	7,139	7,149	7,236
September	7,623	7,570	7,531	7,601	7,617	7,720

Table B-48
Comparison of Whiskeytown Reservoir Water Surface Area (Acres) for the Simulated Period 1922-1991

Month	Compared to No Action Alternative									
	Maximum Flow		Flow Evaluation		Percent Inflow		State Permit		Existing Conditions Compared to Preferred Alternative	
	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	0	0	0	0	0	0	0	0	5
November	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	6
January	0	0	0	0	0	0	0	0	0	1
February	0	0	0	0	0	0	0	0	0	1
March	0	0	0	0	0	0	0	0	0	2
April	0	2	0	-2	0	-2	0	0	1	34
May	0	0	0	0	0	0	0	0	1	19
June	0	0	0	0	0	0	0	0	1	20
July	0	0	0	0	0	0	0	0	1	29
August	0	0	0	0	0	0	0	0	1	47
September	0	0	0	0	0	0	0	0	1	45

Table B-49
Comparison of Shasta Reservoir Water Surface Area (Acres) for the Simulated Period 1922-1990

	Compared to No Action Alternative								Existing Conditions Compared to Preferred Alternative	
	Maximum Flow		Flow Evaluation		Percent Inflow		State Permit			
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)
October	-6	-1291	-2	-475	0	-90	1	251	-3	-672
November	-5	-1050	-2	-392	0	-66	1	207	-3	-580
December	-4	-957	-2	-333	0	-60	1	145	-2	-486
January	-4	-832	-1	-282	0	-69	1	138	-2	-429
February	-3	-682	-1	-244	0	-52	1	151	-2	-367
March	-2	-608	-1	-206	0	-38	0	108	-1	-320
April	-2	-466	-1	-172	0	-83	0	85	-1	-277
May	-2	-503	-1	-315	-1	-140	0	118	-2	-422
June	-3	-737	-2	-540	-1	-264	0	81	-3	-692
July	-3	-829	-2	-530	-1	-316	0	-6	-3	-746
August	-5	-1097	-3	-564	-1	-217	0	107	-4	-782
September	-6	-1310	-1	-302	0	-36	2	349	-3	-536

Table B-50
Comparison of Oroville Reservoir Water Surface Area (Acres) for the Simulated Period 1922-1990

	Compared to No Action Alternative								Existing Conditions Compared to Preferred Alternative	
	Maximum Flow		Flow Evaluation		Percent Inflow		State Permit			
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)
November	0	26	0	10	0	-15	1	109	-7	-787
December	0	14	0	-12	0	-22	1	108	-6	-710
January	0	25	0	-13	0	-18	1	92	-5	-543
February	0	21	0	-9	0	-4	1	63	-3	-397
March	0	29	0	-2	0	-3	0	53	-2	-292
April	0	29	0	-3	0	-7	0	58	-2	-305
May	0	16	0	-7	0	-12	0	51	-2	-307
June	0	19	0	-3	0	-11	1	76	-3	-396
July	0	31	0	2	0	-21	1	81	-4	-553
August	0	-16	0	0	0	-26	1	101	-6	-758
September	0	28	0	-3	0	-24	1	115	-8	-855

Table B-51
Comparison of Folsom Reservoir Water Surface Area (Acres) for the Simulated Period 1922-1990

	Compared to No Action Alternative								Existing Conditions Compared to Preferred Alternative	
	Maximum Flow		Flow Evaluation		Percent Inflow		State Permit			
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)
October	-5	-335	-1	-62	0	-22	2	154	-4	-304
November	-4	-272	-1	-39	0	1	2	121	-3	-251
December	-4	-309	-1	-70	0	-13	1	93	-3	-246
January	-3	-224	-1	-65	0	-3	1	49	-2	-191
February	-2	-182	-1	-42	0	4	1	49	-2	-130
March	-2	-163	0	-18	0	3	0	39	-1	-115
April	-4	-341	-1	-54	0	0	0	21	-2	-148
May	-4	-405	-1	-76	0	-18	0	23	-2	-184
June	-5	-450	-2	-150	0	-36	0	-14	-2	-224
July	-6	-517	-1	-81	-1	-51	2	169	-2	-199
August	-6	-500	-1	-81	-1	-41	2	199	-3	-218
September	-5	-395	-1	-62	-1	-38	2	132	-4	-287

Table B-52
Comparison of San Luis Reservoir Water Surface Area (Acres) for the Simulated Period 1922-1990

Month	Compared to No Action Alternative								Existing Conditions Compared to Preferred Alternative	
	Maximum Flow		Flow Evaluation		Percent Inflow		State Permit			
	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	-4	-278	0	-32	-1	-43	0	35	-3	-261
November	-4	-313	-1	-58	0	-41	0	26	-2	-152
December	-1	-147	0	4	0	-19	0	26	-1	-66
January	0	-42	0	13	0	-10	0	13	0	-34
February	0	2	0	30	0	0	0	15	0	-31
March	0	24	0	18	0	-4	0	9	0	-6
April	1	82	0	20	0	-2	0	12	-1	-83
May	1	114	0	27	0	-5	0	2	-1	-90
June	1	72	0	29	0	-8	0	21	-1	-60
July	-1	-121	-2	-147	0	-30	0	29	-3	-225
August	-1	-77	-2	-133	0	-25	0	-15	-3	-204
September	-1	-53	-1	-93	0	-22	0	-6	-2	-190

Table B-53
Summary Comparison of the Changes in Reservoir Surface Areas during Key Warmwater Fish Spawning and Rearing Months of March through July (Simulated for the Period from 1922 to 1990)

	Compared to No Action Alternative								Existing Conditions Compared to Preferred Alternative	
	Maximum Flow		Flow Evaluation		Percent Inflow		State Permit			
	Range in Mean Annual Change in Reservoir Area									
Reservoir	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres
Shasta	-2 to -3	-829 to - 466	-1 to -2	- 540 to - 172	0 to -1	- 316 to - 38	0	- 6 to + 116	-1 to -3	- 746 to - 277
Whiskeytown	0	0 to + 2	0	- 2 to 0	0	- 2 to 0	0	0	0 to 1	+ 2 to + 34
Oroville	0	+ 16 to + 31	0	- 7 to + 2	0	- 21 to - 3	0 to 1	+ 53 to + 76	-2 to -4	- 553 to - 292
Folsom	-2 to -6	- 517 to - 163	0 to -2	- 150 to - 18	0 to -1	- 36 to + 3	0 to 2	- 14 to + 169	-1 to -2	- 224 to - 115
San Luis	-1 to 1	- 121 to + 114	0 to -2	- 147 to + 29	0	- 8 to - 2	0	+ 2 to + 29	0 to -3	- 225 to - 6

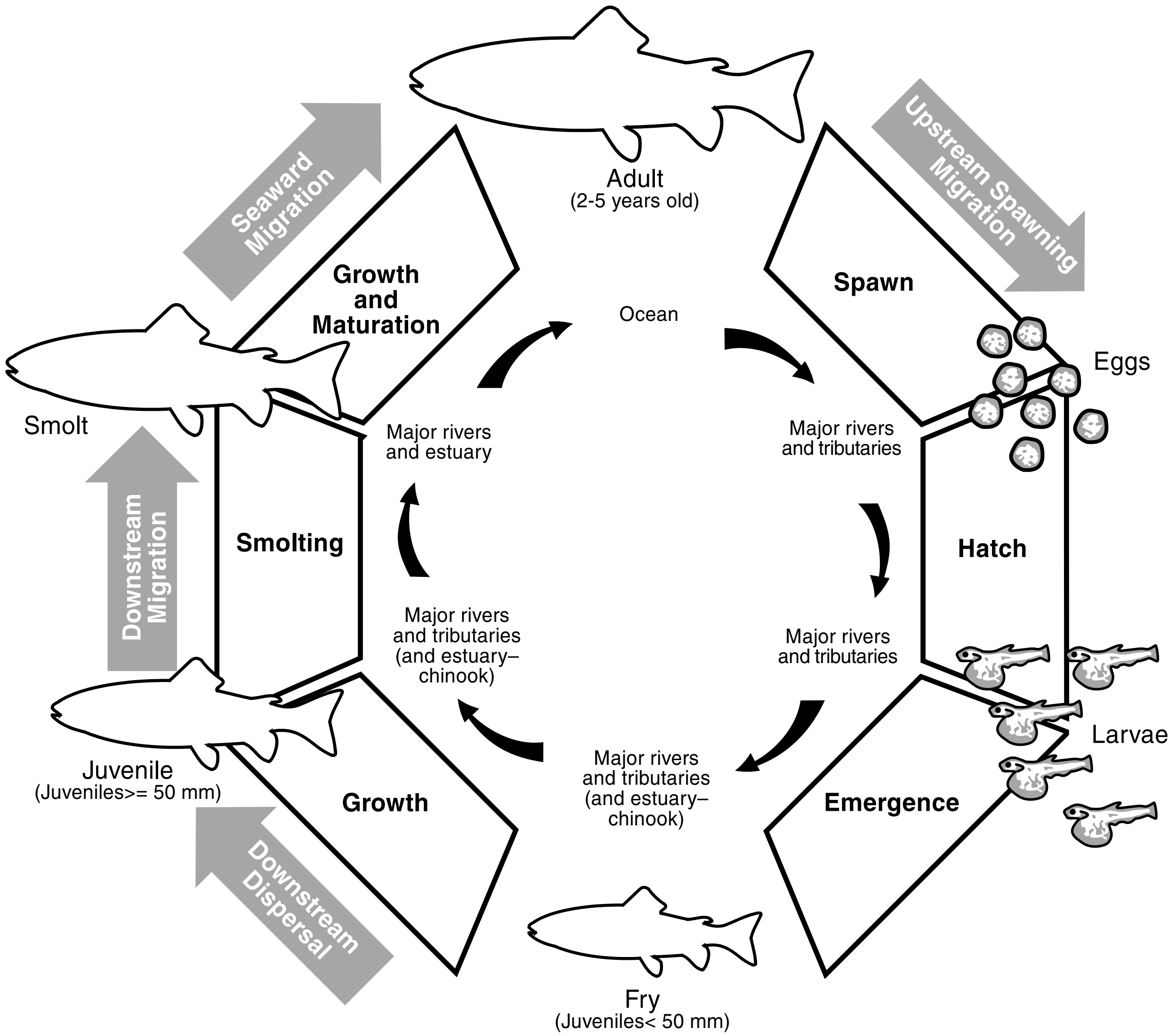


FIGURE B-1
GENERAL LIFE HISTORY OF ANADROMOUS SALMONIDS
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

2655_28 (5/10/99)

Go To TOC

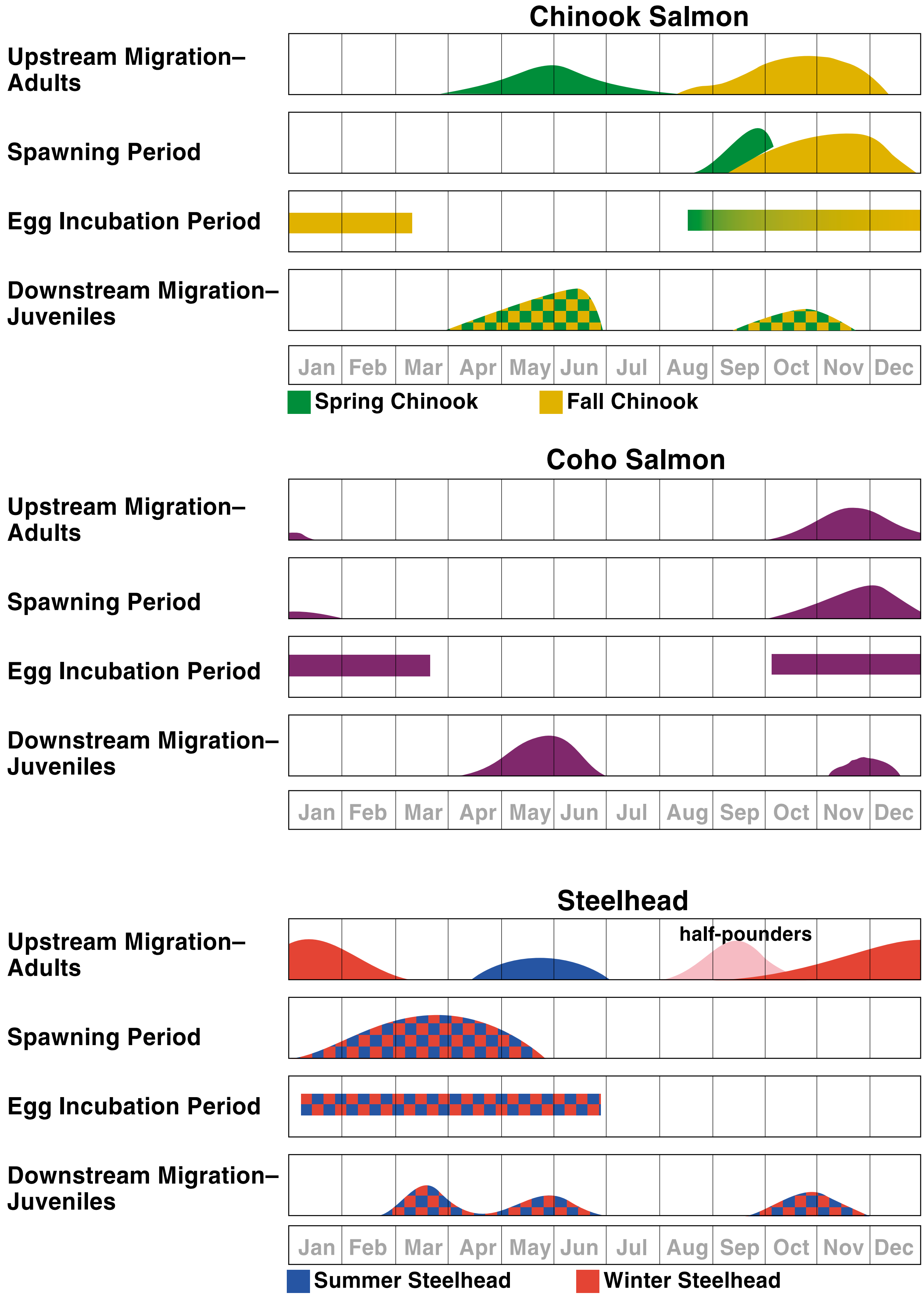


FIGURE B-2
TEMPORAL DISTRIBUTION OF ANADROMOUS SALMONID REPRODUCTION
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

Go To TOC

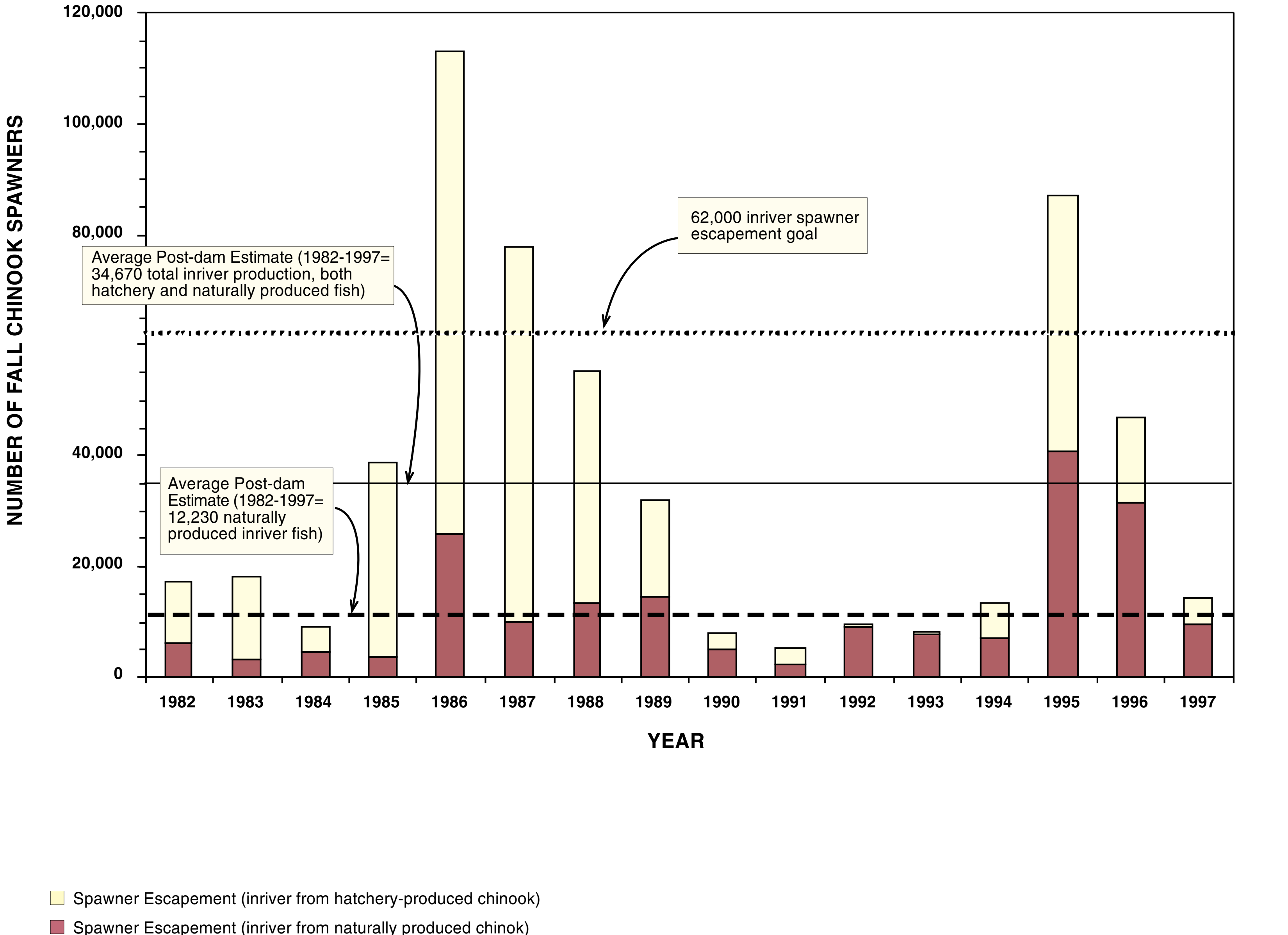
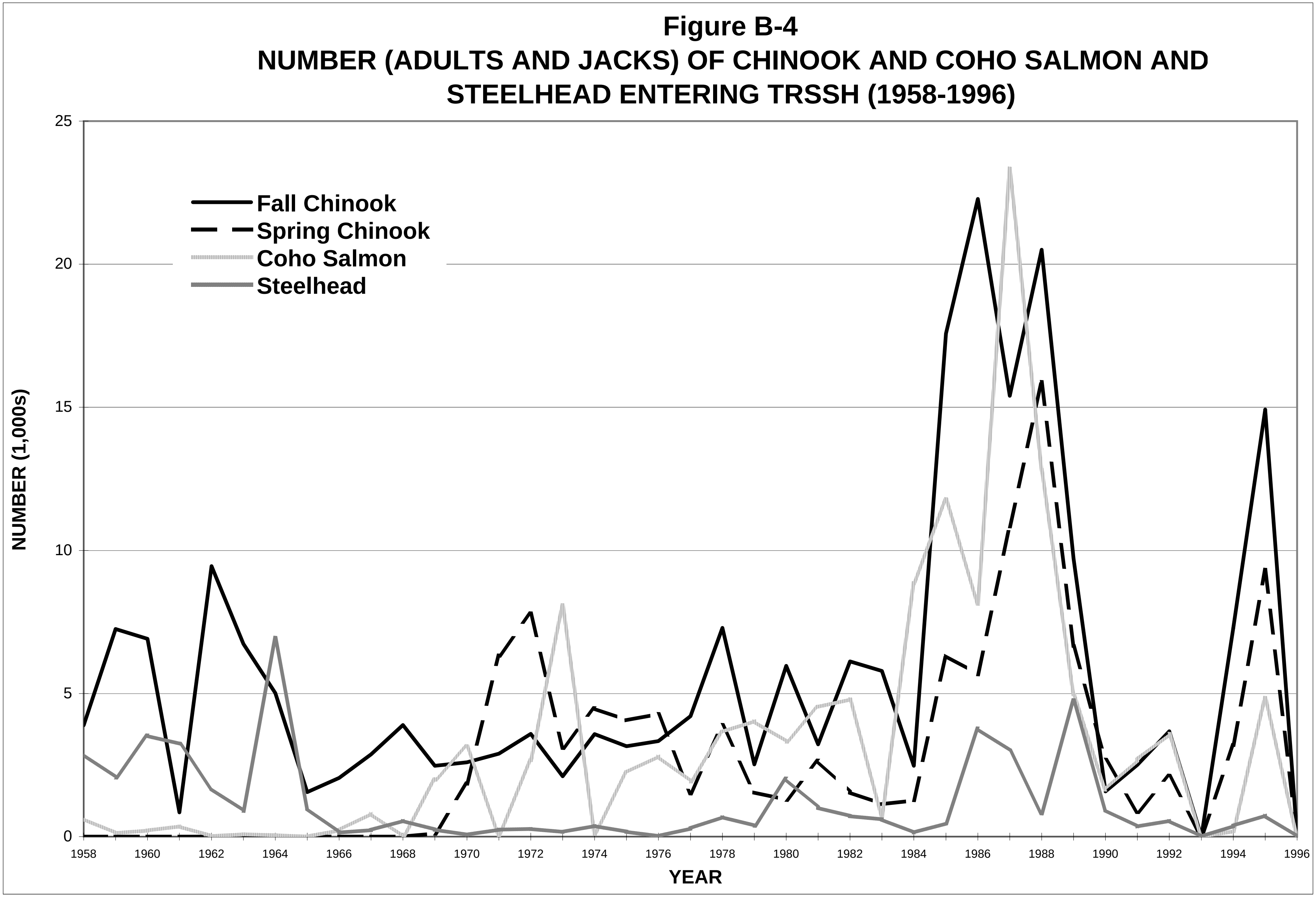


FIGURE B-3
FALL CHINOOK SPAWNER ESCAPEMENT IN THE MAINSTEM TRINITY RIVER (1982-1997)
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

2865_191 (10/8/99)



RDD-SFO/981350027.XLS (Lnb255.xls)
(Figure B-4)

Fishery Resources Technical Appendix B Attachments

Attachment B1	Tables B1-1 through B1-10
Table B1-1	Klamath River Basin Fall Chinook Salmon Run-size, Inriver Harvest, and Spawner Escapement – 1997 Season
Table B1-2	Post-dam Spring Chinook Salmon Run-size, Spawner Escapement, and Angler Harvest Estimates for the Mainstem Trinity River
Table B1-3	Post-dam Fall Chinook Salmon Run-size, Spawner Escapement, and Angler Harvest Estimates for the Mainstem Trinity River
Table B1-4	Post-dam Coho Salmon Run-size, Spawner Escapement, and Angler Harvest Estimates for the Mainstem Trinity River
Table B1-5	Post-dam Winter Steelhead Run-size, Spawner Escapement, and Angler Harvest Estimates for the Mainstem Trinity River
Table B1-6	Summer Steelhead Population Counts and Estimates in the Trinity River Basin
Table B1-7	Summary of Juvenile Salmonid Production at TRSSH 1958-1995
Table B1-8	Estimate Number of Chinook Salmon Returning to Spawn in Rivers and Streams of the Central Valley during 1967 through 1991, Exclusive of Fish Returning to Hatcheries
Table B1-9	Estimates of Steelhead Returning to the Upper Sacramento River and to Hatcheries Operated throughout the Central Valley, 1967 through 1991
Table B1-10	Estimates of the Abundance of White Sturgeon and Green Sturgeon in the Central Valley, 1967 through 1991
Attachment B2	Trinity River Basin Year Type Designations
Attachment B3	Overview of TR FCR Team 12/15/97 Meeting – Draft and Final 1/30/98) – Memo summarizing approach for determining numbers of anadromous fish
Attachment B4	Trinity River Temperature Attribute Scoring Analysis Results
Attachment B5	Weekly Flow Schedules for Each Project Alternative
Attachment B6	Methods Used to Develop Harvest-escapement Ratios for Trinity River EIS
Attachment B7	Alternative Analyses Considered for the Harvest Management Alternative
Attachment B8	Alternative Analyses Considered for the Harvest Management Alternative

Go To TOC

Go To TOC

ATTACHMENT B1

TABLES B1-1 THROUGH B1-10

TABLE B1-1

KLAMATH RIVER BASIN FALL CHINOOK SALMON RUN-SIZE, INRIVER HARVEST, AND SPAWNER ESCAPEMENT
(1997 SEASON)

11/5/98
Bob McAllister
Sup Chairs

Info

KLAMATH RIVER BASIN FALL CHINOOK SALMON RUN-SIZE, IN-RIVER HARVEST AND SPAWNER ESCAPEMENT – 1997 SEASON[1/]

The 1997 adult fall-run chinook salmon run size into the Klamath River system was estimated at 81,732 fish, about 85% of the 1978-1996 average of 96,153 adults. The grilse run was estimated at 9,623 fish, about 47% of the 1978-1996 average of 20,577 fish.

Fisheries scientists projected that 77,700 adult fall chinook would return to the Klamath River this fall. Using this figure, they project an in-river harvest of 26,500 fish (including 1,700 unlanded mortalities), leaving 51,200 adults to spawn naturally or in the hatcheries. The following table presents, in abbreviated form, 1997 preseason adult harvest and spawner escapement projections[2/] along with corresponding postseason estimates.

	Preseason Projection	Postseason Estimate	Percent of Projected
Harvest			
Indian net	21,600	11,745	54.4%
Angler	3,200	4,360	136.3%
Net and angler mortalities (unlanded)	1,700[3/]	1,027	60.4%
Subtotals	26,500	17,132	64.6%
Spawner Escapement			
Natural	35,300	45,945	130.2%
Hatchery	15,900	18,655	117.3%
Subtotals	51,200	64,600	126.2%
Totals	**77,700**	**81,732**	**105.2%**

Complete run-size, harvest and spawner-escapement estimates for both adults and grilse for years 1978-1997 are presented in the accompanying table.

1/ Prepared December 16, 1997, by the California Department of Fish and Game, Klamath-Trinity Program.

2/ From "Preseason Report III, Analysis of Council-Adopted Management Measures for 1996 Ocean Salmon Fisheries". Prepared by the Salmon Technical Team and Staff Economist - Pacific Fisheries Management Council. May 1997

3/ Rich Dixon, California Fish and Game, Inland Fisheries Division, personal communication.

Go To TOC

"Mega-TABLE"

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1997 a

SPAWNER ESCAPEMENT

	1978			1979			1980		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Hatchery Spawners									
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		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Angler Harvest									
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		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
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, 1978-1997 a

SPAWNER ESCAPEMENT

	1981			1982			1983		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Hatchery Spawners									
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		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Angler Harvest									
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		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
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

(continued next page)

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1997 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 i	1,941 i	2,888 i	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

(continued next page)

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1997 a

SPAWNER ESCAPEMENT

	1987			1988			1989		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Hatchery Spawners									
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		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Angler Harvest									
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		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
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

(continued next page)

Prepared 12/16/97

Go To TOC

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1997 [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 [i]	4,071 [i]	4,667 [i]	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

(continued next page)

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1997 a

SPAWNER ESCAPEMENT

	1993			1994			1995		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Hatchery Spawners									
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		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Angler Harvest									
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		
	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
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

(continued next page)

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1997 a

SPAWNER ESCAPEMENT

	1996 Grilse	1996 Adults	1996 Totals	1997 Grilse	1997 Adults	1997 Totals
Hatchery Spawners						
Iron Gate Hatchery (IGH)	543	13,622	14,165	452	13,275	13,727
Trinity River Hatchery (TRH)	249	6,411	6,660	819	5,380	6,199
Subtotals	792	20,033	20,825	1,271	18,655	19,926
Natural Spawners						
Trinity River basin (above Willow Creek, excluding TRH)	4,478	42,646	47,124	2,865	11,757	14,622
Salmon River basin	274	5,189	5,463	209	5,425	5,634
Scott River basin	145	11,952	12,097	259	8,032	8,291
Shasta River basin	46	1,404	1,450	334	1,677	2,011
Bogus Creek basin	377	10,420	10,797	221	9,809	10,030
Main Stem Klamath River (excluding IGH)	218 n	2,790 n	3,008 n	104 n	3,472 n	3,576 n
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	581 o	5,804 o	6,385 o	158 o	5,285 o	5,443 o
Hoopa and Yurok Reservation tribs.	55 p	1,121 p	1,176 p	37 p	488 p	525 p
Subtotals	6,174	81,326	87,500	4,187	45,945	50,132
Total Spawner Escapement	6,966	101,359	108,325	5,458	64,600	70,058

IN-RIVER HARVEST

	1996 Grilse	1996 Adults	1996 Totals	1997 Grilse	1997 Adults	1997 Totals
Angler Harvest						
Klamath River (below Hwy 101 bridge)	100	3,110	3,210	80	1,777	1,857
Klamath River (Hwy 101 to Coon Cr Falls)	1,128	4,052	5,180	2,203	221	2,424
Trinity River basin (above Willow Creek)	331	1,214	1,545 r	345	1,137	1,482 s
Balance of Klamath system	753	4,390	5,143	1,399	1,225	2,624 t
Subtotals	2,312	12,766	15,078	4,027	4,360	8,387
Indian Net Harvest e						
Klamath River (below Hwy 101 bridge)	163	49,113	49,276	36	5,391	5,427
Klamath River (Hwy 101 to Trinity mouth)	19	4,593	4,612	15	5,117	5,132
Trinity River (Hoopa Reservation)	8	2,770	2,778	2	1,237	1,239
Subtotals	190	56,476	56,666	53	11,745	11,798
Total In-river Harvest	2,502	69,242	71,744	4,080	16,105	20,185

IN-RIVER RUN

	1996 Grilse	1996 Adults	1996 Totals	1997 Grilse	1997 Adults	1997 Totals
Totals						
In-river Harvest and Escapement	9,468	170,601	180,069	9,538	80,705	90,243
Angling Mortality (2% of harvest) f	46	255	301	81	87	168
Net Mortality (8% of harvest) f	15	4,518	4,533	4	940	944
Total In-river Run	9,529	175,374	184,903	9,623	81,732	91,355

(continued next page)

Prepared 12/16/97

---

a/ Prepared December 16, 1997. All figures are California Department of Fish and Game (CDFG) counts/estimates unless otherwise indicated. All figures for Iron Gate and Trinity River hatcheries represent counts of fish entering those facilities. All spawner escapement figures for the Shasta River basin for 1978-1987, plus those for Bogus Creek basin for 1980-1991 are based on counts made at counting stations located near the mouths of those streams. All remaining spawner escapements and all harvest figures are estimates developed from data obtained through ongoing field investigations in the Klamath-Trinity system. Figures for years through 1996 are final; 1997 figures are preliminary, subject to revision.

b/ Figure not available.

c/ USFWS estimate.

d/ In 1978, the Klamath River system sport salmon fishing season was closed August 25. There was essentially no sport harvest of fall chinook in the Trinity River basin in 1978.

e/ USFWS estimates for years through 1982; 1983 through 1993 estimates jointly made by USFWS and Hoopa Valley Business Council Fisheries Department (HVBCFD); 1994 through 1997 estimates jointly made by HVBCFD for the Hoopa Reservation and Yurok Tribal Fisheries Department for the Yurok Reservation.

f/ Factors for nonlanded catch mortality calculated by the Klamath River Technical Advisory Team (KRTAT, 1986, "Recommended Spawning Escapement Policy for Klamath River Fall-run Chinook").

g/ US Forest Service estimate.

h/ HVBCFD estimate. Estimate for streams in Hoopa Reservation only.

i/ In 1985, the Klamath River system sport salmon fishing season was closed to the taking of all salmon below the US Highway 101 bridge from September 9 through December 31; the Klamath from the US Highway 101 bridge to Iron Gate Dam and the Trinity River from its mouth to Lewiston Dam were closed to the taking of salmon 22 inches and longer from September 23 through December 31, 1985.

j/ Estimates for Hoopa Reservation portion of catch (=947 grilse and 1,941 adults) are of catch occurring during open fishing periods only.

k/ Estimates jointly made by USFWS and HVBCFD.

l/ Final figures for Salmon River basin natural spawners shown in the December 11, 1991, table were incorrect. Corrected figures plus necessary revisions to the 1990 totals are presented here.

m/ Figure does not include adults that, following entry into Iron Gate Hatchery (IGH), were returned to the river alive and unspawned and which are presumed to have spawned naturally. This includes 2,333 fish in 1994 and 8,932 fish in 1995.

n/ CDFG estimate based on USFWS redd count data.

o/ CDFG and USFS estimates.

p/ HVBCFD and YTFD estimates.

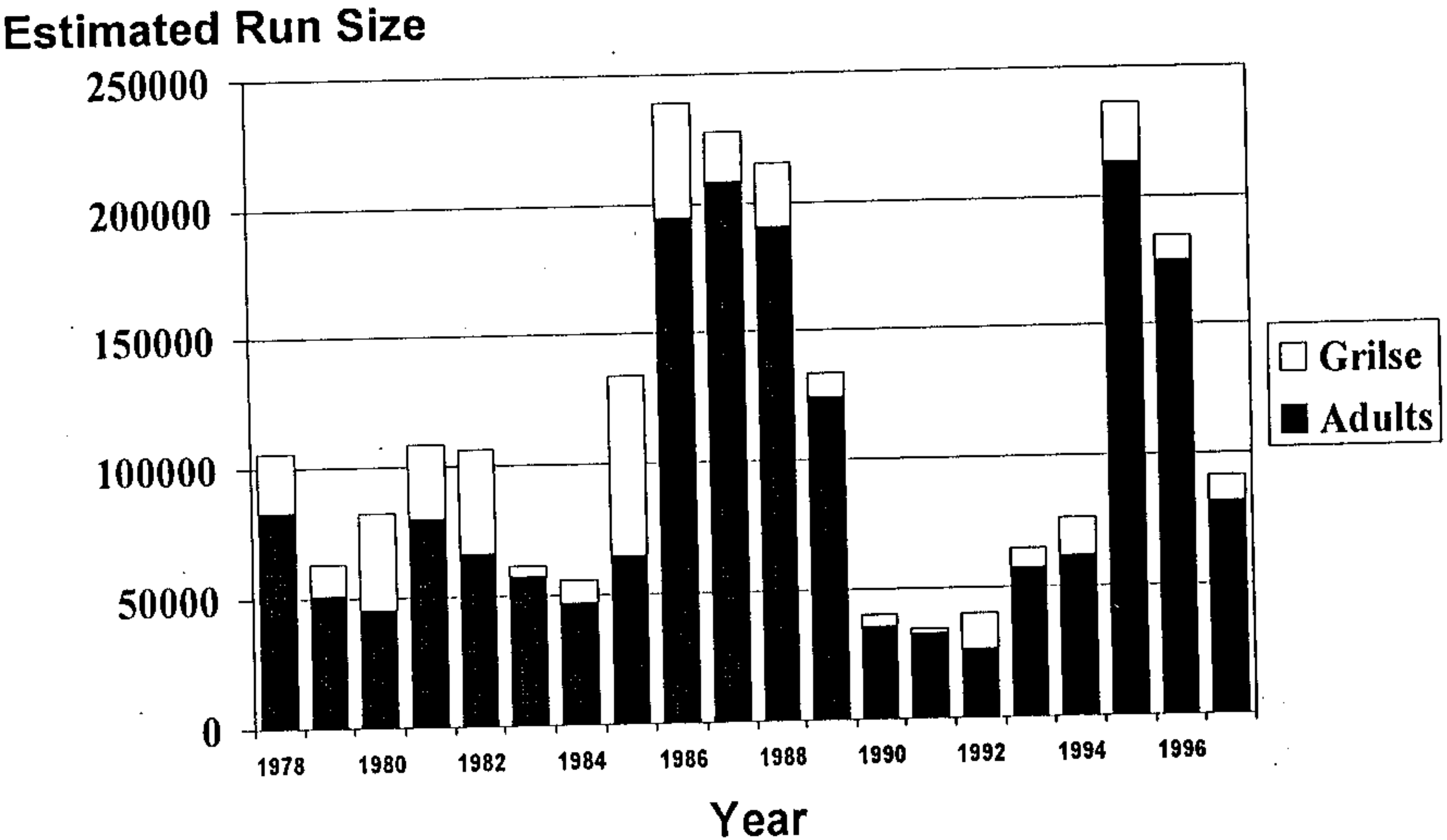
q/ 750 of these adults were harvested between I-5 and IGH after the river reopened to sport angling on October 13, 1995.

r/ Includes 51 grilse and 178 adults harvested in the main stem Trinity River between Willow Creek weir and the mouth of the Trinity River. HVBCFD estimate.

/s Includes 251 grilse and 645 adults harvested in the main stem Trinity River between Willow Creek weir and the mouth of the Trinity River. HVBCFD estimate.

/t Additional but unknown harvest occurred upstream of I-5 for jacks between October 2-18 after the 28-day "window" and October 18-November 30 for all chinook after IGH reached its required 8,000-adult chinook spawning escapement.

Klamath River basin fall-run chinook salmon run-size estimates, 1978-1997 a/



a/ 1997 figures preliminary and subject to revision, all others final.

TABLE B1-2

POST-DAM SPRING CHINOOK SALMON RUN-SIZE, SPAWNER ESCAPEMENT, AND ANGLER HARVEST ESTIMATES FOR THE MAINSTEM TRINITY RIVER

Go To TOC

Table B1-2
Post-dam Spring Chinook Salmon Run-size, Spawner Escapement, and Angler Harvest Estimates for the Mainstem Trinity River (1977-1997)[a]

Year	Run-size Estimate	Total Basin Escapement	Inriver Spawner Escapement	TRSSH Escapement	Angler Harvest	Naturally Produced Inriver Spawner Escapement[b]	Hatchery-produced Inriver Spawner Escapement[b]
1977				1,509			
1978	19,006	18,246	14,413	3,833	760		
1979	8,077	6,779	5,008	1,771	1,298		
1980	4,250	3,826	2,926	900	424		
1981	8,260	6,104	3,604	2,500	2,156		
1982	6,387	5,631	4,255	1,376	756	1,974	3,657
1983				1,158			
1984	2,720	2,306	1,494	812	414	2,104	202
1985	9,712	8,849	5,696	3,153	863	627	8,222
1986	30,421	26,250	17,706	8,544	4,171	0	26,250
1987	50,874	41,513	31,660	9,853	9,361	902	40,611
1988	62,692	53,852	39,570	14,282	8,840	6,214	47,638
1989	26,306	23,676	18,676	5,000	2,630	2,286	21,390
1990	6,388	5,543	3,006	2,537	845	893	4,650
1991	2,381	2,045	1,360	685	336	627	1,418
1992	4,030	3,732	1,886	1,846	298	1,550	2,182
1993	5,232	4,809	2,148	2,661	423	0	4,809
1994	6,788	6,334	3,447	2,887	454	1,440	4,894
1995	c	c	c	9,027	c	c	c
1996	23,416	21,903	16,653	5,250	1,513	c	c
1997	20,039	18,709	13,592	5,117	1,330	c	c
Mean	**16,499**	**14,450**	**10,394**	**4,160**	**2,049**	**1,551**	**13,827**
Years	1978-'82,'84-'94,'96			1977-'97	1978-'82,'84-'94 '96, '97	1982,'84-'94	

[a]All numbers represent jack and adult counts
[b]Stemple, (1988) and Zuspan and Sinnen, (1996) as cited by Service, (1998)
[c]No estimates available

TABLE B1-3

POST-DAM FALL CHINOOK SALMON RUN-SIZE, SPAWNER ESCAPEMENT, AND ANGLER HARVEST ESTIMATES FOR THE MAINSTEM TRINITY RIVER

Go To TOC

Table B1-3
Post-dam Fall Chinook Salmon Run-size, Spawner Escapement, and Angler Harvest Estimates for the Mainstem Trinity River (1977-1997)[a]

Year	Run-size Estimate	Total Basin Escapement	Inriver Spawner Escapement	TRSSH Escapement	Angler Harvest	Naturally Produced Inriver Spawner Escapement[b]	Hatchery-produced Inriver Spawner Escapement[b]
1977	32,914	27,450	23,238	4,212	5,464		
1978	43,123	43,123	35,764	7,359	0		
1979	16,185	14,263	11,964	2,299	1,922		
1980	34,346	30,892	24,537	6,355	3,454		
1981	29,250	24,620	21,246	3,374	4,630		
1982	28,591	23,716	17,423	6,293	4,875	6,213	17,503
1983	26,378	23,902	18,137	5,765	2,476	3,236	20,666
1984	13,131	12,002	9,070	2,932	1,129	4,483	7,519
1985	65,016	59,420	38,671	20,749	5,596	3,992	55,428
1986	147,888	132,411	113,007	19,404	15,477	25,871	106,540
1987	104,612	94,256	77,869	16,387	10,356	10,037	84,219
1988	89,422	77,346	55,242	22,104	12,076	13,453	63,893
1989	46,622	43,359	31,988	11,371	3,263	14,600	28,759
1990	9,992	9,642	7,923	1,719	350	5,144	4,498
1991	9,207	7,936	5,249	2,687	1,271	2,348	5,588
1992	14,164	13,692	9,702	3,990	472	6,665	7,027
1993	10,485	9,922	8,371	1,551	563	7,732	2,189
1994	21,924	21,117	13,411	7,706	807	7,361	13,756
1995	105,725	102,392	87,138	15,254	3,333	41,371	45,767
1996	55,646	53,784	47,124	6,660	1,862	31,429	15,695
1997	21,347	20,559	14,352	6,207	788	9,560	4,792
Mean	**44,095**	**40,277**	**31,974**	**8,303**	**3,817**	**12,227**	**34,165**
Years	1977-'97					1982-'97	

[a]All numbers represent jack and adult counts

[b]Zuspan and Sinnen, (1996) as cited by Service, (1998)

TABLE B1-4

POST-DAM COHO SALMON RUN-SIZE, SPAWNER ESCAPEMENT, AND ANGLER HARVEST ESTIMATES FOR THE MAINSTEM TRINITY RIVER

Table B1-4
Post-dam Coho Salmon Run-size, Spawner Escapement, and Angler Harvest Estimates for the Mainstem Trinity River (1977-1997)[a]

Year	Run-size Estimate	Total Basin Escapement	Inriver Spawner Escapement	TRSSH Escapement	Angler Harvest	Naturally Produced Inriver Spawner Escapement[b]	Hatchery-produced Inriver Spawner Escapement[b]
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	1,674		
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	3,368		
1988	38,904	36,943	24,127	12,816	1,961		
1989	18,752	18,452	13,482	4,970	300		
1990	3,897	3,850	2,215	1,635	47		
1991	9,124	9,015	6,327	2,688	109	0	9,015
1992	10,339	10,315	6,733	3,582	24	928	9,387
1993	5,641	5,577	3,460	2,117	64	82	5,475
1994	852	852	558	294	0	0	852
1995	16,111	15,817	11,050	4,767	294	0	15,817
1996	36,660	36,412	26,457	9,955	248	c	c
1997	7,935	7,893	6,135	1,758	42	c	c
Mean	**16,621**	**16,041**	**10,373**	**5,668**	**581**	**202**	**15,817**
Years	1977-'97					1991-'95	

[a]All numbers represent jack and adult counts
[b]Zuspan and Sinnen, (1996) as cited by Service, (1998)
[c]No estimates available

TABLE B1-5

POST-DAM WINTER STEELHEAD RUN-SIZE, SPAWNER ESCAPEMENT, AND ANGLER HARVEST ESTIMATES FOR THE MAINSTEM TRINITY RIVER

Go To TOC

Table B1-5
Post-dam Winter Steelhead Run-size, Spawner Escapement, and Angler Harvest Estimates for the Mainstem Trinity River (1977-1997)[a]

Year	Run-size Estimate	Total Basin Escapement	Inriver Spawner Escapement	TRSSH Escapement	Angler Harvest	Naturally Produced Inriver Spawner Escapement[b]	Hatchery-produced Inriver Spawner Escapement[b]
1977				285			
1978				683			
1979				382			
1980	24,094	20,568	19,563	1,005	3,526	14,462	5,101
1981				1,004			
1982	10,532	8,573	7,860	713	1,959	6,889	971
1983	8,605	7,260	6,661	599	1,345		
1984	7,833	6,572	6,430	142	1,261		
1985				461			
1986				3,780			
1987				3,007			
1988	12,743	12,743	11,926	817			
1989	37,276	33,698	28,933	4,765	3,578		
1990	5,348	4,118	3,188	930	1,230		
1991	11,417	9,077	8,631	446	2,340		
1992	3,046	2,754	2,299	455	292	1,540	759
1993	3,243	2,862	1,977	885	381	1,176	801
1994	4,244	3,699	3,288	411	545	2,410	878
1995	4,288	3,996	3,291	705	292	1,867	1,424
1996	10,435	9,842	5,830	4,012	593	1,703	4,127
1997	5,212	4,696	4,267	429	516	c	c
Mean	**10,665**	**9,383**	**8,146**	**1,282**	**1,374**	**4,292**	**2,009**
Years	1980, '82-'84, '88-'97			1977-'97	1980, '82-'84, '88-'97	1980, '82, '92-'96	
Mean	**5,078**	**4,642**	**3,492**	**1,150**	**437**	**1,598**	**1,739**
Years	1992-'97					1992-'96	

[a]All numbers represent jack and adult counts

[b]Zuspan and Sinnen, (1996) as cited by Service, (1998) CDFG, 1997

[c]No estimates available

TABLE B1-6

SUMMER STEELHEAD POPULATION COUNTS AND ESTIMATES IN THE TRINITY RIVER BASIN

Go To TOC

Table B1-6 Summer Steelhead Population Counts and Estimates (in parenthesis) in the Trinity River Basin					
			LOCATION		
YEAR	**South Fork**	**New River**	**North Fork**	**Canyon Creek**	**Upper Trinity**
1980	NS	320(355)	456	6	31
1981	NS	236(250)	219	3	2
1982	26	114(300)	193(210)	20	NS
1983	NS	NS	160	3	9
1984	8(30)	335(340)	179	20	5
1985	3(20)	NS	57(112)	10	9
1986	73(100)	NS	NS	NS	6
1987	NS	300	36(300)	0	9
1988	30	204(350)	624	32	16
1989	37	600	347(600)	NS	8
1990	66	343	554	15	13
1991	9(43)	500-600	825-1037	3	NS
1992	29	272	369	6	NS
1993	42	368	604	24	NS
1994	22	404	990	45	NS
1995	30	775	828	17	NS
Average	**40**	**404**	**460**	**15**	**11**

NS=No surveys made

Source: CDFG as cited by Service (1998)

TABLE B1-7

SUMMARY OF JUVENILE SALMONID PRODUCTION AT TRSSH 1958-1995

Go To TOC

Table B1-7 Summary of Juvenile Salmonid production at TRSSH 1958-1995

	CHINOOK (total)		CHINOOK (fall)		CHINOOK (spring)		COHO		STEELHEAD	
Year	Number Fingerlings Planted	Number Yearlings Planted	Number Fingerlings Planted	Number Yearlings Planted	Number Fingerlings Planted	Number Yearlings Planted	Number Fingerlings Planted	Number Yearlings Planted	Number Fingerlings Planted	Number Yearlings Planted
1958	0	0					0	0	0	0
1959	0	0					0	0	0	0
1960	993,900	0					114,900***	0	2,413,900***	0
1961	2,427,070	0					284,000***	0	3,051,000***	0
1962	0	0					0	0	55,600	0
1963	4,704,900	0					0	0	0	688,000
1964	7,471,300	300,000					0	624,600	0	590,100
1965	1,300,000	224,548					0	38,900	6,803,200	630,257
1966	2,873,600	0					0	614,700	0	840,848
1967	2,109,400	52,185					265,000	684,265	0	676,342
1968	4,252,000	518,000					0	790,845	0	120,500
1969	1,270,230	500,000					52,000	452,760	200,400	608,988
1970	1,665,494	750,000					1,084,254	395,430	0	705,423
1971	4,304,720	330,373					0	508,992	0	622,548
1972	5,775,210	1,302,029					0	9,829	101,376	581,444
1973	798,376	946,254					5,676,517	18,620	184,729	411,212
1974	2,267,075	730,775					0	252,905	0	226,452
1975	4,092,000	609,068					0	29,180	8,800	516,577
1976	3,246,075	1,023,710					0	164,730	182,961	370,215
1977	390,400	286,100					0	225,600	0	152,876
1978	4,413,883	592,137					0	219,614	228,030	460,150
1979	826,532	1,187,744					342,000	267,396	65,750	319,461
1980	1,481,045	836,178					129,800	434,383	226,960	232,734
1981	2,228,775	1,007,001					849,080	361,416	164,500	812,413
1982	582,805	1,451,881					889,125	260,951	378,000	299,169
1983	2,575,335	1,193,105					0	560,298	0	237,000
1984	510,000	1,600,238					0	156,150	0	678,425
1985	5,352,235	1,713,568					210,250	901,913	0	450,122
1986	5,773,651	1,511,300	3,680,881	1,018,440	2,092,770	492,860	339,935	568,803	0	536,743
1987	5,799,515	3,786,010	2,996,289	3,299,962	2,803,226	486,048	0	347,256	0	925,100
1988	4,860,896	93,300	2,921,982	93,300	1,938,914	0	0	421,100	0	530,200
1989	4,475,011	1,720,992	2,749,774	1,112,412	1,725,237	608,580	0	519,134	0	456,487
1990	1,839,541	1,448,488	0	1,099,574	1,839,541	348,914	0	627,739	0	1,155,171
1991	791,727	1,244,172	581,539	643,910	210,188	600,262	0	439,523	0	964,488
1992	2,830,256	1,309,097	2,342,037	933,796	488,219	375,301	0	384,555	0	337,589
1993										
1994	3,612,966	1,013,768	2,153,982	213,563	1,458,984	800,205	0	549,983	0	879,841
1995	3,095,498	1,424,995	6,441,834	950,015	1,057,037	474,980	0	614,828	0	614,828

TABLE B1-8

ESTIMATE NUMBER OF CHINOOK SALMON RETURNING TO SPAWN IN RIVERS AND STREAMS OF THE CENTRAL VALLEY DURING 1967 THROUGH 1991, EXCLUSIVE OF FISH RETURNING TO HATCHERIES

Go To TOC

Table B1-8 Estimated Number of Chinook Salmon Returning to Spawn, Exclusive of Fish Returning to Hatcheries, in Rivers and Streams of the Central Valley During 1967 through 1991

Year	Sacramento Fall-run chinook [1]			San Joaquin Fall-run chinook [2]			Sacramento Late-fall-run chinook [3]		
	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	38,410	104,790	143,200	1,176	21,359	22,535	5,730	31,478	37,208
1968	18,181	155,859	174,040	11,211	6,577	17,788	1,910	32,823	34,733
1969	48,528	208,289	256,817	1,935	49,662	51,597	1,747	35,431	37,178
1970	30,121	147,279	177,400	8,539	28,550	37,089	1,823	17,367	19,190
1971	35,775	140,691	176,466	2,986	38,580	41,566	2,277	12,046	14,323
1972	43,795	80,622	124,417	2,321	11,954	14,275	2,398	29,155	31,553
1973	40,640	197,193	237,833	674	6,438	7,112	711	21,493	22,204
1974	25,364	185,953	211,317	762	3,625	4,387	329	6,116	6,445
1975	29,691	141,884	171,575	885	5,841	6,726	816	15,847	16,663
1976	21,926	155,767	177,693	434	3,465	3,899	581	14,699	15,280
1977	22,831	139,971	162,802	60	990	1,050	873	8,217	9,090
1978	23,635	115,363	138,998	244	2,333	2,577	959	7,921	8,880
1979	46,397	152,982	199,379	456	3,897	4,353	44	8,696	8,740
1980	25,472	110,833	136,305	702	5,600	6,302	566	7,181	7,747
1981	42,575	145,503	188,078	8,022	20,295	28,317	168	1,429	1,597
1982	43,396	129,388	172,784	2,681	14,214	16,895	186	955	1,141
1983	41,714	88,676	130,390	32,312	10,970	43,282	1,221	12,053	13,274
1984	40,859	114,563	1155422	18,335	37,641	55,976	2,357	3,550	5,907
1985	41,563	211,695	253,258	4,311	71,873	76,184	1,670	5,990	7,660
1986	27,356	212,739	240,095	3,117	18,588	21,705	490	6,220	6,710
1987	66,364	150,965	217,329	18,269	6,689	24,958	780	13,663	14,443
1988	26,517	197,841	224,358	1,138	20,798	21,937	2,094	8,589	10,683
1989	24,060	116,726	140,786	282	3,489	3,771	286	9,589	9,875
1990	9,443	83,499	92,942	312	663	975	1,536	5,385	6,921
1991	11,546	87,070	98,616	207	647	854	888	5,643	6,531
Average	33,046	143,046	176,092	4,855	15,789	20,644	1,298	12,861	14,159

Table B1-8 Estimated Number of Chinook Salmon Returning to Spawn, Exclusive of Fish Returning to Hatcheries, in Rivers and Streams of the Central Valley During 1967 through 1991

Year	Sacramento Spring-run chinook [4]			Sacramento Winter-run chinook [5]			Central Valley Total chinook salmon		
	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	11,397	12,297	23,694	24,985	32,321	57,306	81,698	202,245	283,943
1968	3,317	11,827	15,144	10,299	74,115	84,414	44,917	281,202	326,119
1969	2,843	24,492	27,335	8,953	108,855	117,808	64,006	426,729	490,735
1970	1,420	6,017	7,437	8,324	32,085	40,409	50,226	231,297	281,525
1971	2,464	6,336	8,800	20,864	32,225	53,089	64,366	229,878	294,244
1972	1,343	7,053	8,396	8,541	28,592	37,133	58,398	157,376	215,774
1973	2,082	9,680	11,762	4,623	19,456	24,079	48,729	254,261	302,990
1974	2,538	5,545	8,083	3,788	18,109	21,897	32,782	219,347	252,129
1975	7,683	15,670	23,353	7,498	15,932	23,430	46,573	195,174	241,747
1976	4,067	22,006	26,073	8,634	26,462	35,096	35,642	222,399	258,041
1977	5,421	8,409	13,830	2,186	15,028	17,214	31,372	172,614	203,986
1978	1,093	7,063	8,156	1,193	23,669	24,862	27,124	156,349	183,473
1979	707	2,203	2,910	113	2,251	2,364	47,717	170,029	217,746
1980	3,734	8,081	11,815	1,072	84	1,156	31,545	131,780	163,325
1981	8,249	13,066	21,315	1,744	18,297	20,041	60,757	198,591	259,348
1982	4,528	21,644	26,172	270	972	1,242	51,061	167,173	218,234
1983	672	3,809	4,481	392	1,439	1,831	76,311	116,947	193,258
1984	4,373	3,988	8,361	1,869	794	2,663	67,794	160,535	228,329
1985	3,792	7,631	11,423	329	3,633	3,962	51,665	300,822	352,487
1986	1,606	17,290	18,896	451	2,013	2,464	33,020	256,850	289,870
1987	4,177	7,330	11,507	236	1,761	1,997	89,826	180,408	270,234
1988	2,132	9,521	11,653	708	1,386	2,094	32,589	238,136	270,725
1989	884	6,304	7,188	53	480	533	25,566	136,587	162,153
1990	948	4,376	5,324	16	425	441	12,256	94,347	106,603
1991	433	1,208	1,641	38	153	191	13,112	94,721	107,833
Average	3,276	9,714	12,990	4,687	18,421	23,109	47,162	199,832	246,994

1. Escapement data for the Sacramento River and its tributaries north of and including the American River.
2. Escapement data for the Mokelumne, Cosumnes, Calaveras, Stanislaus, Tuolumne, and Merced rivers.
3. Escapement data for the main stem Sacramento River above Red Bluff Diversion Dam.
4. Escapement data for the main stem Sacramento River above Red Bluff Diversion Dam.
5. Escapement data for the main stem Sacramento River above Red Bluff Diversion Dam.

TABLE B1-9

ESTIMATES OF STEELHEAD RETURNING TO THE UPPER SACRAMENTO RIVER AND
TO HATCHERIES OPERATED THROUGHOUT THE CENTRAL VALLEY,
1967 THROUGH 1991

Table B1-9 Estimates of Steelhead Returning to the Upper Sacramento River and to Hatcheries Operated throughout the Central Valley, 1967-1991

Year	Inriver Spawners	Steelhead Returns to Hatcheries					Grand Total
	Upper Sacramento	Coleman	Feather River	Nimbus	Mokelumne	Subtotal	
1967	15,312	1,532	563	642	17	2,754	18,066
1968	19,615	3,229	1,005	1,183	103	5,520	25,135
1969	15,222	4,939	361	3,056	24	8,380	23,602
1970	13,240	4,046	1,945	1,734	134	7,859	21,099
1971	11,887	3,742	78	3,033	115	6,968	18,855
1972	6,041	1,486	288	2,256	14	4,044	10,085
1973	8,921	2,645	1,000	2,506	11	6,162	15,083
1974	7,150	1,834	715	3,157	18	5,724	12,874
1975	5,579	1,099	458	2,164	2	3,723	9,302
1976	8,902	2,162	573	3,181	0	5,916	14,818
1977	6,099	2,069	163	1,307	0	3,539	9,638
1978	2,527	697	131	619	0	1,447	3,974
1979	3,499	865	189	680	0	1,734	5,233
1980	11,887	4,264	314	1,310	0	5,888	17,775
1981	3,363	1,118	547	821	0	2,486	5,849
1982	2,757	1,275	891	3,190	0	5,356	8,113
1983	3,486	938	1,238	1,003	0	3,179	6,665
1984	2,036	529	783	5,155	0	6,467	8,503
1985	4,489	2,084	1,721	910	0	4,715	9,204
1986	3,769	2,299	1,554	1,193	0	5,046	8,815
1987	2,963	1,176	1,018	1,431	48	3,673	6,636
1988	1,872	915	2,587	705	0	4,207	6,079
1989	470	492	1,106	289	7	1,894	2,364
1990	2,272	1,319	1,193	594	11	3,117	5,389
1991	991	991	1,024	223	20	2,258	3,249
Average	6,574	1,910	858	1,694	40	4,482	11,056

TABLE B1-10

ESTIMATES OF THE ABUNDANCE OF WHITE STURGEON AND GREEN STURGEON IN THE CENTRAL VALLEY, 1967 THROUGH 1991

Table B1-10 Estimates of the Abundance of White Sturgeon and Green Sturgeon in the Central Valley, 1967 through 1991

Year	White Sturgeon Abundance	Years Abundance Estimated	Ratio White: Green	Green Sturgeon Abundance
1967	114,700	**	62.0:1	1,850
1968	40,000	**	38.6:1	1,040
1969	36,783			900
1970	33,567			760
1971	30,350			620
1972	27,133			480
1973	23,917			340
1974	20,700	**	101.9:1	200
1975	31,460			444
1976	42,220			688
1977	52,980			932
1978	63,740			1,176
1979	74,500	**	52.6:1	1,420
1980	83,120			1,378
1981	91,740			1,336
1982	100,360			1,294
1983	108,980			1,252
1984	117,600	**	106.3:1	1,210
1985	107,700	**	127.3:1	760
1986	96,850			635
1987	86,000	**	163.7:1	510
1988	66,267			520
1989	46,553			530
1990	26,800	**	49.7:1	540
1991	--			--
Average	63,501			867

Go To TOC

ATTACHMENT B2

TRINITY RIVER BASIN YEAR TYPE DESIGNATIONS

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR
TRINITY RIVER BASIN YEAR TYPE DESIGNATIONS

		# Years	Probability
EXTREMELY WET =	1	8	0.12
WET =	2	20	0.29
NORMAL =	3	14	0.20
DRY =	4	19	0.28
CRITICAL DRY =	5	8	0.12
		69	

YEAR[1,2]	YEAR TYPE[3]
1922	4
1923	5
1924	5
1925	2
1926	4
1927	2
1928	3
1929	5
1930	4
1931	5
1932	4
1933	4
1934	5
1935	4
1936	3
1937	4
1938	1
1939	5
1940	2
1941	1
1942	2
1943	3
1944	5
1945	3
1946	2
1947	4
1948	3
1949	3
1950	4
1951	2
1952	2
1953	2
1954	2
1955	4
1956	1
1957	3
1958	1
1959	3
1960	3
1961	3
1962	4
1963	2
1964	4
1965	2
1966	3
1967	2
1968	3

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR
TRINITY RIVER BASIN YEAR TYPE DESIGNATIONS

1969	2
1970	2
1971	2
1972	3
1973	2
1974	1
1975	2
1976	4
1977	5
1978	1
1979	4
1980	2
1981	4
1982	1
1983	1
1984	2
1985	4
1986	2
1987	4
1988	4
1989	3
1990	4

[1] Year extends from March of one water year through February of the subsequent water year (e.g., Year 1922 = March 1922 through February 1923).

[2] First five months of water year 1922 have normal year type designation.

[3] Trinity River Basin year type designations based on inflow to Trinity Lake.

ATTACHMENT B3

OVERVIEW OF TR FCR TEAM 12 / 15 / 97 MEETING—DRAFT AND FINAL 1 / 30 / 98—
MEMO SUMMARIZING APPROACH FOR DETERMINING NUMBERS
OF ANADROMOUS FISH

Go To TOC

OVERVIEW OF TR FCR Team 12/15/97 MEETING---DRAFT AND FINAL (1/30/98)
OBJECTIVE: DETERMINE FISH NUMBERS FOR TRINITY RIVER EIS/EIR

The Trinity River Fish and Channel team met on December 15, 1997, in Acata to re-examine the alluvial river attributes and weekly flow schedules, and resulting fish numbers for each alternative. This meeting was necessary to assure quality and consistency in evaluation between alternatives because some alternatives' flow schedule have changed. Each alternative was scored on its ability to meet the objectives of 11 river attributes. Scoring was based on each schedule's ability to meet threshold criteria (in terms of frequency and/or magnitude and/or duration), which were defined by scientific data (whenever available), and/or professional judgement. Alternatives that have flow schedules for five water year types were assessed based on those five different schedules and the probability of each water year type occurring. The 40% inflow alternative was initially assessed based on release schedules developed using the average weekly inflow data for multiple years within each water year type. However, because this averaging process eliminated many of the peaks that would actually occur if the alternative were implemented, the Team decided to use historical flow data at Lewiston, which was used to calculate annual flow schedules under the protocol for implementation of the 40% inflow alternative. The resulting 80 flow schedules were evaluated to determine if the threshold criteria were met on an annual basis. The number of years that these flow schedules met each threshold criteria was tallied and used to determine a percent occurrence for that threshold (See attached table).

Daily temperature criteria for outmigrating smolts were derived from literature summarized by Zedonis and Newcomb (1997). These criteria were developed based on outmigration timing of Trinity River salmonid species and optimal smolting temperatures for each salmonid species. Scoring was based on the percentage of weeks these criteria were met. Alternatives that have flow schedules for five water year types were assessed based the weighted average number of weeks meeting the criteria, using the probability of each water year type occurring in any given year. Scoring for all alternatives was based results of SNTEMP using minimum average weekly release temperatures from Lewiston Dam for median meteorological and hydrological conditions. This objective was to be re-evaluated using SNTEMP with release temperatures based on modeled diversion patterns and reservoir levels for each alternative from the BETTER model. However, the BETTER model only uses one data year, and selected the most extreme years in each water year class. Hence, the results for the extremely wet years change the Lewiston release schedule in order to model spill events. The FCRT had previously decided evaluate the established set release schedules as if dam operations had complete control over all releases because spill events are unpredictable. As the BETTER model results do not follow the set release schedules and only represent the extremes, the TR EIS management team decided that the FCRTeam's previous temperature analysis, as presented above, was sufficient to complete the fish numbers analysis. Nannett Engelbright, the team leader for power and operations, thought our previous analysis was the best evaluation of the fisheries flows as operated, particularly in light that diversions to the CVP were modified to maintain Lewiston release temperatures below 50F, when possible. Because the fish number analysis is a relative ranking of these alternative, and this change in the agreed-upon methodologies will not substantially change the end results, as temperature criteria only make up a total of 4 points of the 74 possible points.

Go To TOC

Temperature criteria from July 1 through October 15 are based on the NCRWQCB's temperature objectives. Empirical data in recent years (1992-1997) have shown 450 cfs will meet these objectives under most diversion schedules and hydrological and meteorological conditions; therefore, 450 cfs was the chosen minimum criteria during this time period. Alternatives that have flow schedules for five water year types were assessed based the weighted average number of weeks meeting the criteria, using the probability of each water year type occurring in any given year. This objective was also to be re-evaluated based on BETTER model results, but was not for the same reasons the outmigration criteria was not re-evaluated, as described in the previous paragraph.

Tables for the scoring of each alternative by each attribute's objective are attached. The criteria and scoring ranges for each objective is at the bottom of the page. The final scoring summary for all alternatives is on the last page. This final scoring was used to calculate a percentage based on the total number of points possible (74 points). This percentage was then applied to the Trinity River Restoration Program's escapement goals for adult returns to estimate the number of returning adult spawners for chinook, coho and steelhead. A species-specific harvest to escapement ratio developed for the Trinity River was then applied to the number of spawners to obtain ocean and inriver harvest numbers for chinook, coho and steelhead.

Go To TOC

ATTACHMENT B4

TRINITY RIVER TEMPERATURE ATTRIBUTE SCORING ANALYSIS RESULTS

Go To TOC

TABLE OUTMIGRATION 1. Trinity River Flow Evaluation temperature criteria evaluation for outmigrating smolts for median hydrological and meteorological conditions with minimum average Lewiston Dam release temperatures. Temperature criteria are based on a literature review by Zedonis and Newcomb (1997). Percent time that the objective is met is based on the average number of weeks criteria is met, weighted by the probability of each water year type occurring.

		Criteria (F)	Trinity River Flow Alternative				
Month	Week	optimal/marg.	XWET	WET	NORM	DRY	C. DRY
Apr	22	55.4 / 59	2	2	2	2	2
	29	55.4 / 59	2	2	2	2	2
May	6	55.4 / 59	1	2	2	2	1
	13	55.4 / 59	1	2	2	1	1
	20	55.4 / 59	2	2	1	1	1
	27	59 / 62.8	2	2	2	1	1
Jun	3	59 / 62.8	2	2	1	1	1
	10	62.8 / 68	2	2	2	2	2
	17	62.8 / 68	2	2	2	1	1
	24	62.8 / 68	2	2	2	1	1
July	1	62.8 / 68	2	2	2	0	0
	8	62.8 / 68	1	1	1	0	0
Overall Totals	Total # of weeks		Total number of weeks criteria is met				
		Criteria	XWET	WET	NORM	DRY	C. DRY
	12	optimal	9	11	9	4	3
	12	marginal	12	12	12	10	10

Schedule meets **optimal** criteria (based on weighted average) =

[(9x.12)+ (11x.28)+(9x .20)+(4x.28)+(3x.12)]/12 x100= 62%

Schedule meets marginal criteria (based on weighted average) =

[(12x.12)+ (12x.28)+(12x .20)+(10x.28)+(10x.12)]/12 x100=93 %

2= Meets optimal criteria
1= Meets marginal criteria
0= Does not meet criteria.

TABLE OUTMIGRATION 2. Maximum Flow temperature evaluation for outmigrating smolts for median hydrological and meteorological conditions with minimum average Lewiston Dam release temperatures. Temperature criteria are based on a literature review by Zedonis and Newcomb (1997). Percent time that the objective is met is based on the average number of weeks criteria is met, weighted by the probability of each water year type occurring.

		Criteria (F)	Max Flow Alternative				
Month	Week	optimal/marg.	XWET	WET	NORM	DRY	C. DRY
			2146 TAF	1505 TAF	1203 TAF	886 TAF	462 TAF
Apr	22	55.4 / 59	2	2	2	2	2
	29	55.4 / 59	2	2	2	2	1
May	6	55.4 / 59	2	2	2	2	1
	13	55.4 / 59	2	2	2	1	1
	20	55.4 / 59	2	2	1	1	1
	27	59 / 62.8	2	2	2	2	2
Jun	3	59 / 62.8	2	2	2	2	2
	10	62.8 / 68	2	2	2	2	2
	17	62.8 / 68	2	2	2	2	2
	24	62.8 / 68	2	2	2	2	2
July	1	62.8 / 68	2	2	2	2	1
	8	62.8 / 68	2	2	1	1	1
Overall Totals	Total # of weeks		Total number of weeks criteria is met				
		Criteria	XWET	WET	NORM	DRY	C. DRY
	12	optimal	12	12	10	9	6
	12	marginal	12	12	12	12	12

Schedule meets **optimal** criteria (based on weighted average) =
(12x.12)+(12x.28)+(10x .20)+(9x.28)+(6x.12)]/12 x100= 81%

Schedule meets marginal criteria (based on weighted average) =
[(12x.12)+ (12x.28)+(12x .20)+(12x.28)+(12x.12)]/12 x100= 100%

2= Meets optimal criteria
1= Meets marginal criteria
0= Does not meet criteria.

TABLE OUTMIGRATION 3. 40% Inflow Alternative temperature evaluation for outmigrating smolts for median hydrological and meteorological conditions with minimum average Lewiston Dam release temperatures. Temperature criteria are based on a literature review by Zedonis and Newcomb (1997). Percent time that the objective is met is based on the average number of weeks criteria is met, weighted by the probability of each water year type occurring.

		Criteria (F)	**40 % INFLOW Alternative**				
Month	Week	optimal/marg.	XWET	WET	NORM	DRY	C. DRY
			978 TAF	655 TAF	443 TAF	325 TAF	165 TAF
Apr	22	55.4 / 59	2	2	2	2	2
	29	55.4 / 59	2	2	2	2	2
May	6	55.4 / 59	1	1	1	1	1
	13	55.4 / 59	1	1	1	1	1
	20	55.4 / 59	1	1	1	1	0
	27	59 / 62.8	2	2	1	1	1
Jun	3	59 / 62.8	2	1	1	1	1
	10	62.8 / 68	2	2	2	2	1
	17	62.8 / 68	2	1	1	1	1
	24	62.8 / 68	2	1	1	1	1
July	1	62.8 / 68	1	1	0	0	0
	8	62.8 / 68	1	0	0	0	0
Overall Totals	Total # of weeks		Total number of weeks criteria is met				
		Criteria	XWET	WET	NORM	DRY	C. DRY
	12	optimal	7	4	3	3	2
	12	marginal	12	11	10	10	9

Schedule meets **optimal** criteria (based on weighted average) =

[(7x.12)+ (4x.28)+(3x .20)+(3x.28)+(2x.12)]/12 x100= 30%

Schedule meets marginal criteria (based on weighted average) =

[(12x.12)+ (11x.28)+(10x .20)+(10x.28)+(9x.12)]/12 x100=87 %

2= Meets optimal criteria
1= Meets marginal criteria
0= Does not meet criteria.

TABLE OUTMIGRATION 4. No Action / State Permit/ Mechanical Restoration temperature evaluations for outmigrating smolts for median hydrological and meteorological conditions with minimum average Lewiston Dam release temperatures. Temperature criteria are based on a literature review by Zedonis and Newcomb (1997).

		Criteria (F)	Alternatives		
Month	Week	optimal/marg.	STATE PERMIT	NO ACTION	MECH REST
			140 TAF	340 TAF	340 TAF
Apr	22	55.4 / 59	2	2	2
	29	55.4 / 59	1	1	1
May	6	55.4 / 59	1	1	1
	13	55.4 / 59	1	1	1
	20	55.4 / 59	0	1	1
	27	59 / 62.8	1	1	1
Jun	3	59 / 62.8	0	1	1
	10	62.8 / 68	1	1	1
	17	62.8 / 68	1	1	1
	24	62.8 / 68	1	1	1
July	1	62.8 / 68	0	0	0
	8	62.8 / 68	0	0	0
Overall Totals	Total # of weeks		Total number of weeks criteria is met		
		Criteria	STATE PERMIT	NO ACTION	MECH REST
	12	optimal	1	1	1
	12	marginal	8	10	10

STATE PERMIT

Schedule meets **optimal** criteria =1/12 x100= 8%

Schedule meets marginal criteria = 8/12 x100= 67%

NO ACTION and MECH RESTORATION

Schedule meets **optimal** criteria =1/12 x100= 8%

Schedule meets marginal criteria =10/12 x100= 83%

2= Meets optimal criteria
1= Meets marginal criteria
0= Does not meet criteria.

TABLE STATE OBJECTIVES 1. Trinity River Flow Evaluation temperature criteria evaluation for outmigrating smolts. Temperature criteria are based on empirical data that indicates a dam release of 450 cfs will meet the state board objectives under most hydrological and meteorological conditions and dam release temperatures. Percent time that the objective is met is based on the average number of weeks criteria is met, weighted by the probability of each water year type occurring.

Month	Week	Criteria (cfs)	Trinity River Flow Alternative XWET	WET	NORM	DRY	C. DRY
		p=	.12	.28	.20	.28	.12
July	1	450	2	2	2	2	2
	8	450	2	2	2	2	2
	15	450	2	2	2	2	2
	22	450	2	2	2	2	2
	29	450	2	2	2	2	2
Aug	5	450	2	2	2	2	2
	12	450	2	2	2	2	2
	19	450	2	2	2	2	2
	26	450	2	2	2	2	2
Sept	2	450	2	2	2	2	2
	9	450	2	2	2	2	2
	16	450	2	2	2	2	2
	23	450	2	2	2	2	2
Oct	1	450	2	2	2	2	2
	9	450	2	2	2	2	2
Overall Totals	Total # of weeks		Total number of weeks criteria is met				
		Criteria	XWET	WET	NORM	DRY	C. DRY
		300 cfs	15	15	15	15	15
	15	450 cfs	15	15	15	15	15

Schedule meets marginal and **optimal** criteria for all 15 weeks examined (100% of the time).

0=[< 300 cfs]
1= [> or = 300 cfs]
2= [> or = 450 cfs]

TABLE STATE OBJECTIVES 2. Maximum Flow temperature evaluation for outmigrating smolts. Temperature criteria are based on empirical data that indicates a dam release of 450 cfs will meet the state board objectives under most hydrological and meteorological conditions and dam release temperatures. Percent time that the objective is met is based on the average number of weeks criteria is met, weighted by the probability of each water year type occurring.

		Criteria	MAX Flow Alternative				
Month	Week	(cfs)	XWET	WET	NORM	DRY	C. DRY
			2146 TAF	1505 TAF	1203 TAF	886 TAF	462 TAF
July	1	450	2	2	2	2	2
	8	450	2	2	2	2	2
	15	450	2	2	2	2	2
	22	450	2	2	2	2	2
	29	450	2	2	2	2	2
Aug	5	450	2	2	2	2	2
	12	450	2	2	2	2	2
	19	450	2	2	2	2	2
	26	450	2	2	2	2	2
Sept	2	450	2	2	2	2	2
	9	450	1	2	1	1	1
	16	450	1	1	1	1	1
	23	450	1	1	1	1	1
Oct	1	450	1	1	1	1	1
	9	450	1	1	1	1	1
Overall Totals	Total # of weeks		Total number of weeks criteria is met				
		Criteria	XWET	WET	NORM	DRY	C. DRY
		300 cfs	15	15	15	15	15
	15	450 cfs	10	11	10	10	10

Schedule meets **optimal** criteria (based on weighted average) =

[(10x.12)+ (11x.28)+(10x .20)+(10x.28)+(10x.12)]/15 x100= 68.5%

Schedule meets marginal criteria for all 15 weeks examined (100%).

0=[< 300 cfs]
1= [> or = 300 cfs]
2= [> or = 450 cfs]

TABLE STATE OBJECTIVES 3. 40% Inflow Alternative temperature evaluation for outmigrating smolts. Temperature criteria are based on empirical data that indicates a dam release of 450 cfs will meet the state board objectives under most hydrological and meteorological conditions and dam release temperatures. Percent time that the objective is met is based on the average number of weeks criteria is met, weighted by the probability of each water year type occurring.

		Criteria	40% INFLOW Alternative				
Month	Week	(cfs)	XWET	WET	NORM	DRY	C. DRY
			978 TAF	655 TAF	443 TAF	325 TAF	165 TAF
July	1	450	2	2	0	0	0
	8	450	2	1	0	0	0
	15	450	2	1	0	0	0
	22	450	2	0	0	0	0
	29	450	1	0	0	0	0
Aug	5	450	1	0	0	0	0
	12	450	0	0	0	0	0
	19	450	0	0	0	0	0
	26	450	0	0	0	0	0
Sept	2	450	0	0	0	0	0
	9	450	0	0	0	0	0
	16	450	0	0	0	0	0
	23	450	0	0	0	0	0
Oct	1	450	0	0	0	0	0
	9	450	0	0	0	0	0
Overall Totals	Total # of weeks		Total number of weeks criteria is met				
		Criteria	XWET	WET	NORM	DRY	C. DRY
		300 cfs	6	3	0	0	0
	15	450 cfs	4	1	0	0	0

Schedule meets **optimal** criteria (based on weighted average) =

[(4x.12)+ (1x.28)+(0x .20)+(0x.28)+(0x.12)]/15 x100= 5%

Schedule meets marginal criteria (based on weighted average) =

[(6x.12)+ (3x.28)+(0x .20)+(0x.28)+(0x.12)]/15 x100= 10%

0=[< 300 cfs]

1= [> or = 300 cfs]

2= [> or = 450 cfs]

TABLE STATE OBJECTIVES 4. No Action / State Permit/ Mechanical Restoration temperature evaluations for outmigrating smolts. Temperature criteria are based on empirical data that indicates a dam release of 450 cfs will meet the state board objectives under most hydrological and meteorological conditions and dam release temperatures.

Month	Week	Criteria (cfs)	STATE PERM	NO ACTION	MECH REST.
			140 TAF	340 TAF	340 TAF
July	1	450	0	2	2
	8	450	0	2	2
	15	450	0	2	2
	22	450	0	2	2
	29	450	0	2	2
Aug	5	450	0	2	2
	12	450	0	2	2
	19	450	0	2	2
	26	450	0	2	2
Sept	2	450	0	2	2
	9	450	0	2	2
	16	450	0	2	2
	23	450	0	2	2
Oct	1	450	0	2	2
	9	450	0	2	2
Overall Totals	Total # of weeks		Total number of weeks criteria is met		
		Criteria	STATE PERM	NO ACTION	MECH REST.
		300 cfs	0	15	15
	15	450 cfs	0	15	15

STATE PERMIT
Schedule does not meet **optimal** or marginal criteria for any week examined (0%).

NO ACTION and MECHANICAL RESTORATION
Schedule meets **optimal** and marginal criteria in all weeks examined (100%).

0=[< 300 cfs]
1= [> or = 300 cfs]
2= [> or = 450 cfs]

ATTACHMENT B5

WEEKLY FLOW SCHEDULES FOR EACH PROJECT ALTERNATIVE

No-Action Alternative

Week Beginning	Week	All Year Types
01-Oct	1	450
08-Oct	2	450
15-Oct	3	328
22-Oct	4	300
29-Oct	5	300
05-Nov	6	300
12-Nov	7	300
19-Nov	8	300
26-Nov	9	300
3-Dec	10	300
10-Dec	11	300
17-Dec	12	300
24-Dec	13	300
31-Dec	14	300
7-Jan	15	300
14-Jan	16	300
21-Jan	17	300
28-Jan	18	300
4-Feb	19	300
11-Feb	20	300
18-Feb	21	300
25-Feb	22	300
4-Mar	23	300
11-Mar	24	300
18-Mar	25	300

May 28. 1997 PNE newnoact.wpd
Printed May 29. 1997

No-Action Alternative

25-Mar	26	300
1-Apr	27	300
8-Apr	28	300
15-Apr	29	300
22-Apr	30	300
29-Apr	31	300
6-May	32	1714
13-May	33	2000
20-May	34	1700
27-May	35	1086
3-Jun	36	1000
10-Jun	37	628
17-Jun	38	450
24-Jun	39	450
1-Jul	40	450
8-Jul	41	450
15-Jul	42	450
22-Jul	43	450
29-Jul	44	450
5-Aug	45	450
12-Aug	46	450
19-Aug	47	450
26-Aug	48	450
2-Sep	49	450
9-Sep	50	450
16-Sep	51	450
23-Sep	52	450

May 28, 1997 PNE newnoact.wpd
Printed May 29, 1997

Go To TOC

No-Action Alternative

Annual A-F		340.249

May 28. 1997 PNE newnoact.wpd
Printed May 29. 1997

Go To TOC

State Permit Alternative

Week Beginning	Week	All Year Types
01-Oct	1	200
08-Oct	2	200
15-Oct	3	200
22-Oct	4	200
29-Oct	5	200
05-Nov	6	250
12-Nov	7	250
19-Nov	8	250
26-Nov	9	250
3-Dec	10	200
10-Dec	11	200
17-Dec	12	200
24-Dec	13	200
31-Dec	14	200
7-Jan	15	150
14-Jan	16	150
21-Jan	17	150
28-Jan	18	150
4-Feb	19	150
11-Feb	20	150
18-Feb	21	150
25-Feb	22	150
4-Mar	23	150
11-Mar	24	150
18-Mar	25	150
25-Mar	26	150

3/01/96 PNE stateper.wpd
Printed April 17, 1997

Go To TOC

1-Apr	27	150
8-Apr	28	150
15-Apr	29	150
22-Apr	30	150
29-Apr	31	150
6-May	32	150
13-May	33	150
20-May	34	150
27-May	35	150
3-Jun	36	150
10-Jun	37	150
17-Jun	38	150
24-Jun	39	150
1-Jul	40	150
8-Jul	41	150
15-Jul	42	150
22-Jul	43	150
29-Jul	44	150
5-Aug	45	150
12-Aug	46	150
19-Aug	47	150
26-Aug	48	150
2-Sep	49	150
9-Sep	50	150
16-Sep	51	150
23-Sep	52	150
Annual A-F		120.756

Go To TOC

Percent Inflow Alternative

Week Beginning	Week	<=12% Extremely Wet	12<=40 Wet	40<=60 Normal	60<=88 Dry	>88% Critically Dry
01-Oct	1	111	82	70	54	61
08-Oct	2	111	75	77	69	88
15-Oct	3	271	200	82	86	75
22-Oct	4	177	126	129	78	70
29-Oct	5	429	149	93	158	65
05-Nov	6	266	366	134	122	116
12-Nov	7	982	289	194	169	127
19-Nov	8	1845	375	291	312	122
26-Nov	9	1055	590	275	230	99
3-Dec	10	937	726	284	232	111
10-Dec	11	593	868	263	383	171
17-Dec	12	1410	900	227	358	187
24-Dec	13	1661	1595	324	268	118
31-Dec	14	1238	1019	311	241	125
7-Jan	15	826	820	313	256	142
14-Jan	16	1064	859	770	273	149
21-Jan	17	3123	1307	634	271	140
28-Jan	18	1421	1345	558	384	169
4-Feb	19	1231	1316	635	314	212
11-Feb	20	1666	1454	835	519	408
18-Feb	21	1872	1469	738	617	246
25-Feb	22	2132	1349	1110	513	245
4-Mar	23	2456	1401	1120	565	210
11-Mar	24	1788	1156	1311	763	381
18-Mar	25	1660	1038	1296	792	429

3/01/96 PNE 40inflow.wpd
printed April 17, 1997

Go To TOC

25-Mar	26	1582	1018	1156	770	567
1-Apr	27	2087	1429	1306	880	491
8-Apr	28	1982	1393	1406	1085	565
15-Apr	29	1788	1635	1563	1235	542
22-Apr	30	1949	1873	1740	1282	518
29-Apr	31	2202	2068	1551	1266	578
6-May	32	2613	1994	1569	1306	696
13-May	33	2968	2287	1613	1234	608
20-May	34	3164	2476	1555	1198	562
27-May	35	3745	2335	1241	1051	574
3-Jun	36	3394	1813	1200	969	392
10-Jun	37	2805	1414	1041	723	303
17-Jun	38	2257	1088	745	573	267
24-Jun	39	1751	857	488	416	273
1-Jul	40	1400	593	342	285	146
8-Jul	41	1116	430	248	202	99
15-Jul	42	818	313	189	150	73
22-Jul	43	579	237	147	118	61
29-Jul	44	443	181	115	93	51
5-Aug	45	312	145	96	83	42
12-Aug	46	233	118	84	72	38
19-Aug	47	187	102	75	65	34
26-Aug	48	172	93	70	58	33
2-Sep	49	148	97	64	55	33
9-Sep	50	150	84	58	52	30
16-Sep	51	168	81	55	50	29
23-Sep	52	116	92	73	50	50
Annual A-F		978,464	655,495	443,419	324,587	165,161

Go To TOC

Maximum Flow Alternative

Week Beginning	Week	<=12% Extremely Wet	12<=40 Wet	40<=60 Normal	60<=88 Dry	>88% 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
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	3000	300	300	300	300
7-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
4-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
4-Mar	23	3000	3000	3000	2000	300
11-Mar	24	3000	3000	3000	2000	300
18-Mar	25	3000	3000	3000	2000	300

Go To TOC

25-Mar	26	3000	3000	3000	2000	300
1-Apr	27	3000	3000	3000	2000	300
8-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
6-May	32	10,205	6155	5429	2500	300
13-May	33	11,643	6786	4000	2300	1250
20-May	34	27,857	6429	2714	2100	2000
27-May	35	7929	4286	2300	2000	2000
3-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
1-Jul	40	2000	2000	2000	2000	900
8-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
5-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
2-Sep	49	450	650	650	700	900
9-Sep	50	300	650	650	700	900
16-Sep	51	300	300	300	300	300
23-Sep	52	300	300	300	300	300
Annual A-F		2,146,441	1,505,390	1,203,159	886,347	462,231

Go To TOC

Flow Study Alternative

Week Beginning	Week	<=12% Extremely Wet[a]	12<=40 Wet[b]	40<=60 Normal[c]	60<=88 Dry[d]	>88% Critically Dry[e]
01-Oct	1	450	450	450	450	450
08-Oct	2	450	450	450	450	450
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
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

Go To TOC

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	557	1243
29-Apr	31	300	300	1029	4071	1500
6-May	32	300	400	5683	3788	1500
13-May	33	643	5786	5006	2783	1500
20-May	34	7786	7803	3870	2045	1500
27-May	35	10014	5888	2992	1503	1445
3-Jun	36	7669	4413	2486	1104	1104
10-Jun	37	5778	3308	2362	811	811
17-Jun	38	4353	2480	2237	596	596
24-Jun	39	3280	2113	2113	461	461
1-Jul	40	2471	1989	1989	450	450
8-Jul	41	1542	1517	1517	450	450
15-Jul	42	696	696	696	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
Annual A-F		815.000	701.000	636.000	453.000	369.000

Go To TOC

ATTACHMENT B6

METHODS USED TO DEVELOP HARVEST-ESCAPEMENT RATIOS FOR TRINITY RIVER EIS

Harvest-Escapement Ratio
Trinity River EIS

The assessment methodology used by the Fish and Channel Restoration Team (FCRT) to evaluate the alternatives for the Trinity River EIS provides estimates of spawning escapement for each salmonid species. While this methodology addresses the extent to which each alternative will restore freshwater habitat and the subsequent gains or losses in spawning escapement levels, the need to assess economic effects on harvest necessitated development of a methodology to estimate allowable harvest levels for each alternative. To assess the potential harvest of naturally produced anadromous salmonids from the Trinity River, harvest to escapement ratios ($H\text{-}E_{sp}$) to convert the potential escapement of chinook salmon (spring and fall combined), coho salmon, and steelhead into potential harvest were developed.

Methods

Two methods were used to develop harvest factors. For chinook salmon, the long-term equilibrium harvest rate model (HRM-EQ) used for the management of Klamath Basin fall chinook by the Klamath River Technical Advisory Team was used. Harvest factors specific to the chinook fisheries (ocean and inriver) that impact this stock and maturity rates specific to Trinity River chinook were used in the model (Table 1). Harvest rate combinations for ocean and inriver fisheries that maximized harvest and met harvest sharing agreements (described below) were selected and the harvest to escapement ratio for chinook ($H\text{-}E_{chin}$) was calculated by dividing equilibrium total harvest level (ocean and inriver fisheries) by the equilibrium spawning escapement level (Equation 1).

$$HE_{chin} = \frac{Harvest_{chin}}{Spawning\ Escapement_{chin}} \qquad \text{Equation 1}$$

The HRM-EQ uses a Ricker stock-recruit function to estimate recruitment. The alpha and beta factors in the function were set at values specific for the Trinity River. Alpha for age 3 recruits (A3R) in the ocean prior to ocean fisheries being executed was set at 5.8. This value was based on a value of 14 for age 2 recruits (A2R) for Klamath Basin (including Trinity), an age 2 maturity rate (MR_2) of 0.17, and an overwinter survival rate (S_2) of 0.50 from age 2 to 3 (Equation 2 and 3) (KRTAT 1986).

$$A3R = A2R * (S_2) * (1 - MR_2) \qquad \text{Equation 2}$$

$$A3R = 14.0 * (0.50) * (1 - 0.17) = 5.8 \qquad \text{Equation 3}$$

For coho salmon and steelhead, harvest to escapement ratios ($H\text{-}E_{coho}$ and $H\text{-}E_{sth}$, respectively) were derived by algebraically manipulating harvest equations and using harvest rate information pertinent to the individual species (Table 2). This different analysis for coho salmon and steelhead was necessary because of the lack of sufficient data to construct a model similar to the HRM-EQ. Since the majority of coho salmon mature at age 3, it was assumed that for this species all fish matured at age 3 and the differential impacts of ocean fisheries on immature fish (such at those that occur with chinook) were avoided. The steelhead H-E factor only applies to the inriver sport fishery. No attempt was made to estimate harvest for the inriver tribal fishery due to the lack of steelhead harvest data by this fishery and because these numbers would not be used in the economic analysis. Ocean harvest of steelhead was assumed to be insignificant.

To allocate the fishery resources among the various user groups current harvest sharing regulations and agreements were used. Chinook and coho salmon harvest were equally allocated between tribal and non-tribal fisheries (50/50 sharing) and the non-tribal share was allocated among the ocean commercial and sport fisheries (85% of the non-tribal share) and to the inriver sport fishery (15% of the non-tribal share).

Results

Chinook Salmon.

Output generated by the HRM-EQ, indicated that ocean and terminal (inriver) harvest rates of 0.26 and 0.77, respectively, achieved maximum equilibrium harvest, harvest sharing among various harvest groups, and approximately the chinook escapement goal of the Trinity River Fish and Wildlife Restoration Program (Tables 3A, 3B, 3C, and 3D).

Based on these data, the harvest to escapement factor for chinook salmon was:

$$H\text{-}E_{chin} = 123{,}260 / 67{,}040 = 1.84$$

Coho Salmon.

To calculate the $H\text{-}E_{coho}$ factor, the total allowable harvest rate of 67% was used based on the Oregon Department of Fish and Wildlife's coho salmon harvest management plan (1982). This harvest rate was used because it was believed that healthy coho stocks could sustain this level of harvest. Based on this harvest rate level and Equation 5 of Table 2, the harvest to escapement factor for coho salmon was:

$$H\text{-}E_{coho} = 0.67 / (1\text{-}.067) = 2.03$$

Go To TOC

Steelhead (for inriver sport fishery ONLY)

An estimate of steelhead harvest rate was obtained from CDFG escapement and harvest estimates for the Trinity River above Willow Creek (Table 4). To account for harvest below Willow Creek and on the Klamath River, the harvest above Willow Creek was expanded by the proportion of the length of river that this estimate represented to produce a total harvest estimate for Trinity natural steelhead in the Klamath and Trinity rivers. Based on an estimated inriver harvest rate of 0.243 and Equation 5 of Table 2, the harvest to escapement factor for steelhead was:

$$(H\text{-}E_{sth}) = (0.243)/(1-0.243) = 0.321$$

Go To TOC

Table 1. Age specific harvest factors and maturity rates used in the equilibrium harvest rate model (KRTAT 1986).

Age	3	4	5
Offshore Contact Rate	0.88	1.00	1.00
% Legal	0.80	1.00	1.00
Shaker Mortality	0.25	0.25	0.25
Maturity Rate	0.637	0.847	1.00
Terminal Contact Rate	0.59	1.00	1.00
Terminal Dropoff Rate	0.067	0.067	0.067
Overwinter Survival Rate	0.80	0.80	0.80

Table 2. Derivation of Equation Used to Determine the Coho Salmon and Steelhead Harvest to Escapement Factor. (HR = Harvest Rate, Harv = Harvest, Popn = Total Population Size, Esc = Spawning Escapement)

1.	HR	=	Harv / Popn
	HR	=	Harv / (Harv + Esc)
2.	1/HR	=	(Harv + Esc)/ Harv
		=	1 + (Esc/Harv)
3.	Esc/Harv	=	1/HR - 1
		=	1/HR - HR/HR
		=	(1-HR)/HR
4.	Harv/Esc	=	HR/(1-HR)
5.	Harv	=	Esc*(HR)/(1-HR)

Table 3A. Equilibrium spawning escapement levels of age 3-5 chinook for varying ocean and inriver fishery harvest rates (Bolded/underlined numbers are maximum harvest for ocean and inriver harvest rate combination).

Ocean Harvest Rate	Terminal Harvest Rate														
	0.700	0.710	0.720	0.730	0.740	0.750	0.760	0.770	0.780	0.790	0.800	0.810	0.820	0.830	0.840
0.200 :	85090	83592	82074	80534	78972	77388	75781	74150	72494	70813	69105	67371	**65609**	63818	61998
0.210 :	83892	82399	80885	79350	77793	76214	74612	72986	71336	69661	67960	**66231**	64476	62692	60878
0.220 :	82686	81197	79688	78158	76606	75032	73435	71815	70170	68501	**66805**	65083	63334	61556	59749
0.230 :	81471	79987	78482	76957	75410	73841	72250	70635	68996	**67332**	65642	63926	62183	60412	58612
0.240 :	80247	78767	77267	75747	74205	72641	71055	69445	67812	66154	64470	62761	61024	59259	57466
0.250 :	79013	77539	76044	74528	72991	71432	69851	68247	**66619**	64967	63289	61586	59855	58097	56311
0.260 :	77771	76301	74810	73300	71768	70214	68639	**67040**	65418	63771	62099	60402	58678	56926	55146
0.270 :	76519	75054	73568	72062	70535	68987	**67416**	65823	64207	62566	60900	59209	57491	55746	53973
0.280 :	75258	73797	72316	70815	69293	**67750**	66185	64597	62986	61351	59691	58006	56295	54556	52790
0.290 :	73987	72530	71054	69558	**68041**	66503	64943	63361	61756	60126	58473	56794	55088	53357	51597
0.300 :	72706	71254	69783	**68291**	66780	65247	63692	62115	60515	58892	57244	55571	53873	52147	50394
0.310 :	71415	69967	68501	67014	65508	63980	62431	60859	59265	57647	56006	54339	52646	50928	49181
0.320 :	70113	68670	**67209**	65727	64225	62703	61159	59593	58005	56393	54757	53096	51410	49698	47958
0.330 :	68801	**67363**	65906	64429	62933	61415	59877	58316	56733	55127	53498	51843	50163	48458	46725
0.340 :	**67478**	66045	64593	63121	61629	60117	58584	57029	55452	53851	52228	50579	48906	47207	45481

Table 3B. Equilibrium total (ocean and inriver) harvest levels of age 3-5 chinook for varying ocean and inriver fishery harvest rates (Bolded/underlined numbers are maximum harvest for ocean and inriver harvest rate combination).

Ocean Harvest Rate	Terminal Harvest Rate														
	0.700	0.710	0.720	0.730	0.740	0.750	0.760	0.770	0.780	0.790	0.800	0.810	0.820	0.830	0.840
0.200 :	119605	120183	120707	121174	121579	121919	122187	122380	122490	122513	122440	122266	**121983**	121581	121052
0.210 :	120260	120787	121260	121673	122024	122306	122516	122648	122695	122653	122514	**122270**	121915	121439	120833
0.220 :	120878	121354	121773	122132	122426	122650	122800	122870	122853	122745	**122537**	122223	121794	121243	120559
0.230 :	121456	121879	122245	122548	122784	122949	123038	123044	122962	**122786**	122508	122122	121619	120991	120227
0.240 :	121993	122363	122673	122919	123097	123201	123227	123168	123020	122775	122426	121966	121387	120680	119836
0.250 :	122487	122802	123056	123244	123361	123404	123366	123241	**123025**	122709	122288	121753	121096	120309	119382
0.260 :	122936	123195	123391	123520	123576	123555	123452	**123260**	122974	122586	122091	121480	120744	119875	118863
0.270 :	123339	123541	123678	123745	123739	123653	**123483**	123222	122865	122405	121833	121144	120327	119375	118277
0.280 :	123692	123836	123912	123918	123847	**123696**	123457	123126	122696	122161	121512	120743	119844	118807	117621
0.290 :	123994	124078	124093	124035	**123899**	123680	123372	122969	122465	121853	121125	120275	119292	118167	116892
0.300 :	124243	124266	124218	**124095**	123892	123603	123224	122748	122168	121478	120670	119736	118667	117454	116087
0.310 :	124436	124396	124284	124094	123823	123463	123011	122460	121803	121033	120142	119123	117967	116663	115202
0.320 :	124571	124467	**124288**	124031	123689	123258	122731	122103	121367	120515	119540	118434	117188	115792	114236
0.330 :	124644	**124474**	124228	123901	123488	122983	122380	121673	120856	119921	118860	117665	116327	114837	113183
0.340 :	**124654**	124417	124101	123703	123216	122635	121955	121168	120268	119247	118099	116813	115382	113795	112041

Table 3C. Equilibrium inriver harvest levels of age 3-5 chinook for varying ocean and inriver fishery harvest rates (Bolded/underlined numbers are maximum harvest for ocean and inriver harvest rate combination).

Ocean Harvest Rate	Terminal Harvest Rate 0.700	0.710	0.720	0.730	0.740	0.750	0.760	0.770	0.780	0.790	0.800	0.810	0.820	0.830	0.840
0.200 :	75232	75992	76715	77399	78039	78632	79175	79664	80094	80462	80761	80986	**81132**	81193	81160
0.210 :	73949	74678	75370	76021	76628	77188	77698	78153	78548	78880	79144	**79333**	79443	79466	79397
0.220 :	72664	73362	74022	74641	75216	75743	76219	76640	77001	77299	**77527**	77680	77753	77740	77633
0.230 :	71377	72045	72673	73260	73803	74297	74740	75127	75453	**75716**	75908	76026	76063	76013	75869
0.240 :	70089	70726	71323	71878	72388	72850	73259	73612	73904	74132	74289	74371	74372	74286	74105
0.250 :	68799	69405	69971	70494	70972	71401	71777	72096	**72354**	72547	72669	72715	72680	72557	72340
0.260 :	67508	68083	68617	69109	69555	69950	70293	**70579**	70803	70961	71048	71059	70988	70829	70575
0.270 :	66215	66759	67262	67722	68135	68499	**68808**	69060	69250	69374	69426	69401	69295	69099	68809
0.280 :	64919	65433	65905	66333	66714	**67045**	67322	67540	67696	67785	67802	67743	67600	67369	67042
0.290 :	63622	64105	64546	64943	**65292**	65590	65833	66018	66140	66195	66178	66083	65905	65638	65275
0.300 :	62323	62775	63185	**63550**	63867	64133	64344	64495	64583	64604	64552	64422	64209	63906	63507
0.310 :	61022	61444	61823	62156	62441	62674	62852	62970	63025	63011	62925	62760	62511	62173	61738
0.320 :	59719	60110	**60458**	60760	61013	61214	61359	61444	61465	61417	61296	61096	60813	60439	59968
0.330 :	58414	**58774**	59091	59362	59583	59751	59864	59915	59903	59821	59666	59431	59113	58703	58196
0.340 :	**57106**	57436	57722	57961	58151	58287	58366	58385	58339	58224	58034	57765	57411	56966	56424

Table 3D. Equilibrium ocean harvest levels of age 3-5 chinook for varying ocean and inriver fishery harvest rates (Bolded/underlined numbers are maximum harvest for ocean and inriver harvest rate combination).

Ocean Harvest Rate	Terminal Harvest Rate: 0.700	0.710	0.720	0.730	0.740	0.750	0.760	0.770	0.780	0.790	0.800	0.810	0.820	0.830	0.840
0.200 :	44373	44190	43991	43775	43541	43287	43012	42716	42396	42051	41680	41280	**40850**	40388	39892
0.210 :	46312	46110	45890	45653	45396	45118	44818	44495	44147	43772	43370	**42937**	42472	41972	41436
0.220 :	48214	47992	47751	47491	47210	46907	46580	46229	45852	45446	**45010**	44543	44041	43503	42926
0.230 :	50078	49835	49571	49287	48981	48652	48298	47917	47509	**47070**	46600	46096	45556	44978	44358
0.240 :	51903	51637	51350	51041	50708	50351	49968	49557	49116	48643	48137	47595	47015	46395	45731
0.250 :	53687	53397	53085	52749	52389	52003	51589	51145	**50670**	50162	49619	49037	48416	47752	47042
0.260 :	55428	55113	54774	54411	54022	53605	53159	**52681**	52171	51626	51043	50421	49756	49046	48289
0.270 :	57124	56782	56416	56023	55604	55155	**54675**	54162	53615	53031	52408	51742	51033	50276	49468
0.280 :	58773	58403	58008	57585	57133	**56651**	56136	55586	55000	54376	53710	53000	52244	51438	50579
0.290 :	60372	59973	59547	59092	**58607**	58090	57538	56951	56324	55658	54947	54191	53386	52529	51617
0.300 :	61920	61491	61033	**60544**	60024	59470	58880	58253	57585	56874	56118	55313	54458	53548	52580
0.310 :	63414	62953	62461	61938	61381	60789	60159	59490	58778	58021	57217	56363	55455	54490	53465
0.320 :	64852	64357	**63830**	63271	62676	62044	61372	60659	59902	59098	58244	57338	56375	55353	54268
0.330 :	66231	**65701**	65138	64540	63905	63231	62516	61758	60953	60100	59194	58234	57215	56134	54987
0.340 :	**67548**	66981	66380	65742	65066	64348	63588	62783	61929	61024	60065	59048	57971	56829	55618

Table 4. Estimates of fall-run steelhead run size, harvest, and harvest rate (HR) above Willow Creek (WC) on the Trinity River and estimated total run size and harvest of Trinity River steelhead harvest in the Trinity and lower Klamath River.[1]

Year	Run Size above WC	Harvest above WC	HR above WC	Total Run Size	Total Harvest	Total HR
1978						
1979						
1980	25,094	3,562	0.142	27,928	6,396	0.229
1981						
1982	10,532	1,959	0.186	12,091	3,518	0.291
1983	8,605	1,345	0.156	9,675	2,415	0.250
1984	7,833	1,261	0.161	8,836	2,264	0.256
1985						
1986						
1987						
1988						
1989	37,276	3,578	0.096	40,123	6,425	0.160
1990	5,348	1,230	0.230	6,327	2,209	0.349
1991	11,417	2,340	0.205	13,279	4,202	0.316
1992	3,046	292	0.096	3,278	524	0.160
1993	3,243	381	0.117	3,546	684	0.193
1994	4,244	545	0.128	4,678	979	0.209
1995	4,288	708	0.165	4,851	1,271	0.262
Average			0.153			0.243

River Mileage			River Miles	% Total		
	Lewiston to Willow Creek		86.1	55.7		
	Willow Creek to Weitchpec		25.0	16.2		
	Weitchpec to mouth of Klamath		43.5	28.1		
	Total		154.6			

[1] Run size, harvest and harvest rate adjusted for harvest of Trinity steelhead in the lower Klamath River.
Harvest Rate = Harvest/Run Size
Adjusted Harvest = Harvest/0.557
Adjusted Run Size = Run Size – Harvest + Adjusted Harvest

ATTACHMENT B7

ALTERNATIVE ANALYSES CONSIDERED FOR THE HARVEST MANAGEMENT ALTERNATIVE

To: Joe Pollos
U.S. Fish and Wildlife Service
From: Michael Orcutt, Co-lead
Hoopa Valley Tribe Fisheries Department
CC:
Date: March 14, 1997
Re: Trinity River EIS - Harvest Management Alternative

The Hoopa Valley Tribe has been asked to evaluate harvest management as an option for restoring natural populations of anadromous fish in the Trinity River basin. The following are our scientific and legal analyses which conclude that it is not appropriate for the EIS to fully consider the harvest management alternative. Instead it should be treated similarly to the proposed removal of the Trinity Dam.

BIOLOGICAL ANALYSIS

The purpose and need for restoration options explored as part of the Trinity River EIS are "...to restore and maintain natural **production** of anadromous fish populations of the Trinity River mainstem downstream of the Lewiston Dam. This action is needed to restore and maintain the fish **populations** towards levels approximating those which existed prior to construction of the Central Valley Project Trinity River Diversion."

The key phrases in the EIS statement of purpose are "..restore and maintain natural **production**.." and "..maintain the fish **populations**..". Although not stated explicitly, it must be assumed that the term "population" refers to numbers of individuals in the larval, juvenile, or adult life history stages of a genetically or reproductively distinct group of fish. "Production" in salmonids is typically measured at a life history stage as the number of individuals surviving to that stage relative to the initial number of gametes deposited in the streambed by spawning adults.

Major efforts have been expended to understand the many factors that affect the productivity and abundance of natural fish populations and the literature on the topic is exhaustive. Productivity of anadromous salmon populations is a function of the initial number of gametes deposited in a stream relative to the quantity and quality of freshwater and marine rearing habitat. Habitat in this context includes the entire spectrum of physical and biological factors which affect fish survival. Changes in the productivity of fish populations where the availability of suitable freshwater and marine habitat is relatively stable are often strongly correlated to changes in spawner abundance (i.e. initial number of gametes deposited). Conversely, when the quantity or quality of freshwater or marine habitat is highly variable or in decline, spawner abundance is typically not the major factor which limits the productivity of a salmon population and efforts to restore productivity which are predicated on achieving some average long term spawning escapement goal are doomed to fail [1]. There is ample evidence that the later case applies to the Trinity River. Consequently, a restoration option for Trinity River salmon populations which is predicated on achieving spawning escapement goals through harvest management will not succeed and is unreasonable to pursue.

Biologically the harvest management option for restoring Trinity River salmon productivity has two major flaws. First, it assumes that mature adult salmon which escape into the Trinity River to spawn have access to a quantity and quality of habitat that was available prior to the Central Valley Project Trinity River Division. Second, it implies that the declines in the productivity of anadromous fish populations in the Trinity River are attributable to inadequate spawning escapements that result from over-fishing. Neither the assumption nor the implication are supported by biological, limnological, or hydrologic data.

It is implicit in the purpose and need statement that habitat changes related to the implementation of the Trinity River Division of the Central Valley Project have resulted in diminished production of natural anadromous fish populations in the Trinity River. There is ample evidence to support this contention. Indeed, in addition to poor marine survival, Pacific Fishery Management Council (PFMC) has identified low mainstem flows, degradation of spawning and rearing habitat, and competitive interactions with hatchery populations as the most probable causes for variations and declines in natural populations of Trinity River chinook salmon[2]. Similarly, draft status review documents prepared by National Marine Fisheries Service under the Federal Endangered Species Act identify variations in marine survival, habitat loss, and interactions with hatchery populations as principal causes for the decline in natural anadromous Pacific salmonid populations [3]. Finally, an evaluation study commissioned by the Hoopa Tribe identified habitat loss associated with stream flow, and marine zooplankton abundance as major factors contributing to the survival of fish released from the Trinity River Hatchery[4].

---

[1] Lawson, Peter W., 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries, Vol. 18, No. 5.

[2] Klamath River Fall Chinook Review Team Report, 1994.

[3] National Marine Fisheries Service, Biological Review Teams for Chinook Salmon, Coho Salmon, and Steelhead,1996

[4] Terraqua Environmental Consulting. 1996. A comparative study of factors affecting the production of Trinity River Hatchery fall chinook salmon. Draft report prepared for the Hoopa Valley Tribal Council.

While there is ample evidence to support the contention that habitat loss has been a major factor contributing to the decline of anadromous fish populations in the Trinity River, there is no evidence that escapement shortfalls are a contributing factor. Furthermore, although escapement goals have frequently not been met, there is no evidence that changes in harvest management strategies could significantly alter that outcome. Available data for healthy salmon chinook salmon populations elsewhere along the Pacific coast suggest that they have successfully withstood long term exploitation rates in the 60% to 80% range[5]. In contrast, the exploitation rate for Trinity River chinook salmon has averaged 60% over the long term and less than 40% in the last 5 years. Despite these relatively low exploitation rates, our analysis of available brood data from 1984 through 1995 indicates that desired escapement levels were achieved in only three years during that 12 year period (Attachment I). Production from the basin was low even for brood years when escapement goals were met. Furthermore, escapement objectives would have been achieved in only two additional years even if exploitation rates had been reduced to zero in all 12 years. It is evident that declining production in the Trinity River is not attributable to escapement shortfalls and that declines in productivity in the system preclude achieving escapement goals in almost all years even in the total absence of harvest.

Although production can theoretically be measured at any life history stage, the number of spawning adults required to produce subsequent returns of mature adult fish (spawner/recruit relationship) is a the most practical and common measure of production in salmon populations[6]. To develop this measure of production the initial number of spawning adults in a brood year and the number of individuals that survive to the mature adult stage from gametes deposited by brood year spawners must be known. The measure of numbers surviving to the mature adult stage is the sum of mature adults from the brood year that occur in harvests and escapements.

Spawner/recruit relationships are well documented and extensively modeled for many anadromous fish populations but not for natural populations of salmon and steelhead in the Trinity River. While escapements to natural spawning areas can be estimated for the Klamath and Trinity basins, Trinity River natural returns cannot be distinguished from Klamath River natural returns in ocean and in-river harvests. Consequently, although estimates of total returns of mature adults for natural anadromous fish populations are possible for the combined Klamath/Trinity basins, they are not possible for the Trinity basin alone. Even if accurate estimates of total adult returns and production were possible for the Trinity River basin, it is unlikely that any reliable spawner/recruit relationship could be made to assess the success of restoration efforts until large variations in fish abundance related to marine survival, habitat loss, and competitive interactions are accounted for. The latter is not likely until habitat is restored and stable and more reliable predictors of early marine survival are developed.

---

[5] Annual Report of the Pacific Salmon Commission Joint Chinook Technical Committee, 1994.
[6] Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations.

It is clear that low production from anadromous fish populations in the Trinity River basin is not attributable to escapement shortfalls. It is also clear that optimum production from published escapement goals for the basin cannot be achieved or even measured until habitat is restored and impacts of hatchery mitigation on natural populations are fully addressed. Nevertheless, the Hoopa Valley Tribe recognizes the importance of maintaining goals for the abundance, distribution, and genetic diversity of spawning escapements which are appropriate for a healthy ecosystem even though the habitat restoration process is not complete. The Tribe is committed to management of fisheries to achieve this end and participates in the Pacific Fishery Management Council as well as the Klamath Fishery Management Council established under the Klamath Restoration Act (PL99-552), explicitly to address management of Klamath/Trinity fisheries.

Under the existing Council management scheme the natural runs of chinook salmon to the Klamath and Trinity rivers are managed for a fixed escapement rate of 33%[7]. However, if a threshold escapement of 35,000 fish is not achieved, management actions may be taken to reduce exploitation rates in ocean and in-river fisheries and increase the escapement. In fact, during the last five years the returns of Trinity River chinook salmon were smaller than average and the total exploitation rate on that population was decreased by approximately 80%. This decrease was a direct result of fishery management actions taken by the Council in attempts to insure that threshold escapement levels were achieved.

In summary, the harvest management option is biologically not a viable or reasonable restoration option because:

- available biological data do not indicate that poor returns of natural populations of anadromous fish to the Trinity River basin are attributable to the number of spawning adults,
- there is evidence that many of the large variations in returns of adult anadromous fish originating from natural populations in the Trinity River are attributable to annual variations in ocean survival,
- there is strong evidence that fish habitat has been lost or degraded in the Trinity River basin as a result of the Central Valley Project,
- there is evidence of a relationship between loss and degradation of fish habitat and the declines of natural fish populations in the Trinity River,
- hatchery production designed to mitigate habitat loss associated with the Central Valley Project may result in competitive interactions which are detrimental to natural fish populations and,
- existing management policies are already in place to ensure a minimum threshold escapement for the Klamath/Trinity basin until habitat is restored and the impacts of supplemental hatchery production on natural populations is understood.

[7] PFMC, 1988. Ninth Amendment to the Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California Commencing in 1978.

LEGAL ANALYSIS

In addition to the biological reasons that belie the justification for analysis of a harvest management alternative is the following analysis of the legal context for the restoration program.

The Trinity River restoration program was authorized by Public Law 98-541 (October 24, 1984) and reauthorized and amended by Public Law 104-143 (May 15, 1996). In enacting the 1984 law, Congress identified the construction and operation of the Trinity River Division of the Central Valley Project--which blocked the river and diverted up to ninety percent of the flow from the upper watershed to the central valley--as contributing to the "drastic reduction in the anadromous fish populations" of the Trinity River. Pub. L. 98-541 section 1(1). The 1984 Act also recognized that other activities such as inadequate erosion control and fishery harvest management practices also contributed to the fish population decline. At the time of the 1984 act, the combination of impacts on the fishery was such that the decline could not be attributed to single cause. Id. at 1(1).

While Congress may have not been able to sort out precisely the causes of the decline in the Trinity River fishery in 1984, its response to the decline in the fishery was clear: To give the Secretary of the Interior "additional authority to implement a management program in order to achieve the long-term goal of restoring fish and wildlife populations in the Trinity River Basin to a level approximating that which existed immediately before the start of the construction of the Trinity River Division." Id. at 1(6). The findings in the 1984 act focus appropriately enough on the goals of restoring and maintaining natural production of fish and wildlife. The 1984 act was silent about, though it did not preclude recognition of, the economic potential to be created by the restoration program. It is understandable, then, that in developing the statement of purpose for the EIS **pursuant to the 1984 act** the focus was on the biological objective of restoring and maintaining naturally producing anadromous fish populations. Viewed in isolation, the 1984 act may have justified full consideration of a restoration program alternative that concentrated on harvest management.

However, the 1984 act cannot be viewed in isolation. Subsequent events made clear that the existence value of a restored fishery could not have been considered to have been a reason for the restoration program. In 1992 Congress enacted the Central Valley Project Improvement Act (Public Law 102-575 Title XXXIV) (CVPIA). In section 3406 (b)(23) of that act Congress expressly affirmed that the Trinity River fishery is a trust resource ~~of the~~ Hoopa Valley ~~Tribe for which the~~ United States has a fiduciary responsibility. Congress also reaffirmed the restoration goals of the 1984 act by establishing deadlines for completing a key element of the restoration program, the flow study report and recommendations pertaining to the needs of the fishery. By affirming that the fishery was a tribal trust resource, Congress was acknowledging the Indians' historic relation to the Trinity River fishery as both a source of fish for sustenance and commerce and the focus of tribal customs, traditions and culture discussed in Section __ **[referring to trust/culture section of the EIS]**.

Less than a year after enactment of the CVPIA, the Solicitor of the Department of the Interior issued an opinion about the nature and extent of the Hoopa Valley and Yurok Tribes' reserved rights in the Trinity and lower Klamath River fishery. (Opinion M-36979, October 4, 1993). The Solicitor concluded that the tribes had a vital economic dependence on the fishery which entitled them to fifty percent of the harvestable stock to the extent of maintaining a moderate standard of living. Following publication of the Solicitor's opinion, the Secretary of Commerce published a rule applying the opinion to the ocean harvest of Klamath-Trinity fishery resources. The rule states that the Commerce Department recognizes the federally reserved rights of the tribes and restricts non-Indian ocean harvesting of fish accordingly. 58 Fed. Reg. 68063 (December 23, 1993). Judicial challenges to the reserved fishing right and the Secretary of Commerce's regulation calculated to ensure the tribes' enjoyment of the right were rejected. Parravano v. Babbitt and Brown, 837 F.Supp. 1034 (N.D. Calif. 1993) and 861 F.Supp. 914 (N.D. Calif. 1994); aff'd 20 F.3d 539 (9th Cir. 1995); cert. denied 116 S.Ct. 2546 (1996).

Just as the Supreme Court was readying its decision in Parravano, the Congress enacted the reauthorization of the Trinity River Basin restoration program. Public Law 104-143 (May 15, 1996). The 1996 reauthorization included significant amendments to the act that comported with the recently adjudicated tribal fishing rights and underscored the economic purpose of the Trinity River fishery. The 1996 act included a clarification of findings that restated the meaning of the restoration program:

> Trinity Basin fisheries restoration is to be measured not only by returning adult anadromous fish spawners, **but by the ability of dependent tribal, commercial, and sport fisheries to participate fully, through enhanced in-river and ocean harvest opportunities, in the benefits of restoration** . . . [and] to achieve the long-term goals of restoring fish and wildlife populations in the Trinity River Basin, and, to the extent these restored populations will contribute to ocean populations of adult salmon, steelhead, and other anadromous fish, such management program will **aid in the resumption of commercial, including ocean harvest, and recreational fishing activities.**

(Emphasis added) Public Law 104-143 sec. 2.

In addition, the EIS scoping that led to inclusion of the harvest management alternative occurred prior to both judicial confirmation of the tribes' reserved rights and Congress' clarification of the restoration program's purposes. In view of the recognition by the Congress, the Executive and the Courts of the vested, reserved fishing rights of the tribes to harvest fish, and Congress' recent declaration that a measure of the restoration program's success will be the resumption of commercial and recreational fishing activities, a harvest management alternative that contemplates maintaining or reducing current harvest levels as a means of restoration would be unreasonable, conflict with recently enacted federal law and policy, and confiscatory of Indian property rights. Since Congress and the courts made their decisions while the harvest management alternative was pending, and the former now cannot be reconciled with the latter, the harvest management alternative is no longer appropriate for full consideration.

We would be pleased to answer any questions which you may have about our analyses.

ATTACHMENT I

A significant portion of the analysis of the harvest management restoration option for the Trinity River EIS focused on reconstruction of natural returns of chinook salmon to the Trinity River. The analysis was limited to Fall adult chinook returns for years 1984 through 1995. Returns in those years can be fully reconstructed by age group for Trinity River Hatchery, Iron Gate Hatchery, and natural stocks using available cohort analysis data.(Table 1).

Because individuals in cohorts captured in ocean fisheries would not all mature if harvests are forgone, the contributions of a cohort in the current and succeeding years were accounted for when estimating annual total returns from brood table data (Table 2). Annual contributions of natural and hatchery cohorts (C_i) to in-river returns as a result of forgone ocean harvests (O_i) were estimated for each age (i) using maturity rates (M_i) and natural mortality rates ($D_{i\ to\ i+1}$) as follows:

$C_2 = O_2 * M_2$
$H_{2\text{-}3} = (0_2 * (1\text{-}M_2)) * D_{2\ to\ 3}$
$C_3 = H_{2\ to\ 3} * M_3$
$H_{3\text{-}4} = (H_{2\ to\ 3} * (1\text{-}M_3)) * D_{3\ to\ 4}$
$C_4 = H_{3\ to\ 4} * M_4$
$H_{4\text{-}5} = (H_{3\ to\ 4} * (1\text{-}M_4)) * D_{4\ to\ 5}$
$C_5 = H_{4\ to\ 5} * M_5$

Where:
$H_{i\ to\ i+1}$ = the number of fish of age i which do not mature and return the next year at age i+1

Returns of fish which did not originate from hatchery production were not reported as Klamath or Trinity River fish in the cohort analysis. Two methods of apportioning these natural fish to their respective rivers of origin were examined. In the first method it was assumed that exploitation rates on Trinity River Hatchery returns and Trinity River natural returns in fisheries were equal and that escapement rates would also be equal. The natural return was estimated by dividing the measured natural escapement by the hatchery escapement rate. The disadvantage of this method is that the estimate of total natural returns is not constrained by observed numbers of total returns and in some years estimates of the former vastly exceeded reasonable estimates of the later. The second method, and the one which was adopted, was to assume that the ratio of Trinity River natural returns and Klamath River natural returns in the catch were the same as those observed in the escapements (Table 3).

Another factor in estimating natural escapement in a no-fishing scenario is the tendency for hatchery returns to stray and spawn in natural areas. Estimates of hatchery fish in natural escapements which are reported annually by the Trinity River Basin Salmon and Steelhead Monitoring Project were used to estimate an average annual rate of straying of Trinity River Hatchery fish into natural spawning areas. This average straying rate of slightly more than 50% was used to portion out annual estimates of in-river hatchery returns to natural spawning areas.

When discussing "escapement" from the perspective of the Tribe it is probably appropriate to include spawning escapement plus some reasonable estimate of average in-river harvest in tribal fisheries. This interpretation was included as part of the analysis in one version (a) of Table 4. In another version (b) of Table 4, I have assumed no tribal fisheries occur and treat all in-river returns as spawning escapement. In the first case where tribal fisheries are considered, fish in Hoopa tribal fisheries are assumed to be of Trinity River origin. The natural and hatchery portions of these projected catches were apportioned based on the ratio of those two stocks in the estimates of total in-river returns. The Trinity River portion of mixed stock harvests in Yurok tribal fisheries was estimated using the ratio of Trinity fish observed in the total in-river return. The Trinity River natural and hatchery components were estimated in the same manner described for Hoopa Tribal Fisheries.

Clearly if there are no fisheries, escapements will be larger and this should have an effect on total returns in subsequent years. However, spawner return relationships for the Trinity appear to masked by many other effects and were not included in this model.

In summary, to complete an analysis of the no-fishing option, the following assumptions were made:

1. maturity schedules for 2, 3, 4, and 5 year old fish were 0.035, 0.35, 0.95, and 1.0 respectively;
2. natural mortality rates for 2, 3, 4, and 5 year old fish were 0.5, 0.8, 0.8, and 0.8 respectively;
3. the ratios of Trinity River fish of natural origin to Klamath River fish of natural origin is the same in the fishery as in the combined Klamath/Trinity escapement;
4. the straying rate of adult fish Trinity River Hatchery returns into natural spawning areas is relatively constant, independent of run size, and equal to the average straying rate in the years for which we have coded-wire tag recovery data form natural spawning areas;
5. Hoopa tribal fisheries are composed entirely of fish originating from Trinity River natural and hatchery stocks. The ratio of natural to hatchery stocks is the same in tribal fishery harvests as it is in the estimate of total returns;
6. Klamath tribal fisheries are composed of mixed Trinity River and Klamath River natural and hatchery stocks;
7. Trinity and Klamath stocks are present in the fishery harvests in the same ratios as in the total return;
8. Trinity River natural and hatchery stock are present in the same ratio as in the total return estimate for that drainage and;

9. there is no effect of escapement size on return size in subsequent years.

For the period 1984 through 1995 escapement goals for natural spawning areas were achieved in only three years (1986, 1987, and 1995; Table 5). The average exploitation rate on Trinity River fish during that period was approximately 60% for all fisheries and about 16% in Hoopa and Yurok tribal fisheries. Exclusion of ocean fisheries would have resulted in the escapement goals being met in two additional years. Exclusion of in-river fisheries would not allow goals to be met in any additional years but obviously would reduce shortfalls in all years when the goal was not met. For the five years when the escapement goal could be met by constraining fisheries, the average exploitation rate on Trinity River stocks would be approximately 11%.

Table 1. Estimated annual returns by age in ocean harvests and escapements. Escapements include in-river tribal and sport fisheries. Returns for Iron Gate Hatchery (IGH) and Trinity River Hatchery (TRH) are reported by release type.

			Fish aged i which are caught in the ocean in year j							Fish aged i which escape ocean fisheries and enter the river in year j						
Return Year	Age	Brood Year	IGH Yearling	IGH Fingerling	TRH Yearling	TRH Fingerling	TRH Yearling+	Natural	Totals	IGH Yearling	IGH Fingerling	TRH Yearling	TRH Fingerling	TRH Yearling+	Natural	Totals
84	2	82	123	12	9	0	0	151	295	746	200	1550	700	0	5081	8277
	3	81	1046	1617	759	172	0	12262	15856	818	2558	3977	454	0	21843	29640
	4	80	4816	341	774	151	0	6210	12492	4683	705	1497	66	0	8268	15217
	5	79	57	14	0	3	1	1263	1338	45	35	51	29	17	2097	2274
	Totals		6042	2184	1542	326	1	19886	29981	6292	3538	7025	1249	17	37287	55408
85	2	83	299	101	513	2835	133	12803	16706	408	750	15000	36198	3028	23788	80375
	3	82	9774	684	4689	284	0	21491	37122	9114	698	8818	466	0	11605	30701
	4	81	1987	885	1128	107	0	9085	13193	4180	2427	3071	659	0	22386	32723
	5	80	85	65	37	0	0	33	220	603	24	124	38	0	140	931
	Totals		12145	1735	6367	3226	135	43413	67241	14507	3899	27016	27361	3028	57918	133730
86	2	84	352	391	559	174	2	4983	6461	849	341	4333	2319	634	35692	44332
	3	83	11291	7959	31089	20224	1543	122886	195012	7399	3885	56643	22158	28794	48999	167888
	4	82	5632	457	2258	171	0	20624	29142	5491	423	1887	252	0	18844	26897
	5	81	0	0	0	0	0	0	0	42	11	0	0	0	0	53
	Totals		17275	8747	34026	20569	1545	148495	230615	13781	4668	63086	24909	29428	103475	239566
87	2	85	108	362	140	455	26	3789	5080	182	2346	4308	12137	23	31	19042
	3	84	9822	4368	10428	4332	682	122266	158798	4995	3417	36378	3006	8585	65949	120728
	4	83	23657	5086	10462	1608	5823	56097	102833	18437	4315	9069	3626	4703	43839	87399
	5	82	34	0	9	0	0	0	43	14	4	11	1	0	0	30
	Totals		33621	12236	20979	6395	6531	187152	269974	23248	9102	49751	17768	13311	114819	227799
88	2	86	0	0	17	912	112	10168	11209	41	313	1941	2715	15	19023	24049
	3	85	4869	32068	8843	13310	172	177961	238215	2449	13882	34286	21466	18	64405	136524
	4	84	10707	4137	5722	226	1437	26303	48532	8713	4576	8800	302	1905	29222	53532
	5	83	370	67	14	10	6	617	1084	435	115	0	26	0	619	1215
	Totals		15946	37182	14478	14458	1927	215249	299460	11678	18886	45030	24510	1930	113277	215320
89	2	87	0	797	0	0	0	18007	18804	344	159	77	816	24	7676	9096
	3	86	489	110	1790	2329	158	23711	28589	310	1038	3164	3254	345	7189	15300
	4	85	11043	4289	9227	2200	154	56894	80607	10816	7080	11613	3146	25	72880	105580
	5	84	506	176	47	0	27	1007	1763	366	635	143	5	47	2032	3228
	Totals		12037	5372	10867	4529	339	99619	132763	11836	8831	14997	7221	341	89787	133113
90	2	88	0	1577	0	0	8	10682	12267	33	0	463	924	72	2897	4389
	3	87	3158	1906	262	868	212	66687	73193	1421	80	242	653	13	6646	9057
	4	86	1250	774	661	922	125	38255	42030	344	663	269	807	40	24284	26597
	5	85	307	84	43	31	0	3	467	61	0	96	0	0	1	158
	Totals		4838	4341	965	1821	345	115627	127957	2059	723	1070	2385	125	33828	40201
91	2	89	0	0	171	0	0	0	171	0	134	397	127	21	1075	1754
	3	88	3378	332	640	247	218	2999	7815	168	628	5939	991	291	7332	14439
	4	87	947	0	60	149	96	3937	3189	2567	411	280	545	107	14198	18208
	5	86	2	0	0	0	0	0	2	40	0	0	31	0	0	71
	Totals		4327	332	871	397	314	6936	13177	2775	1173	5686	1694	409	22605	34352
92	2	90	0	553	0	0	0	577	1130	312	4044	125	0	7	9199	13687
	3	89	0	29	194	0	0	316	539	0	350	1880	218	30	4851	7329
	4	88	30	0	232	44	58	476	860	445	1459	4530	683	302	10891	18300
	5	87	66	0	0	0	0	176	242	115	0	28	158	0	699	1000
	Totals		116	582	426	44	58	1545	2771	872	5853	6580	1059	339	23640	40344
93	2	91	0	0	34	0	0	0	34	41	157	343	800	2	6233	7598
	3	90	320	4669	20	0	181	5982	11172	3268	17457	490	0	345	26337	47897
	4	89	0	0	266	0	104	746	1116	0	201	426	0	129	7229	7985
	5	88	0	0	0	0	0	0	0	0	0	22	0	4	603	631
	Totals		320	4669	340	0	285	6728	12342	3309	17815	1281	800	480	40426	64111
94	2	92	0	0	0	0	0	0	0	4	376	1019	3317	12	9340	14368
	3	91	235	259	276	125	37	2837	3787	1888	1732	3745	3977	97	26164	35603
	4	90	456	662	37	0	105	807	2067	6745	7333	549	0	217	10133	24997
	5	89	0	0	0	0	0	0	0	0	27	0	27	2	906	962
	Totals		691	921	313	125	142	3644	5836	8637	9468	5313	7321	328	44463	75630
95	2	93	0	0	0	0	0	0	0	0	214	112	24	6	36375	36849
	3	92 1/	16	3807	2129	5338	160	22076	33469	186	23634	16663	23462	36	118022	182293
	4	91	391	225	146	42	87	3004	3895	571	1558	634	177	220	12859	16222
	5	90	31	55	0	0	3	0	89	407	420	81	0	25	1288	2301
	Totals		438	4087	2275	5380	250	25080	37453	1564	25826	17510	23663	280	158022	227665

1/ The number of three year old fish of natural origin in the 1995 ocean harvest was not reported in the cohort analysis table. The shaded number shown was estimated using totals of natural fish in other age groups in the ocean harvest and the age composition data for hatchery fish in the ocean harvests.

Table 3. Natural and hatchery returns by natural and hatchery origin in the absence of ocean fishing. The ratio of Trinity to Klamath fish in natural escapements in the presence of fisheries are used to portion natural in-river natural returns by river in the absence of ocean fisheries.

Return Year	Adult Natural Escapements When Ocean Fishing Occurs					Unfished Natural Returns Portioned by River			Unfished Hatchery Returns Portioned by Hatchery	
	Number of Fish			Percents						
	Trinity	Klamath	Total	Trinity	Klamath	Total	Trinity	Klamath	Trinity River Hatchery	Iron Gate Hatchery
84	5654	10410	16064	35.2%	64.8%	43660	15367	28293	7248	14960
85	9215	16462	25677	35.9%	64.1%	56702	20349	36353	16630	25156
86	92548	20812	113360	81.6%	18.4%	144124	117664	26460	133754	35154
87	71920	29797	101717	70.7%	29.3%	278172	196684	81488	113564	72282
88	44616	34770	79386	56.2%	43.8%	252134	141702	110431	91726	67879
89	29445	14423	43868	67.1%	32.9%	239232	160577	78655	45991	55381
90	7682	7914	15596	49.3%	50.7%	114184	56242	57941	7629	8859
91	4867	6782	11649	41.8%	58.2%	67382	28153	39230	6772	9109
92	7139	4889	12028	59.4%	40.6%	23035	13672	9363	8650	4650
93	5905	15953	21858	27.0%	73.0%	37438	10114	27324	2012	22893
94	10906	21427	32333	33.7%	66.3%	42094	14199	27896	7032	21535
95	77876	83918	161794	48.1%	51.9%	135231	65090	70141	44256	29308

Table 4a. Estimated annual escapements to natural and hatchery spawning areas in the absence of ocean fisheries and in-river sport harvests. Estimates of returns to natural spawning areas and the hatchery have been adjusted for straying rates observed among hatchery returns.

Return Year	Total Unfished Natural and Hatchery Returns		In-River Harvest Of Trinity River Returns in Tribal Fisheries			Trinity River Spawning Escapements When Tribal Fisheries Occur	
	Trinity	Klamath	Hoopa	Yurok	Total	Natural	Hatchery
84	22615	43253	1170	6008	7178	13062	2375
85	36979	61509	1941	3614	5555	24641	6783
86	251418	61614	4808	16320	21128	171484	58807
87	310248	153770	4982	32170	37152	225113	47983
88	233428	178310	5070	26408	31478	163859	38091
89	206568	134036	3474	25527	29001	158590	18977
90	63872	66799	811	3468	4279	58176	3417
91	36925	48339	1280	3862	5142	28158	3624
92	22522	14213	946	2967	3913	15099	3510
93	12126	50217	1492	1584	3076	8329	721
94	21230	49431	2266	2832	5098	13567	2565
95	109347	99449	3383	6376	9759	80241	19347
AVG.	110606	80078	2635	10928	13563	79860	17183

Table 4b. Estimated annual escapements to natural and hatchery spawning areas in the absence of ocean and in-river fisheries. Estimates of returns to natural spawning areas and the hatchery have been adjusted for straying rates observed among hatchery returns.

Return Year	Total Unfished Natural and Hatchery Returns Combined		Trinity River Spawning Escapements When No Fishing Occurs		Potential Exploitation Rate On Natural Fish
	Trinity	Klamath	Natural	TRH	
84	22615	43253	19136	3479	0.0%
85	36979	61509	28997	7982	0.0%
86	251418	61614	187216	64202	66.3%
87	310248	153770	255737	54511	75.4%
88	233428	178310	189400	44028	66.7%
89	206568	134036	184492	22076	65.9%
90	63872	66799	60210	3662	0.0%
91	36925	48339	32714	4211	0.0%
92	22522	14213	18274	4248	0.0%
93	12126	50217	11160	966	0.0%
94	21230	49431	17855	3375	0.0%
95	109347	99449	88104	21243	28.5%
AVG.	110606	80078	91108	19499	25.2%

Table 5. Historic exploitation rates on Trinity River fish with ocean and in-river fishing, projected exploitation rates with tribal fisheries only, and allowable exploitation rates for tribal fisheries to allow for natural escapement of 63,000 adults when total returns in excess of that goal occur.

Return Year	Historic Trinity River Spawning Escapements With Fishing		Estimated Unfished Trinity River Total Return	Historic Annual Exploitation Rate on Trinity River Fish	Trinity River Spawning Escapements When Tribal Fisheries Occur		Exploitation Rates of Tribal Fisheries on Trinity River Fish	
	Natural	Hatchery			Natural	Hatchery	Actual Observed	To Achieve 63,000 Goal
84	5654	2,166	22615	65.4%	13062	2375	31.7%	0.0%
85	9215	2583	38979	68.1%	24641	6783	15.0%	0.0%
86	92548	15795	251418	56.9%	171484	58807	8.4%	8.4%
87	71920	13934	310248	72.3%	225113	47983	12.0%	12.0%
88	44616	17352	233428	73.5%	163839	38091	13.5%	13.5%
89	29445	11132	206568	80.4%	158590	18977	14.0%	14.0%
90	7682	1348	63872	85.9%	56176	3417	6.7%	0.0%
91	4867	2482	36925	80.1%	28158	3624	13.9%	0.0%
92	7139	3779	22522	51.5%	15099	3510	17.4%	0.0%
93	5905	815	12126	44.6%	8329	721	25.4%	0.0%
94	10906	3264	21230	33.3%	13567	2565	24.0%	0.0%
95	77876	15178	109347	14.9%	80241	19347	8.9%	8.9%
Avg.	30648	7486	110606	60.6%	79660	17183	15.9%	4.7%

FROM: DAVID HANKIN
HSU

Hoopa Valley Tribe Fisheries Dept.
Attn.: Sam Sharr
P.O. Box 417
Hoopa, CA 95576

10 September 1997

Dear Sam,

Per your request, I have reviewed several documents and/or comments prepared by yourself, Joe Polos and Duane Neitzel regarding the so-called "harvest management alternative" that is being developed as one of the options for the Trinity River flow EIS. If my understanding of this proposal is correct, this alternative would propose two actions to restore anadromous fish populations and production to pre-dam levels : (1) much more serious restrictions on harvest of Trinity River chinook salmon, and (2) revival of a harvest management approach that is based more on a "management by escapement" approach than on the current harvest rate approach. I do not think that return to an escapement oriented management approach would be a productive move and in this memo I try to make a case for sticking to the harvest rate approach. I would appreciate it if you would circulate my memo to those individuals who will be responsible for the final version of this fishery management alternative and who will provide an assessment of its probable shortcomings and/or benefits were it to be adopted.

First, I need to state that I agree strongly with you on your points concerning the difference between *production* and *escapement*. In the context of management of Pacific salmon, production is best thought of as the number of fish alive at age two produced by the adults that spawned two years previously. In the demographic models of chinook salmon that I developed in the mid-80s (Hankin and Healey 1986), I referred to this value as *recruitment*. From an accounting standpoint, salmon managers attempt to estimate this recruitment by adding up all fishery catches and escapement throughout the life of the cohort, from age 2 through age 6, with a modest addition of unknown natural mortality. More severe restrictions of fisheries would, in principle, increase spawning escapement but this device does not necessarily increase recruitment (production) in future generations. In theory, the recruitment from a given level of escapement is determined by some underlying population-level relation between parent stock and recruitment (e.g., via the famous Ricker or Beverton-Holt stock-recruitment models), as modified by environmental factors that may affect survival rates from egg deposition to hatching, from hatching to emergence, from emergence to first feeding, during freshwater juvenile rearing, during downstream migration, at the transition from fresh to salt water, and finally in the ocean. Over the past 20 years, it has become abundantly evident to me that interannual variation in these environmental factors is extreme for Klamath/Trinity chinook salmon, in particular, and for south-migrating (Nicholas and Hankin 1988) chinook salmon in general. Hence, it is no surprise that it is difficult or perhaps impossible to make much sense out of Klamath/Trinity data sets for adult stock and subsequent recruitment. Indeed, in the Klamath/Trinity system, this problem is complicated by the continuing difficulties in separating wild and hatchery fish at all locations in the Klamath/Trinity system. We have no idea whether or not hatchery fish that stray into natural spawning grounds perform *as if* they were wild fish. My personal guess is that "sometimes they do and sometimes they don't" depending on optimal run timing for wild fish and other similar considerations. Nevertheless, wild and hatchery fish have routinely been lumped together as *natural esapement*.

The above is a long-winded way of stating that it is no surprise to me that it continues to be difficult to determine some optimal or even desirable spawning escapement goal strictly on the basis of examination of accumulating stock-recruitment data. Indeed, this same difficulty provided the essential motivation for development of the harvest rate approach that is presently employed by the Pacific Fisheries Management Council to manage Klamath-Trinity fall chinook populations. The harvest rate approach stresses that the underlying *productivity* of the population, measured by recruits per spawner at low population size, is the key factor that determines allowable harvest rates. If a reasonable guess of this productivity parameter can be made, then existing very good information on the demography of Klamath/Trinity chinook can be used to establish harvest rate regimes that limit fishing rates to those that would be consistent with underlying population productivity. It would certainly be worthwhile to reexamine the basis for the value of the productivity parameter that is currently used for management. If this value is unrealistically high, then further reductions in harvest rates would definitely be in order.

In addition to there being no nice basis for selecting an "optimal escapement" goal for management of Klamath/Trinity chinook, there are other, perhaps equally important, reasons to object to the classical "management by escapement" approach. Given the extreme volatility in recruitment of Klamath/Trinity chinook, independent of the influence of parent adult stock size, management by escapement would lead to extreme volatility in annual fishing regimes. In years of extreme abundance, fisheries would be cranked up to levels that can only be justified under such extreme situations. Just a few years later, harvest opportunities might be negligible. It is extremely difficult to control fisheries when this kind of volatility exists and is indeed encouraged by fishery managers who are striving to achieve a fix escapement goal. The general public does not know about the Ricker stock-recruitment model. Wild swings in management regimes, particularly in recreational fisheries, generate resentment for severe restrictions imposed just one or two years after fisheries have had far more generous bag limits. As a reflection of the difficulties with management by escapement, several years ago I reviewed a paper written by Ray Hilborn and Rick Deriso. It_s title (ripped off from Peter Larkin) was "A requiem for management by fixed escapement". These two fellows are among the top brains in fishery dynamics; surely they are on to something.

Finally, I also think that harvest rate management provides a very natural and powerful connection with Trinity River restoration efforts. My understanding is that the long-term goal is to somehow restore the *production* of anadromous salmonids in the river system to pre-dam levels. The only way that this can be achieved is if various flow modifications and other strategies somehow manage to restore the *productivity* of the habitat for chinook salmon. We could choose to measure that productivity indirectly as average recruits per spawner, but such values would be very much affected by environmental variation at all stages during a the life of a cohort. Instead, we might choose to carry out field research designed to directly assess survival rates through various freshwater life stages in the Trinity River system. If system productivity is really increased, then (a) more spawning and rearing habitat should become available, and (b) its suitability to support incubation and rearing must be improved. Those are things that can be directly measured, I think, and we ought to focus our attention on that problem. It is not enough to assert that we have improved habitat or created more habitat that we think (or assert) is what is needed. We need to directly assess the performance of fish in the river system.

I encourage the EIS team to develop a critical and negative assessment of the so-called "harvest management alternative". If this alternative would lead to resurrection of management by escapement, then it would be a move in the wrong direction.

ATTACHMENT B8

ALTERNATIVE ANALYSES CONSIDERED FOR THE HARVEST MANAGEMENT ALTERNATIVE

Harvest Management Alternative

Water Management

Same as No Action Alternative

Water Operations

Same as No Action Alternative

Watershed Protection

Same as No Action Alternative

Fish Habitat Management

Same as No Action Alternative

Fish Population Management

Harvest policy for ocean and in-river fishing will be managed to allow spawning escapement in the mainstem Trinity River of 62,000 fall chinook salmon, 6,000 spring-run chinook salmon, 1,400 coho salmon, and 40,000 steelhead trout. This alternative would restore natural fish population levels of the Trinity River by managing tribal, sport, and commercial fisheries to meet the spawning escapement goals of the Trinity River Restoration Program. This alternative would require a change in the harvest rate stated in the Pacific Fisheries Management Council fisheries management plan (PFMC 1997).

Progress toward the Trinity River Restoration Program goal is based on changing the harvest rate established escapement policy of 34 % (PFMC 1997 management plan Table 6-1, page 6-2). The analysis of changing the harvest rate demonstrates that changing current harvest policies could result in progress toward the natural spawning goal for the Trinity River chinook salmon. The percent of the goal that can be achieved ranges from about 30% with a 10% reduction in harvest rate to over 100% with a 100% reduction in harvest rate.

Dam Modifications

Same as No Action Alternative

Reference

Pacific Coast Fisheries Commission. 1997. "Pacific Coast Salmon Plan: Fishery Management Plan for Commercial and Recreational Salmon Fisheries Off the Coasts of Washington, Oregon, and California as Revised in 1996 and Implemented in 1997." Pacific Coast Fisheries Commission, Portland, Oregon

The following assumptions were accepted and followed for the "Analysis of Modified Harvest Rates on Progress towards the Natural Escapement Goal for Trinity River Chinook Salmon."

1. The No Action alternative results in a 22% progression toward the natural escapement goal for Trinity River salmonids (Fish and Channel Team analysis of other EIS alternatives).
2. For all alternatives, the present harvest rate of 66% is sustainable (PFMC 1997).
3. The period of 12 years in the cohort analysis provided by the Hoopa Valley Tribe (SEE APPENDIX ATTACHMENT B6) represents the range of runs sizes that may occur in the future.
4. Both density-dependent and density-independent factors are affecting population numbers (i.e., both productivity and capacity have been reduced by the dams).
5. If we assume "full capacity" (i.e., the salmonid populations of the Trinity River cannot increase), then run size will not increase following a decrease in harvest rate.
6. If we assume "maximum sustainable yield" (i.e., the present population is being harvested at a rate that maximizes the sustainable fishery), then run size will increase following a decrease in harvest rate.
7. If we assume productivity is lower than we assumed for the "maximum sustainable yield" scenario and capacity is higher (you have to assume capacity is higher to be consistent with assumptions 1 through 4), then run size will increase following a decrease in harvest rate. In fact run size will increase to a level greater than 100% of the Trinity River Restoration goal depending on the how great a change is made in the estimates of productivity and capacity.

Reference

Pacific Coast Fisheries Commission. 1997. "Pacific Coast Salmon Plan: Fishery Management Plan for Commercial and Recreational Salmon Fisheries Off the Coasts of Washington, Oregon, and California as Revised in 1996 and Implemented in 1997." Pacific Coast Fisheries Commission, Portland, Oregon

Analysis of Modified Harvest Rates on Progress towards the Natural Escapement Goal for Trinity River Chinook Salmon

The Harvest Management Alternative assumes that changing harvest policies that potentially impact Trinity River salmonids is an alternative to the No Action Alternative and makes possible the restoration of natural salmon and steelhead ~~trout~~ populations toward levels approximating those which existed prior to the start of construction of the Trinity River Division. The percent of the goal that can be achieved ranges from about 30% with a 10% reduction in harvest rate to over 100% with a 100% reduction in harvest rate. The analysis is based on the assumption that the current harvest policy under the No Action Alternative results in the achievement of 22 % of the natural escapement goal.

The basis for harvest (and escapement) management policies for salmon populations is some assumed relationship between recruitment and parent spawner abundance. For this analysis we looked at three assumptions: 1) the population (i.e., the number of recruits) can not increase beyond its current abundance, 2) the population is being harvested at a rate that produces the maximum sustainable yield, and 3) the population is being harvested BELOW ~~at~~ the maximum sustainable yield AND ~~except that~~ the density-independent survival is reduced. The effect of modifying the rate of harvest depends upon what we assume about this *spawner-recruit* relationship, which in turn is a function of the processes that determine reproductive success (survival and reproduction).

Reproductive success of salmon populations is determined by the four processes of: birth, death, immigration, and emigration. These processes are regulated by mechanisms that are either *density-independent or density-dependent*. The relative importance of these two mechanisms determine the population response to changes in harvest rate. Density-dependent mortality is regulated primarily by the *quantity* of resources such as food and space (Ricklefs 1973) and it is most important when abundance is large relative to the quantity of these resources. Density-independent mortality on the other hand is determined by the *quality* of the environment and it operates at all population densities.

One of the most obvious density-independent factors that may be adversely impacting progress toward increasing natural spawning in the Trinity River is harvest. All the alternatives, except the Harvest Management Alternative, assume no change in current harvest management. Since a case can be made that for Trinity River salmonids that both the quality and quantity of their environment has been altered, changing harvest management ~~was examined~~ as ~~an alternative to~~ No-Action.

In the following we examine the effect of different harvest rates: 1) on the progress towards the natural spawning goal, and 2) on the amount of harvest. We examine these effects under the three different assumptions about the spawner-recruit relationship stated above. For all scenarios, assume ~~that~~ the current escapement policy of 34 % (PFMC 1997 management plan Table 6-1, page 6-2).

Scenario 1: The "**full capacity**" scenario assumes simply that the population cannot increase beyond its current average abundance. In other words, increasing the present average natural escapement will not increase the average abundance of chinook salmon available for harvest (marine and in-river) and escapement.

Scenario 2: The "**Maximum Sustainable Yield**" scenario (MSY~~MYS~~) assumes that the population is at present harvested at rate that maximizes the sustainable harvest (to all fisheries). In analyzing this scenario we assumed the Beverton-Holt (B-H) spawner-recruit model (Beverton and Holt, 1957, Hilborn and Walters 1992). Under this assumption each additional spawner (above current average) produces one additional recruit. The highly variable escapement and abundance data for the period 1984-1995 (Tables 1 and 2) certainly does not rule out the possibility that habitat capacity is large relative to population abundance. This scenario assumes only that the capacity is large enough to sustain present harvest rates under the B-H survival model. If this is not the case then either the harvest is not sustainable under current policy or, the productivity (density-independent survival) is significantly greater than that predicted by the B-H model and of less capacity.

Scenario 3. The "**Low Productivity**" scenario is the same as scenario 2, except that the density-independent survival is reduced AND CAPACITY IS INCREASED. ~~I~~In order to maintain escapement at 22% with present harvest rates. ~~, we have assumed that the capacity is increased by 21%.~~ (WE REDUCED PRODUCTIVITY BY 25 AND INCREASED CAPACITY BY 21%.) This scenario is harvesting less than the MSY ~~MYS~~.

Under the "full capacity" scenario, 65% of THE natural spawning goal will be met if the harvest rate is zero (Table 3). This is an increase from 22%; the expected percent of the goal reached for the No Action Alternative. If the "maximum sustainable yield" assumption is valid, then a complete restriction of harvest results in reaching 87% of the goal. Under the third scenario, "low productivity," a complete restriction of harvest results in meeting 100% of the stated goal.

For the "low productivity" scenario, we used a Beverton-Holt relationship that reduces productivity by 25%. An assumption that this number could be greater would yield results where capacity is increased and productivity is further reduced. Too frequently, restoration efforts focus on increasing carrying capacity to reduce density-dependent mortality WHEN LOW PRODUCTIVITY IS THE MORE IMPORTANT PROBLEM (Hankin and Healey, 1986). This appears to be the case with most of the alternatives in the EIS. A case can no doubt be made for the Trinity river chinook, that both the quantity and quality of their environment has been altered. Factors affecting density-independent survival include for example: flow patterns, temperature, sedimentation, channel stability, and harvest. Factors affecting density-dependent survival include: amount of key habitat, abundance of food, and abundance of competitors (e.g., hatchery fish).

Thus, if we reduce productivity more than 25%, say 36% (Table 4), the natural spawning goal could be met with a 10% harvest rate. If we reduce productivity to 41% (Table 5),), the natural spawning goal could be met with a harvest rate of about 20%.

This analysis demonstrates that changing current harvest policies could result in progress toward the natural spawning goal for the Trinity River chinook salmon. The percent of the goal that can be achieved ranges from about 30% with a 10% reduction in harvest rate to over 100% with a 100% reduction in harvest rate.

References

Beverton, R. J. H. and S. J. Holt. 1957 (Reprinted 1993). On the Dynamics of Exploited Fish Populations. Chapman & Hall, London.

Hankin, D. and M. Healey. 1986. Dependence of exploitation rates for maximum yield and stock collapse on age and sex structure of chinook salmon (Oncorhynchus tshawytscha) stocks. Canadian Journal of Fisheries and Aquatic Sciences 43(9): 1746-1759.

Healey, 1982. Catch, escapement and stock-recruitment for British Columbia chinook salmon since 1951. Can. Tech. Rep. Fish. Aquatic Sci. 1107:77p.

Hilborn, R. and C. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics & uncertainty. Routledge, Chapman and Hall, New York.

Pacific Coast Fisheries Commission. 1997. "Pacific Coast Salmon Plan: Fishery Management Plan for Commercial and Recreational Salmon Fisheries Off the Coasts of Washington, Oregon, and California as Revised in 1996 and Implemented in 1997." Pacific Coast Fisheries Commission, Portland, Oregon

Ricklefs, R.E. 1973. Ecology. Chiron Press, Newton, MA.

Table 1. Estimated Number of Trinity River Fish Caught in the Ocean Fishery during 1984 through 1995									
Return Year	Age	Brood Years	Fish aged i which are caught in the ocean in year j						
			IGH Yearling	IGH Fingerling	TRH Yearling	TRH Fingerling	TRH Yearling	Natural	Total
	2	82	123	12	9	0	0	151	295
	3	81	1046	1617	759	172	0	12261	15855
1984	4	80	4816	541	774	151	0	6210	12492
	5	79	57	14	0	3	1	1263	1338
	Totals		6042	2184	1542	326	1	19885	29980
	2	83	299	101	513	2855	135	12803	16706
	3	82	9774	684	4689	284	0	21691	37122
1985	4	81	1987	885	1128	107	0	9086	13193
	5	80	85	65	37	0	0	33	220
	Totals		12145	1735	6367	3246	135	43613	67241
	2	84	352	291	659	174	2	4983	6461
	3	83	11251	7999	31089	20224	1563	122886	195012
1986	4	82	5632	457	2258	171	0	20624	29142
	5	81	0	0	0	0	0	0	0
	Totals		17235	8747	34006	20569	1565	43613	230615
	2	85	108	562	140	455	25	3789	5079
	3	84	9802	6388	10428	4232	682	127266	158798
1987	4	83	23037	5085	10402	1608	5823	56097	102052
	5	82	34	0	9	0	0	0	43
	Totals		32981	12035	20979	6295	6530	187152	265972
	2	86	0	0	17	912	112	10168	11209
	3	85	4869	32958	8945	13310	172	177961	238215
1988	4	84	10707	4157	5722	226	1637	26503	48952
	5	83	370	67	14	10	6	617	1084
	Totals		15946	37182	14698	14458	1927	215249	299460
	2	87	0	797	0	0	0	18007	18804
	3	86	489	110	1793	2329	158	23711	28590
1989	4	85	11043	4289	9027	2200	154	56894	83607
	5	84	506	175	47	0	27	1007	1762
	Totals		12038	5371	10867	4529	339	99619	132763
	2	88	0	1577	0	0	8	10682	12267
	3	87	3258	1905	262	868	212	66687	73192
1990	4	86	1293	774	661	922	125	38255	42030
	5	85	307	84	42	31	0	3	467
	Totals		4858	4340	965	1821	345	115627	127956
	2	89	0	0	171	0	0	0	171
	3	88	3378	332	640	248	218	2999	7815
1991	4	87	947	0	60	149	96	3937	5189
	5	86	2	0	0	0	0	0	2
	Totals		4327	332	871	397	314	6936	13177
	2	90	0	553	0	0	0	577	1130
	3	89	0	29	194	0	0	316	539
1992	4	88	50	0	232	44	58	476	860
	5	87	66	0	0	0	0	176	242
	Totals		116	582	426	44	58	1545	2771
	2	91	0	0	54	0	0	0	54
	3	90	320	4669	20	0	181	5982	11172
1993	4	89	0	0	266	0	104	746	1116
	5	88	0	0	0	0	0	0	0
	Totals		320	4669	340	0	285	6728	12342
	2	92	0	0	0	0	0	0	0
	3	91	235	259	276	123	37	2837	3767
1994	4	90	456	662	37	0	105	807	2067
	5	89	0	0	0	0	0	0	0
	Totals		691	921	313	123	142	3644	5834
	2	93	0	0	0	0	0	0	0

	3	92	16	3807	2129	5338	160	22019	33469
1995	4	91	391	225	146	42	87	3004	3895
	5	90	31	55	0	0	3	0	89
	Totals		438	4087	2275	5380	250	25023	37453

Table 2. Estimated Number of Trinity River Fish Caught in the In-River Fishery during 1984 through 1995

Return	Age	Brood	Fish aged i which enter the river in year j						
Year		Years	IGH Yearling	IGH Fingerling	TRH Yearling	TRH Fingerling	TRH Yearling	Natural	Total
	2	82	746	200	1550	700	0	5081	8277
	3	81	818	2598	3927	454	0	21843	29640
1984	4	80	4683	705	1497	66	0	8266	15217
	5	79	45	35	51	29	17	2097	2274
	Totals		6292	3538	7025	1249	17	37287	55408
	2	83	609	750	15003	26198	3028	23788	69376
	3	82	9114	698	8818	466	0	11605	30701
1985	4	81	4180	2427	3071	659	0	22386	32723
	5	80	605	24	124	38	0	140	931
	Totals		14508	3899	27016	27361	3028	57919	133731
	2	84	849	341	4555	2519	634	35632	44530
	3	83	7399	3893	56643	22158	28794	48999	167886
1986	4	82	5491	423	1887	252	0	18844	26897
	5	81	42	11	0	0	0	0	53
	Totals		13781	4668	63085	24929	29428	103475	239366
	2	85	182	2366	4303	12137	23	31	19042
	3	84	4595	2417	36378	3004	8385	65949	120728
1987	4	83	18457	4315	9059	2626	4703	48839	87999
	5	82	14	4	11	1	0	0	30
	Totals		23248	9102	49751	17768	13111	114819	227799
	2	86	41	313	1941	2715	15	19023	24048
	3	85	2469	13882	34286	21466	18	64403	136524
1988	4	84	8713	4576	8803	302	1906	29232	53532
	5	83	455	115	0	26	0	619	1215
	Totals		11678	18886	45030	24509	1939	113277	215319
	2	87	344	159	77	816	24	7676	9096
	3	86	310	1038	3164	3254	245	7189	15200
1989	4	85	10816	7099	11613	3146	25	72890	105589
	5	84	366	635	143	5	47	2032	3228
	Totals		11836	8931	14997	7221	341	89787	133113
	2	88	33	0	463	924	72	2897	4389
	3	87	1421	80	242	655	13	6646	9057
1990	4	86	544	643	269	807	40	24294	26597
	5	85	61	0	96	0	0	1	158
	Totals		2059	723	1070	2386	125	33838	40201
	2	89	0	134	397	127	21	1075	1754
	3	88	168	628	5039	991	281	7332	14439
1991	4	87	2567	411	260	545	107	14198	18088
	5	86	40	0	0	31	0	0	71
	Totals		2775	1173	5696	1694	409	22605	34352
	2	90	312	4044	125	0	7	9199	13687
	3	89	0	350	1880	218	30	4851	7329
1992	4	88	445	1459	4550	683	302	10891	18330
	5	87	115	0	28	158	0	699	1000
	Totals		872	5853	6583	1059	339	25640	40346
	2	91	41	157	343	800	2	6255	7598
	3	90	3268	17457	490	0	345	26337	47897
1993	4	89	0	201	426	0	129	7229	7985
	5	88	0	0	22	0	4	605	631
	Totals		3309	17815	1281	800	480	40426	64111
	2	92	4	576	1019	5517	12	7240	14368
	3	91	1888	1732	3745	1977	97	26164	35603
1994	4	90	6745	7333	549	0	217	10153	24997
	5	89	0	27	0	27	2	906	962
	Totals		8637	9668	5313	7521	328	44463	75930
	2	93	0	214	132	24	6	26573	26949
	3	92	186	23634	16663	23462	26	118322	182293

1995	4	91	971	1558	634	177	223	12659	16222
	5	90	407	420	81	0	25	1268	2201
	Totals		1564	25826	17510	23663	288	158822	227665

Table 3. Effects of Harvest Rate on Progress Toward Natural Escapement Goal and Sustainable Harvest in All Fisheries. Analysis assumes a -25% change in productivity and 21% change in capacity. Current harvest rate in shaded text (PFMC 1997).

	"Full Capacity" Scenario (1)		"MSY" Scenario (2)		"Low Productivity" Scenario (3)	
Harvest Rate	% of Goal	Harvest Change	% of Goal	Harvest Change	% of Goal	Harvest Change
0%	65%	-100%	87%	-100%	100%	-100%
10%	58%	-85%	77%	-80%	88%	-77%
20%	52%	-70%	67%	-61%	76%	-55%
30%	45%	-55%	57%	-43%	65%	-35%
40%	39%	-39%	47%	-26%	53%	-18%
50%	32%	-24%	38%	-12%	41%	-4%
60%	26%	-9%	28%	-2%	29%	2
66%	22%	0%	22%	0%	22%	0%

Table 4. Effects of Harvest Rate on Progress Toward Natural Escapement Goal and Harvest in All Fisheries. Analysis assumes a -36% change in productivity and 41% change in capacity. Current harvest rate in shaded text (PFMC 1997).

	"Full Capacity" Scenario (1)		"MSY" Scenario (2)		Low Productivity" Scenario (3)	
Harvest Rate	% of Goal	Harvest Change	% of Goal	Harvest Change	% of Goal	Harvest Change
0%	65%	-100%	87%	-100%	113%	-100%
10%	58%	-85%	77%	-80%	99%	-74%
20%	52%	-70%	67%	-61%	86%	-50%
30%	45%	-55%	57%	-43%	72%	-28%
40%	39%	-39%	47%	-26%	58%	-10%
50%	32%	-24%	38%	-12%	44%	3%
60%	26%	-9%	28%	-2%	30%	6%
66%	22%	0%	22%	0%	22%	0%

Table 5. Effects of Harvest Rate on Progress Toward Natural Escapement Goal and Harvest in All Fisheries. Analysis assumes a -41% change in productivity and 56% change in capacity. Current harvest rate in shaded text (PFMC 1997).

	"Full Capacity" Scenario (1)		"MSY" Scenario (2)		Low Productivity" Scenario (3)	
Harvest Rate	% of Goal	Harvest Change	% of Goal	Harvest Change	% of Goal	Harvest Change
0%	65%	-100%	87%	-100%	123%	-100%
10%	58%	-85%	77%	-80%	108%	-72%
20%	52%	-70%	67%	-61%	92%	-46%
30%	45%	-55%	57%	-43%	77%	-23%
40%	39%	-39%	47%	-26%	62%	-4%
50%	32%	-24%	38%	-12%	46%	9%
60%	26%	-9%	28%	-2%	31%	10%
66%	22%	0%	22%	0%	22%	0%

TABLE 1. Effects of harvest rate on progress toward natural escapement goal and harvest in all fisheries.

		"Full Capacity" Scenario (1)		"MSY" Scenario (2)		Low Productivity" Scenario (3)	
	Harv Rate	% of Goal	Harvest Change	% of Goal	Harvest Change	% of Goal	Harvest Change
	0%	65%	-100%	87%	-100%	100%	-100%
	10%	58%	-85%	77%	-80%	88%	-77%
	20%	52%	-70%	67%	-61%	76%	-55%
	30%	45%	-55%	57%	-43%	65%	-35%
	40%	39%	-39%	47%	-26%	53%	-18%
	50%	32%	-24%	38%	-12%	41%	-4%
	60%	26%	-9%	28%	-2%	29%	2%
CURRENT	66%	22%	0%	22%	0%	22%	0%

//

Spawner-Recruit Assumptions for Scenarios 1-3.

Scenario 1: R=.22/.34 if S>.22
R=S/.34 if S<.22

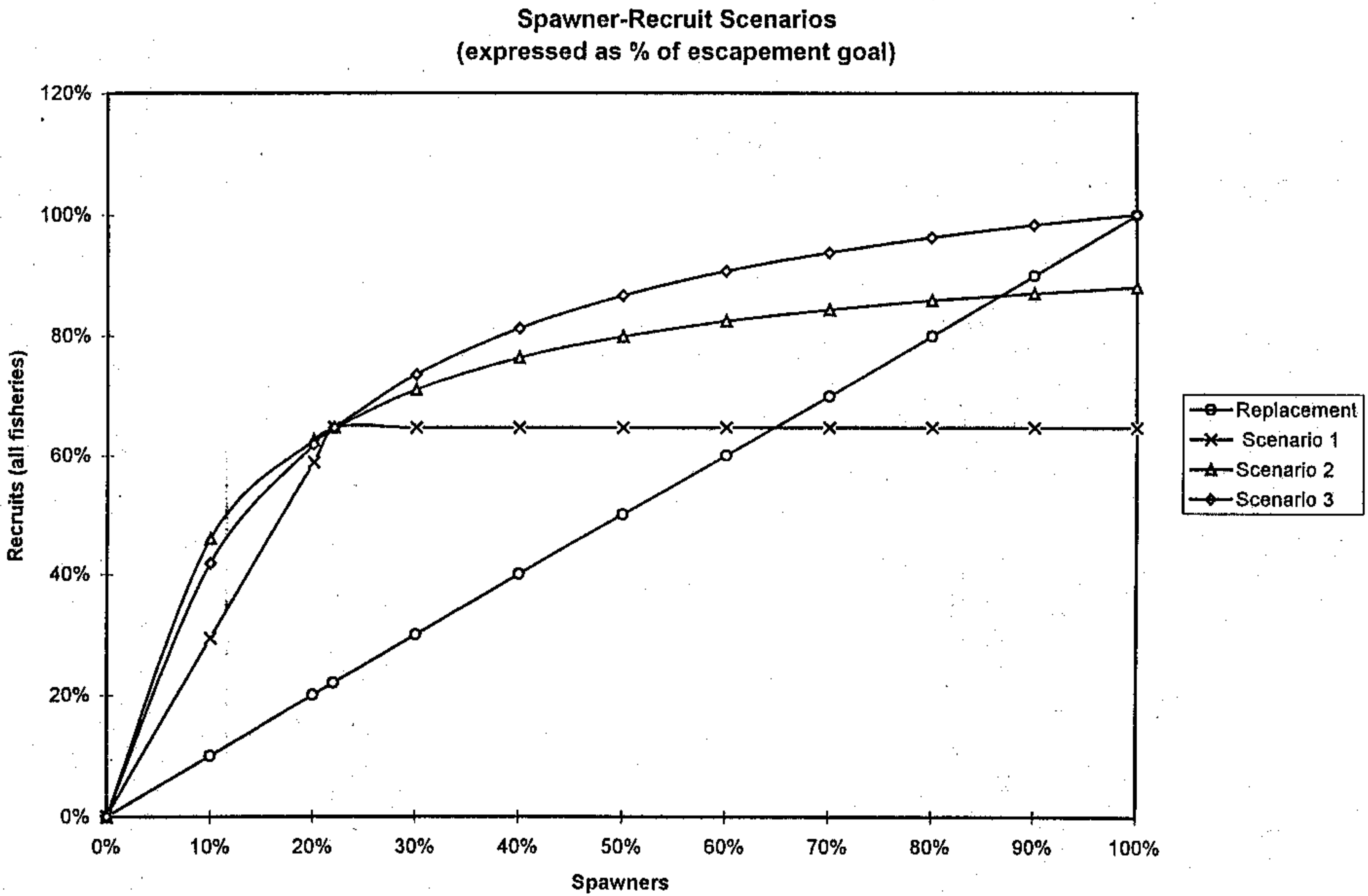
Scenarios 2,3: R=aS/(b+S) (Beverton-Holt)

Capacity (a) Change:	21%
Productivity Change:	-25%

	Beverton Holt Parameters	
	Scenario 2	Scenario 3
a=	0.980	1.184
b=	0.113	0.182

Number of Spawners	Line of Replacement	Number of Recruits (Unfished) Full Capacity Scenario 1	MSY Scenario 2	Low Productivity Scenario 3
0%	0%	0%	0%	0%
10%	10%	29%	46%	42%
20%	20%	59%	63%	62%
22%	22%	65%	65%	65%
30%	30%	65%	71%	74%
40%	40%	65%	76%	81%
50%	50%	65%	80%	87%
60%	60%	65%	82%	91%
70%	70%	65%	84%	94%
80%	80%	65%	86%	96%
90%	90%	65%	87%	98%
100%	100%	65%	88%	100%

Figure 1



Spawner-Recruit Scenarios
(expressed as % of escapement goal)
120%
100%
80%
60%
40%
20%
0%
Recruits (all fisheries)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Spawners
Replacement
Scenario 1
Scenario 2
Scenario 3

13

TABLE 1. Effects of harvest rate on progress toward natural escapement goal and harvest in all fisheries.

		"Full Capacity" Scenario (1)		"MSY" Scenario (2)		Low Productivity" Scenario (3)	
	Harv Rate	% of Goal	Harvest Change	% of Goal	Harvest Change	% of Goal	Harvest Change
	0%	65%	-100%	87%	-100%	113%	-100%
	10%	58%	-85%	77%	-80%	99%	-74%
	20%	52%	-70%	67%	-61%	86%	-50%
	30%	45%	-55%	57%	-43%	72%	-28%
	40%	39%	-39%	47%	-26%	58%	-10%
	50%	32%	-24%	38%	-12%	44%	3%
	60%	26%	-9%	28%	-2%	30%	6%
CURRENT	66%	22%	0%	22%	0%	22%	0%

Spawner-Recruit Assumptions for Scenarios 1-3.

Scenario 1: R=.22/.34 if S>.22
R=S/.34 if S<.22

Scenarios 2,3: R=aS/(b+S) (Beverton-Holt)

Capacity (a) Change:	41%
Productivity Change:	-36%

	Beverton Holt Parameters	
	Scenario 2	Scenario 3
a=	0.980	1.382
b=	0.113	0.250

		Number of Recruits (Unfished)		
Number of Spawners	**Line of Replacement**	**Full Capacity Scenario 1**	**MSY Scenario 2**	**Low Productivity Scenario 3**
0%	0%	0%	0%	0%
10%	10%	29%	46%	39%
20%	20%	59%	63%	61%
22%	22%	65%	65%	65%
30%	30%	65%	71%	75%
40%	40%	65%	76%	85%
50%	50%	65%	80%	92%
60%	60%	65%	82%	98%
70%	70%	65%	84%	102%
80%	80%	65%	86%	105%
90%	90%	65%	87%	108%
100%	100%	65%	88%	111%

Figure 1

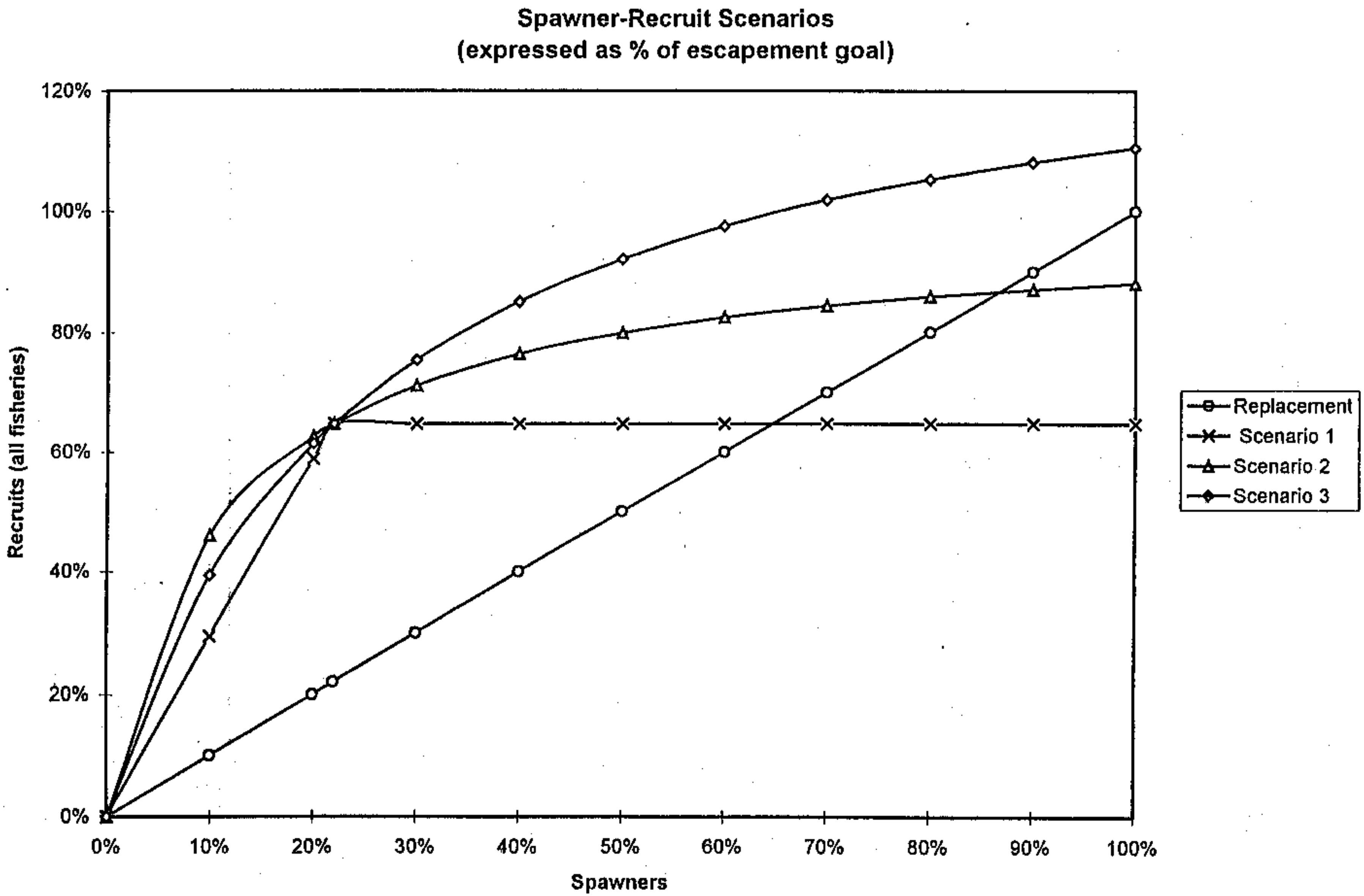

Spawner-Recruit Scenarios
(expressed as % of escapement goal)
Recruits (all fisheries)
Spawners
120%
100%
80%
60%
40%
20%
0%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Replacement
Scenario 1
Scenario 2
Scenario 3

TABLE 1. Effects of harvest rate on progress toward natural escapement goal and harvest in all fisheries.

	"Full Capacity" Scenario (1)		"MSY" Scenario (2)		Low Productivity" Scenario (3)	
Harv Rate	% of Goal	Harvest Change	% of Goal	Harvest Change	% of Goal	Harvest Change
0%	65%	-100%	87%	-100%	123%	-100%
10%	58%	-85%	77%	-80%	108%	-72%
20%	52%	-70%	67%	-61%	92%	-46%
30%	45%	-55%	57%	-43%	77%	-23%
40%	39%	-39%	47%	-26%	62%	-4%
50%	32%	-24%	38%	-12%	46%	9%
60%	26%	-9%	28%	-2%	31%	10%
CURRENT 66%	22%	0%	22%	0%	22%	0%

Spawner-Recruit Assumptions for Scenarios 1-3.

Scenario 1: R=.22/.34 if S>.22
R=S/.34 if S<.22

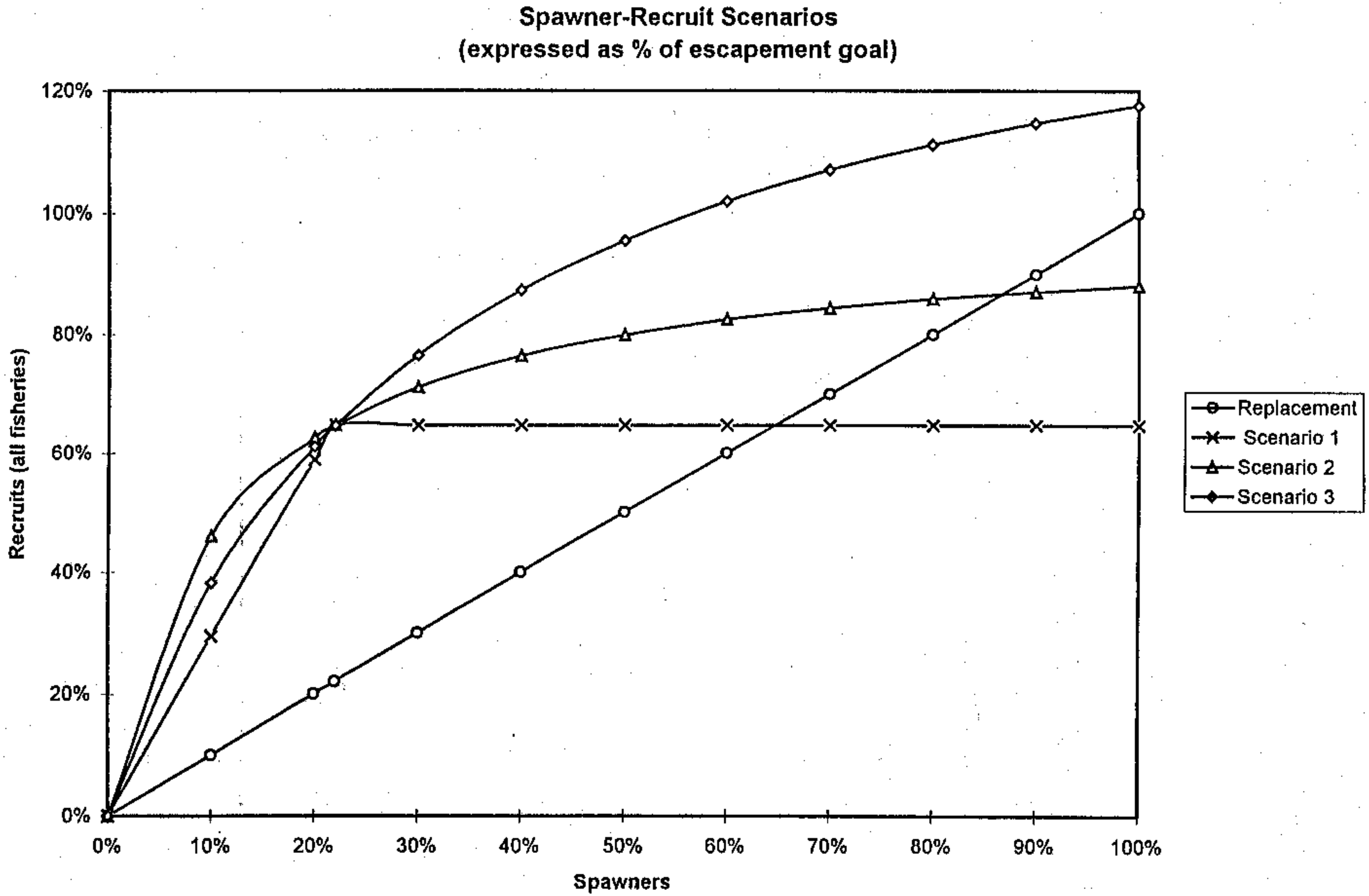
Scenarios 2,3: R=aS/(b+S) (Beverton-Holt)

Capacity (a) Change:	56%
Productivity Change:	-41%

	Beverton Holt Parameters	
	Scenario 2	Scenario 3
a=	0.980	1.529
b=	0.113	0.300

Number of *Spawners*	Line of Replacement	*Number of Recruits (Unfished)* Full Capacity Scenario 1	MSY Scenario 2	Low Productivity Scenario 3
0%	0%	0%	0%	0%
10%	10%	29%	46%	38%
20%	20%	59%	63%	61%
22%	22%	65%	65%	65%
30%	30%	65%	71%	76%
40%	40%	65%	76%	87%
50%	50%	65%	80%	96%
60%	60%	65%	82%	102%
70%	70%	65%	84%	107%
80%	80%	65%	86%	111%
90%	90%	65%	87%	115%
100%	100%	65%	88%	118%

Figure 1



Spawner-Recruit Scenarios
(expressed as % of escapement goal)
Recruits (all fisheries)
120%
100%
80%
60%
40%
20%
0%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Spawners
Replacement
Scenario 1
Scenario 2
Scenario 3

ATTACHMENT B9

ANOTHER WAY TO ASSESS THE HARVEST MANAGEMENT ALTERNATIVE

Go To TOC

July 14, 1997

To: TR EIS Fish and Channel Restoration Team (FCRT)
From: Joe Polos, USFWS-Arcata
Subject: Another way to assess the Harvest Management Alternative

Here's a simplified method of assessing the effectiveness of the Harvest Management Alternative (HMA) in meeting the Trinity River Restoration Goals for chinook salmon (spring and fall), which incorporates information used to assess the other alternatives (the attributes and objectives) and provides estimates of harvest and escapement. The only difference between the HMA and the No Action Alternative is that, in the HMA, fishery impacts are managed (reduced) to meet the spawning escapement goals of the Trinity River Restoration Program. Annual inriver allocations (340,000 af), restoration activities, etc. are the same for both alternatives. The FCRT estimated that 22% (~14,960 spawners) of the Restoration Program's spawning escapement goals would be met under the No Action Alternative.

Methods: The Harvest Rate Model (Table 1), which calculates harvest in ocean and inriver fisheries and resulting spawning escapement, was seeded with the appropriate ocean stock size (50,721 age 3; 22,672 age 4; and 781 age 5) so that under current ocean and inriver harvest rates used by the PFMC (0.20 ocean, 0.66 inriver), the spawning escapement would result in an escapement of ~14,960 fish (22% of the Restoration Program's chinook spawning goal). Ocean and inriver harvest rates were then reduced (by 25%, 50%, 75%, 90% and 100%) and the resulting harvest and escapement calculated. Reductions in ocean and inriver harvest rates were calculated without adjusting for equal sharing of the numbers of harvested chinook between tribal and non-tribal fisheries.

Results: Reduction of ocean and inriver harvest rates by 25% resulted in a spawning escapement that achieved 29.9% of the Restoration Program goal (Table 2), compared to 22% under full ocean and inriver harvest rates. Completely eliminating ocean and inriver fisheries (100% reduction) resulted in attainment of 57.7% of the Restoration Program's spawning escapement goal.

Conclusion: While reducing ocean and inriver harvest rates results in more spawners, even complete closure of ocean and inriver fisheries would only result in an attainment of 57.7% of the Restoration Program's chinook spawning escapement goal. Furthermore, based on the FCRT assessment that 22% of the goal is appropriate under the No Action Alternative, allowing spawning escapements above 22% of the Restoration Program goal is likely to oversaturate river habitats and may result in decreased production due to density-dependent mortality. While decreasing harvest leads to increased spawning escapement, implementation of this alternative does not meet the purpose and need of the Trinity River EIS, because reducing harvest and increasing escapement under the current No Action conditions may lead to a decrease in production of Trinity River salmonids.

Table 1. Harvest Rate Model Output for Chinook Based on Equilibrium Harvest Rates and Harvest Allocated Among Ocean and Inriver Fisheries (0% of allowable harvest rates).

HARVEST RATE MODEL(DEVELOPED BY USFWS, ARCATA) DATE: 7-13-97
TIME: 10:26 PM

*	OCEAN ADULT HARVEST	11,800	*	
*	INRIVER ADULT HARVEST	16,000	* REDUCTION FACTOR =	0
*	TRIBAL ADULT HARVEST	13,900	* TRIBAL SHARE =	0.869
*	NON-TRIBAL ADULT HARVEST	13,900	* RIVER REC SHARE OF	
*	INRIVER REC. ADULT HARVEST	2,100	* NON-TRIBAL HARVEST	15.1%
*	NAT SPAWNING ESCAPEMENT	14,963	*	

AGE	OSC	PERCENT LEGAL	SHAKER MORT	PERCENT MATURING	NATURAL MORT	OCEAN HARVEST RATE	TERMINAL HARVEST RATE
3	0.88	80.0%	0.31	33.5%	0.20	0.20	0.66
4	1.00	100.0%	0.00	94.6%	0.20	0.20	0.66
5	1.00	100.0%	0.00	100.0%	0.20	0.20	0.66
		LONG TERM H.R. COMB. FISH/FISH =				0.200	0.656
						0.2100	0.6500

14,963	AGE	STOCK STATUS	PREV FALL	POTENTIAL CONTACTS	CONTACTS	OCEAN LANDINGS	SHAKER DEATHS	OCEAN IMPACTS
74175								
0.6838	3	50,721	0	44634.85	8926	7140	554	7694
0.3057	4	22,672	0	22672.47	4534	4534	0	4534
0.0105	5	781	0	781.1098	156	156	0	156
	SUM	74175	0			11830		12384
	ADULT					11830		

AGE	REMAIN POP	ADULT RIVER RUN SIZE	RIVER CONTACT RATE	RIVER IMPACT RATE	RIVER DROPOFF RATE	RIVER IMPACTS	RIVER HARVEST
3	43027	14431	0.59	0.39	0.072	5585	5182
4	18138	17156	1.00	0.66	0.072	11254	10442
5	625	625	1.00	0.66	0.072	410	380
SUM	61790	32212				17249	16004

AGE	SPAWNING ESCAPE.	PROP IN NAT AREAS	NATURAL ESCAPE.		
3	8846	1.00	8846	ADULT ESCAPEMENT	14963
4	5902	1.00	5902	ADULT NAT ESCAPE.	14963
5	215	1.00	215		
SUM	14963		14963		

Table 2. Estimated harvest, escapement, and % of restoration goal achieved (%RG) for Trinity River chinook salmon at varying reductions of ocean and inriver harvest rates.[a]

Harvest Reduction	Tribal Harvest	Non-Tribal Harvest	Total Harvest	Spawning Escapement	%RG
0%	13,900	13,900	27,800	14,963	22.0%
25%	11,000	10,600	21,600	20,299	29.9%
50%	7,700	7,100	14,800	26,123	38.4%
75%	4,100	3,600	8,800	32,436	47.7%
90%	1,700	1,500	3,200	36,459	53.6%
100%	0	0	0	39,237	57.7%

[a] Reductions in ocean and inriver harvest rates were calculated without adjusting for equal sharing of the numbers of harvested chinook between tribal and non-tribal fisheries.

ATTACHMENT B10

JUSTIFICATION OF NO NATURAL PRODUCTION FOR THE STATE PERMIT ALTERNATIVE

State Permit DRAFT Justification of No Natural Production in year 2022 (2/10/98)

Given the rating of the attributes, the FCRT would expect that naturally producing populations of salmonids in the mainstem Trinity River will be at extremely low levels in the year 2022. Justification for this conclusion is:

Current population status is poor:

1. Williamson et al., citing four references, states:
"At least an 80% decline in salmon and steelhead production from the Trinity River followed" [the reduction in stream flow following the completion of the TRD].

2. The Mainstem Trinity River Watershed Analysis (1995) states:
"Overall, 90% of the historic anadromous fish runs have been lost, primarily in the past four decades."

3. Coho salmon populations in the Trinity/Klamath Rivers were listed as threatened, pursuant to the Endangered Species Act (62 Fed. Reg. 24588).

Flows similar to the state permit flows were released during the first years of TRD operation, and resulted in documented degradation of river habitats. If the State Permit flows (120,500 AF) were maintained over the next 30 years, the habitat would continue to degrade as described below:

1. Berms would increase, resulting in monotypic habitat that does not address the needs of all lifestages of anadromous fish that evolved in the pre-dam dynamic system;

2. Encroachment of riparian vegetation would further fossilize channels, maintaining that monotypic habitat, and stabilizing gravels, which would then no longer be suitable for spawning;

3. Summer temperatures would be inadequate for the holding of adult spring chinook and summer steelhead, or rearing and outmigration of juvenile salmonids; and

4. Fine sediment would not be exported out of the system and continue to accumulate in the mainstem, increasing embeddedness, which results in poor spawning gravels, low survival rates from eggs to emergence, and decreases the amount of surface area available for macroinvertebrates that are important prey items to anadromous fishes.

With such impacts to an already degraded habitat and depressed numbers of natural fish, the FCRT expect natural reproduction of salmonids in the mainstem Trinity to be at extremely low levels, and indistinguishable from hatchery strays. Strays from the hatchery may attempt to spawn inriver, but survival of any eggs deposited inriver would expected to be extremely low.

ATTACHMENT B11

SUMMARY OF SACRAMENTO RIVER CHINOOK SALMON SPAWNING DISTRIBUTIONS

To: Walter Bourez, SWRI Date: Mar 6, 1997
Russ Brown, JSA
Cindy Lowney, UCD
Jeff Meyer, WRMI
Saquib Najmus, Abdul Khan, CH2MHILL
Alice Rich, AARA
Rob Tull, Vanessa Nishikawa, MW

From: Jack Rowell, USBR

Subj: Model update: USBR Sacramento River Basin Temperature Model - Sacramento River Salmon Model

A change in the modeled spatial distribution of winter-run salmon spawning in the Sacramento River was recently proposed by Jim Smith (FWS) and Gary Stern (NMFS). The distribution currently used in the salmon model (**LSALMON2**) is based on 1981-93 redd observations. The proposed distribution is based on 1990-1996 data. The justification for using the 1990-1996 period is as follows:

During the past 10 years, Red Bluff Diversion Dam (RBDD) gates and water temperature in the upper Sacramento River have been actively managed to attract adult winter-run chinook through and above RBDD. However, only since 1990 have the RBDD gates remained raised continuously until late April or mid-May. It is expected that the gates will continue to be operated in this manner in future years.

All USBR model studies from now on including the Trinity River Fishery Restoration EIS/EIR, the 800 TAF or B2 studies, and others will use the proposed distribution. I recommend that other users adopt this revision also. Since the revised distribution substantially reduces modeled winter-run losses, all alternatives being compared should use the same distribution.

The old and new winter-run distributions are as follows:

River Reach	**Winter-run Spawning Distribution - %** **OLD (1981-93)**	**NEW (1990-96)**
Keswick Dam - ACID Dam	.5	2.7
ACID Dam - Hwy 44	31.9	54.7
Hwy 44 - Upper Anderson Br.	24.2	29.2
Up. Anderson Br. - Balls Ferry	8.1	7.9
Balls Ferry - Jelly's Ferry	7.1	1.5
Jelly's Ferry - Bend Bridge	8.1	2.1
Bend Bridge - RBDD	1.4	.0
RBDD - Tehama Bridge	12.8	1.6
Tehama Bridge - Woodson Bridge	5.9	.3

Go To TOC

Woodson Bridge - Hamilton City	.0	.0
Hamilton City - Ord Ferry	.0	.0
Ord Ferry - Princeton	.0	.0

In the Sacramento River salmon mortality model (**LSALMON2**), the data statement (or external input data) for the variable **RD(I,3)** should be revised with the new distributions in decimal form.

Another minor revision in the Sacramento River temperature model (**LSACTEM3**), which reflects a change in the river mile designation for Upper Anderson Bridge, should be made. This does not change the temperature model output at specific nodes, but does alter the temperature model input to the salmon model and, consequently, the salmon spawning river reach temperatures calculated in the salmon model. The effects of this change on salmon losses are relatively minor.

In the **DO 800** loop in **LSACTEM3**, change the statement:

IF(L.EQ.9)GO TO 799 to IF(L.EQ.8)GO TO 799

If you have any questions on the above model revisions, call me at (916) 979-2434.

Jack

cc: Jeff Sandberg, USBR
Paul Fujitani, USBR
Ken Lentz, USBR
Bernice Sullivan, USBR
Derek Hilts, FWS
Jim Smith, FWS
Gary Stern, NMFS

WINTER-RUN CHINOOK SALMON
Recent Spawning Distribution
1990-1996

1990 Spawning Season

River Reach	Percent Redds Observed
Keswick Dam (RM 302) to ACID Dam (RM 298)	0
ACID Dam (RM 298) to Highway 44 (RM 296)	39
Highway 44 (RM 296) to Upper Anderson Bridge (RM 285)	47
Up. Anderson Bridge (RM 285) to Balls Ferry (RM 276)	5
Balls Ferry (RM 276) to Jelly's Ferry (RM 267)	2
Jelly's Ferry (RM 267) to Bend Bridge (RM 256)	0
Bend Bridge (RM 256) to RBDD (RM 242)	0
Downstream of RBDD (RM 242)	7

Total Redds Observed = 97

1991 Spawning Season

River Reach	Percent Redds Observed
Keswick Dam (RM 302) to ACID Dam (RM 298)	0
ACID Dam (RM 298) to Highway 44 (RM 296)	67
Highway 44 (RM 296) to Upper Anderson Bridge (RM 285)	33
Up. Anderson Bridge (RM 285) to Balls Ferry (RM 276)	0
Balls Ferry (RM 276) to Jelly's Ferry (RM 267)	0
Jelly's Ferry (RM 267) to Bend Bridge (RM 256)	0
Bend Bridge (RM 256) to RBDD (RM 242)	0
RBDD (RM 242) to Tehama Bridge (RM ??)	0

Total Redds Observed = 10

1992 Spawning Season

River Reach	Percent Redds Observed
Keswick Dam (RM 302) to ACID Dam (RM 298)	1.9
ACID Dam (RM 298) to Highway 44 (RM 296)	27.8
Highway 44 (RM 296) to Upper Anderson Bridge (RM 285)	40.7
Up. Anderson Bridge (RM 285) to Balls Ferry (RM 276)	14.8
Balls Ferry (RM 276) to Jelly's Ferry (RM 267)	5.6
Jelly's Ferry (RM 267) to Bend Bridge (RM 256)	5.6
Bend Bridge (RM 256) to RBDD (RM 242)	0
RBDD (RM 242) to Tehama Bridge (RM ??)	3.7

Total Redds Observed = 54

1993 Spawning Season

River Reach	Percent Redds Observed
Keswick Dam (RM 302) to ACID Dam (RM 298)	4.2
ACID Dam (RM 298) to Highway 44 (RM 296)	64.6
Highway 44 (RM 296) to Upper Anderson Bridge (RM 285)	22.9
Up. Anderson Bridge (RM 285) to Balls Ferry (RM 276)	2.1
Balls Ferry (RM 276) to Jelly's Ferry (RM 267)	2.1
Jelly's Ferry (RM 267) to Bend Bridge (RM 256)	2.1
Bend Bridge (RM 256) to RBDD (RM 242)	0
RBDD (RM 242) to Tehama Bridge (RM ??)	2.1

Total Redds Observed = 48

1994 Spawning Season

River Reach	Percent Redds Observed
Keswick Dam (RM 302) to ACID Dam (RM 298)	0
ACID Dam (RM 298) to Highway 44 (RM 296)	40
Highway 44 (RM 296) to Upper Anderson Bridge (RM 285)	20
Up. Anderson Bridge (RM 285) to Balls Ferry (RM 276)	33.3
Balls Ferry (RM 276) to Jelly's Ferry (RM 267)	0
Jelly's Ferry (RM 267) to Bend Bridge (RM 256)	6.7
Bend Bridge (RM 256) to RBDD (RM 242)	0
RBDD (RM 242) to Tehama Bridge (RM ??)	0

Total Redds Observed = 15

1995 Spawning Season

River Reach	Percent Redds Observed
Keswick Dam (RM 302) to ACID Dam (RM 298)	6
ACID Dam (RM 298) to Highway 44 (RM 296)	87.9
Highway 44 (RM 296) to Upper Anderson Bridge (RM 285)	5
Up. Anderson Bridge (RM 285) to Balls Ferry (RM 276)	0
Balls Ferry (RM 276) to Jelly's Ferry (RM 267)	0.5
Jelly's Ferry (RM 267) to Bend Bridge (RM 256)	0
Bend Bridge (RM 256) to RBDD (RM 242)	0
RBDD (RM 242) to Tehama Bridge (RM ??)	0.5

Total Redds Observed = 199

1996 Spawning Season

River Reach	Percent Redds Observed
Keswick Dam (RM 302) to ACID Dam (RM 298)	6.8
ACID Dam (RM 298) to Highway 44 (RM 296)	56.8
Highway 44 (RM 296) to Upper Anderson Bridge (RM 285)	36.4
Up. Anderson Bridge (RM 285) to Balls Ferry (RM 276)	0
Balls Ferry (RM 276) to Jelly's Ferry (RM 267)	0
Jelly's Ferry (RM 267) to Bend Bridge (RM 256)	0
Bend Bridge (RM 256) to RBDD (RM 242)	0
RBDD (RM 242) to Tehama Bridge (RM ??)	0

Total Redds Observed = 44

JUSTIFICATION for use of 1990-96 period: During the past 10 years, Red Bluff Diversion Dam (RBDD) gates and water temperature in the upper Sacramento River have been actively managed to attract adult winter-run chinook through and above RBDD. However, only since 1990 have the gates of RBDD gates remained raised continuously until late April or mid-May. We expected the gates of RBDD will remained operated in this manner in future years.

c:\wp51\misc\wrspawn.dis

ATTACHMENT B12

RESULTS OF ATTRIBUTE SCORING THE ECOSYSTEM OBJECTIVES FOR THE SIMULATED 1922-1990 HYDROLOGY

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Restore alluvial channel (able to form its own bed, particle, and bank dimensions	*	*	*	*	*	*	*
2	Create and/or maintain structural complexity of alternate bar sequences	*	*	*	*	*	*	*
3	Create and maintain functional floodplains	*	*	*	*	*	*	*
4	Increase diversity of channelbed particle size	*	*	*	*	*	*	*
5	Greater topographic complexity in side channels	*	*	*	*	*	*	*
	SUM OF ALTERNATIVE:	**0**	**0**	**0**	**0**	**0**	**0**	**0**

THRESHOLDS:

1,2,3 Dependent on integration of all Attributes

SCORING: *'As these objectives are dependent on the integration of all other attributes, the fish team did not assess these objectives to eliminate potential double counting.

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Provide inter- and intra-annual flow variation for summer baseflows (7/1-10/1)	0	0	0	0	2	0	0
2	Provide inter- and intra-annual flow variation for winter baseflows (1/1-4/1)	0	0	0	0	2	0	0
3	Provide inter- and intra-annual flow variation for winter floods (10/1-4/30)	0	0	0	0	1	0	0
4	Provide inter- and intra-annual flow variation for snowmelt peak floods (4/1-6/30)	0	1	1	1	2	2	2
5	Provide inter- and intra-annual flow variation for snowmelt recession (5/1-7/31)	0	1	1	1	2	2	2
	SUM OF ALTERNATIVE:	**0**	**2**	**2**	**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

	OBJECTIVES	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Exceed incipient motion for mobile active channel alluvial features (median bars, pool tails, spawning gravel deposits) every 2 of 3 years	0	0	0	0	1	2	2
2	Achieve incipient motion for most of channelbed surface (riffles, face of point bars) every two of three years	0	0	0	0	0	2	2
3	Exceed threshold for transporting sand through most pools every two of three years	0	0	1	0	2	2	2
	SUM OF ALTERNATIVE:	**0**	**0**	**1**	**0**	**3**	**6**	**6**

THRESHOLDS:

Bed surface mobilization of the mobile active channel alluvial features occurs > 3,000 cfs
Bed surface mobilization of the most of the channebed surface occurs > 6,000 cfs (TARGET VALUE)
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 rarely exceeds threshold

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Scour/redeposit spawning gravel deposits (at least 2 D84 thickness) every 2-3 years	0	0	0	0	0	2	2
2	Scour/redeposit faces of alternate bars (at least 2 D84 thickness) every 3-5 years	0	0	0	0	0	2	1
3	Deposit fine sediment onto upper alternate bar and floodplain surfaces	0	0	0	0	0	2	2
4	Maintain scour channels on alternate bar surfaces every 3-5 years	0	0	0	0	0	2	1
	SUM OF ALTERNATIVE:	**0**	**0**	**0**	**0**	**0**	**8**	**6**

THRESHOLDS:

1,3 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

Attributes are also based on frequency occurrences listed above

SCORING:

"2" always or nearly always exceeds threshold

"1" sometimes exceeds threshold

"0" never or rarely exceeds threshold

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Reduce fine sediment storage in mainstem	0	0	1	0	0	2	2
2	Maintain coarse sediment budget in the mainstem	0	0	0	0	0	2	2
3	Route mobilized D84 through alternate bar sequence every 2 of 3 years	0	0	0	0	0	2	2
4	Prevent excessive aggradation of tributary derived material in mainstem	0	0	0	0	0	1	2
	SUM OF ALTERNATIVE:	**0**	**0**	**1**	**0**	**0**	**7**	**8**

THRESHOLDS:

1 Ability of combined flow magnitude & duration to transport fine sediment through the system (Table SEDIMENT BUDGET).
2 Ability of combined flow magnitude & duration to acheive ZERO net coarse sediment budget (Table SEDIMENT BUDGET),
3 Exceeded by flows greater than 6,000 cfs
4 Mechanically excavated and distributed downstream and/or maintained by flows; distributioin of delta begins at flows >6,000,
4 r particales require flows >14,000 cfs

SCORING:

1 Alternatives were scored relative to one another, "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
2 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 rarely exceeds threshold

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Channel migrates in alluvial reaches	0	0	0	0	0	1	1
2	Maintain channel geometry as channel migrates	0	0	0	0	0	2	2
3	Create channel avulsions every 10 years	0	0	0	0	0	0	2
	SUM OF ALTERNATIVE:	**0**	**0**	**0**	**0**	**0**	**3**	**5**

THRESHOLDS:

1 Requires partial removal of riparian berm + estimated > 6,000 cfs flow
2 Requires adequate coarse sediment supply + 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 rarely exceeds threshold

08/19/99

	[illegible] OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Inundate the floodplain on average every 2 of 3 years	0	0	0	0	0	2	2
2	Encourage local floodplain surface scour and deposition by infrequent (every 3-5 years) but larger floods	0	0	0	0	0	2	1
3	Floodplain construction keeps pace with floodplain loss on opposite bank	0	0	0	0	0	2	2
	SUM OF ALTERNATIVE:	**0**	**0**	**0**	**0**	**0**	**6**	**5**

THRESHOLDS:

1 Flows greater than 6,000 cfs
2 Flows greater than 8,500 cfs
3 Requires fine sediment supply and flows >6,000 cfs

SCORING:

"2" always or nearly always exceeds threshold
"1" sometimes exceeds threshold
"0" never or rarely exceeds threshold

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Major re-organization of alternate bar sequences every 10 to 20 years	0	0	0	0	0	0	2
2	Remove upstream bedload impedence by distributing tributary delta materials	0	0	0	0	0	0	2
3	Infrequent (once every 5-10 yrs) deep scour on floodplain surfaces	0	0	0	0	0	0	2
4	Construct and maintain/ rejuvenate side channels	0	0	1	0	1	1	2
5	Deposit fine sediment on lower terrace surfaces	0	0	0	0	0	1	2
	SUM OF ALTERNATIVE:	**0**	**0**	**1**	**0**	**1**	**2**	**10**

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 maintain side channels
5 Flows greater than 11,000-14,000 cfs causing inundation of pre-dam flood plains (which now function as low terraces)

SCORING:

"2" always or nearly always exceeds threshold
"1" sometimes exceeds threshold
"0" never or rarely exceeds threshold

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Prevent seedling germination on lower bar surfaces	0	0	0	0	1	1	1
2	Scour or remove most initiating seedlings (0 to 1 year old plants)	0	0	1	0	0	2	2
3	Scour of most established seedlings (2 to 3 year old plants)	0	0	1	0	0	1	2
4	Periodic removal of individual mature riparian trees at least every 10 years	0	0	2	0	0	0	2
5	Seed deposition on floodplains every 2-3 years	0	0	0	0	1	2	2
	SUM OF ALTERNATIVE:	**0**	**0**	**4**	**0**	**2**	**6**	**9**

THRESHOLDS:

1 Bar inundation of seed dispersal period (1,500 cfs-2,000 cfs) in June and July
2 Surficial bed scour on lower bar surfaces requires flows greater than 6,000 cfs OR hand and/or mechanical removal
3 Deep bed scour on 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
4 OR mature riparian alders are mechanically removed
5 Floodplain access begins at 5,000-6,000 cfs and these flows are needed in June and July

SCORING:

"2" always or nearly always exceeds threshold
"1" sometimes exceeds threshold
"0" never or rarely exceeds threshold

08/19/99

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Groundwater recharge of gravel bars	0	2	2	2	2	2	2
2	Groundwater recharge of floodplains and off-channel wetland habitats	0	0	0	0	0	2	2
3	Groundwater recharge of terraces and associated wetland habitats	0	0	0	0	0	1	1
	SUM OF ALTERNATIVE:	**0**	**2**	**2**	**2**	**2**	**5**	**5**

THRESHOLDS:

1 Exceeded by flows greater than 1500-2000 cfs
2 Exceeded by flows greater than 6000 cfs
3 y flows greater than 10,000 to 14,000 cfs

SCORING:

"2" always or nearly always exceeds threshold
"1" sometimes exceeds threshold
"0" never or rarely exceeds threshold

	OBJECTIVE	STATE PERMIT	NO ACTION	MECH REST	REG HARVEST	40% FLOW	TRFS	MAX FLOW
1	Flows sufficient to meet smolt outmigration Temperature criteria (4/22-7/14)	0	0	0	0	0	1	1
2	Flow sufficient (450 cfs or greater) to meet state board temperature objectives under all conditions	0	2	2	2	0	2	1
3	Provides adequate fry and juvenile rearing flows	*	*	*	*	*	*	*
4	Provides adequate adult spawning flows	*	*	*	*	*	*	*
	SUM OF ALTERNATIVE:	**0**	**2**	**2**	**2**	**0**	**3**	**2**

THRESHOLDS:

1 Temperatures were assessed based on data presented in (Table OUTMIGRATION 1-4)

2 Temperatures were assessed on schedules ability to provide 450 cfs flow during this time period (Table STATE OBJECTIVES 1-4)

*3&4 *These objectives were not assesed as there is no conclusive data available for change d channel configuration, and and relative assessment of alternatives was not possible*

SCORING:

"2" optimal temperature criteria are met >90% of the time

"1" optimal temperature criteria are met 50-90% of the time

"0" optimal temperature criteria are met <50% of the time

Total scoring of attributes for each alternative and calculated percentage based on the total points possible (74).

Attribute	State Permit	No Action	Mechanical Restoration	Regulated Harvest*	40% Inflow**	TR Flow Study	Maximum Flow****
1	0	0	0	0	0	0	0
2	0	2	2	2	9	4	4
3	0	0	1	0	3	6	6
4	0	0	0	0	0	8	6
5	0	0	1	0	0	7	8
6	0	0	0	0	0	3	5
7	0	0	0	0	0	6	5
8	0	0	1	0	1	2	10
9	0	0	4	0	2	6	9
10	0	2	2	2	2	5	5
11	0	2	2	2	0	3	2
Points:	0	6	13	6	17	50	60
Percentage	0.00	0.08	0.18	0.08	0.23	0.68	0.81

* Regulated Harvest alternative is to be assessed as previously decided by the fish team, using the spawning escapement determined from the No Action Alternative

** The 40% inflow alternative has been re-assessed using the percentage of annual flow schedules (based on 80 years of historical data) that meet the defined criteria. The previous scoring was based on average flow schedules for each water year type.

**** The Maximum Flow alternative assumed that a peak release of 8,500 cfs is NOT met in Wet water year types..

ATTACHMENT B13

ASSUMPTIONS AND RATIONALE FOR SCORING THE ECOSYSTEM ATTRIBUTES FOR THE SIMULATED 1912-1995 HYDROLOGY

Fish and Channel Restoration Team- Scoring of the attributes- Rationale

Assumptions:

1. If actions are made that move closer to meeting or that meet the attributes, fish production will increase.
2. All attributes were weighted equally important for fish production.
3. These attributes provide and maintain habitat for all freshwater life stages of anadromous fish.
4. The decline of one attribute can negate the benefits to fish of all other attributes (i.e. habitat diversity, water quality).
5. Changes in fish numbers are not linearly correlated with flow.
6. Only set flow release schedules were scored, no safety of dam releases were assessed.
7. Sediment related attributes are limited to mainstem channel upriver from the Indian Creek confluence.
8. The 40 % inflow alternative is based on Table 40%INFLOW and not average flow schedules by water year types used for other impact assessment.
9. Current harvest management practices are sustainable.

Attribute #1, all objectives

As the objectives under attribute #1 depend on integrating all other attributes, alternatives were not scored to eliminate potential double counting.

Attribute #2, Objective 1

"0" scores: State Permit, No Action, Mechanical Restoration, TRFES, and Maximum Flow scored "0" because each has the same set schedule for summer baseflows and that schedule does not vary by water year type. There is virtually no variation in these schedules for the summer months, whereas the pre-dam hydrograph was highly variable between and within years.

"1" scores: No alternatives scored "1" for this objective.

"2" scores: The 40% Inflow scored "2" because its release schedule is based on unregulated flow into the reservoir , which will provide release patterns that respond to current conditions and variation in those patterns.

Attribute #2, Objective 2

"0" scores: State Permit, No Action, Mechanical Restoration, TRFES, and Maximum Flow scored "0" because each has the same unvarying schedule for winter baseflows and that schedule does not vary by water year type. There is no variation in these schedules for the winter months, whereas pre-dam annual hydrographs were highly variable between and within years.

"1" scores: No alternatives scored "1" for this objective.

"2" scores: The 40% Inflow scored "2" because its release schedule is based on unregulated flow into the reservoir , which will provide flow patterns similar to pre-dam flow patterns.

Attribute #2, Objective 3

"0" scores: State Permit, No Action, Mechanical Restoration, TRFES, and Maximum

Go To TOC

Flow scored "0" because each has the same set schedule throughout winter and does not vary by water year type. There is no variation in these schedules for the winter months, and no large releases that simulate floods occur during the winter months, whereas the pre-dam annual hydrographs indicate that winter floods were common.
"1" scores: The 40% Inflow scored "1" because it is based on the amount of water inflow to the reservoir on a weekly time step (similar to the pre-dam hydrograph scaled-down) and therefore most closely mimics the timing and relative magnitudes of the hydrograph if the dam were not there, including floods. However, the winter flood magnitudes are much smaller, and below a geomorphic threshold expected of unregulated winter floods, than pre-dam floods.
"2" scores: No alternatives scored "2" for this objective.

Attribute #2, Objective 4

"0" scores: State Permit scored "0" because there is no attempt to schedule water in any year to mimic snowmelt peak floods, but instead typically held at a constant flow, and scheduled releases are the same regardless of water year type.
"1" scores: No Action and Mechanical Restoration scored "1" because these schedules mimic a snowmelt peak flood in mid-May with a 2,000 cfs release, but this flood has the same magnitude and timing every year, regardless of water year type.
"2" scores: The 40% Inflow, TRFES, and Maximum Flow scored "2" because these schedules mimic a snowmelt peak flood, which differ in magnitude and timing for each water year type.

Attribute #2, Objective 5

"0" scores: State Permit scored "0" because there is no scheduled release that mimics snowmelt recession in the spring/summer.
"1" scores: No Action and Mechanical Restoration scored "1" because these schedules mimic a snowmelt recession, but this recession is the same for every year, regardless of water year type.
"2" scores: The 40% Inflow, TRFES, and Maximum Flow scored "2" because these schedules mimic snowmelt recession and this recession is scheduled differently for each water year type.

Go To TOC

Attribute #3, Objective 1

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 3,000 cfs.

"1" scores: The 40% Inflow scored "1" because dam releases exceed 3,000 cfs in 50% of the years (see Table 40% Inflow; every 1 of 2 years), whereas 3,000 cfs is needed in every 2 of 3 years.

"2" scores: TRFES and Maximum Flow scored "2" because dam releases meet or exceed 3,000 cfs in all water year types, except Critically Dry years (p=0.12).

Attribute #3, Objective 2

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 6,000 cfs. 40% Inflow scored "0" because dam releases of 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).

"1" scores: No alternatives scored "1" on this objective.

"2" scores: TRFES and Maximum Flow scored "2" because dam releases meet or exceed 6,000 cfs in three water year types (Extremely Wet (p=0.12), Wet (p=0.28) and Normal (p=0.20).

Attribute #3, Objective 3

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases do not exceed threshold for transporting significant volumes of sand through pools. Limited dredging on the mainstem does occur for all these alternatives, except the State Permit Alternative, but the effectiveness of dredging will be limited to locale sites, and negligible to the overall mainstem.

"1" scores: Mechanical Restoration scores a "1" because of additional dredging sites and additional upper watershed work to decrease fine sediment input to the Trinity River, which will affect large portions of the river.

"2" scores: The 40% Inflow, TRFES, and Maximum Flow scored "2" because the threshold for transporting significant volumes of sand through pools is between 2,000 cfs and 3,000 cfs, and transporting will occur river-wide.

Attribute #4, Objective 1

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 6,000 cfs. 40% Inflow scored "0" because dam releases of at least 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).

"1" scores: No alternatives scored "1" on this objective.

"2" scores: TRFES and Maximum Flow scored "2" because both alternatives meet or exceed 6,000 cfs in Extremely Wet, Wet and Normal years, which is 60% of the years on average.

Attribute #4, Objective 2

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to exceed 8,500 cfs. 40% Inflow scored "0" because dam releases of 8,500 cfs are only expected in 4% of the years (see Table 40%INFLOW).

Go To TOC

"1" scores: Maximum Flow scored "1" because schedules for Extremely Wet years exceed 8,500 cfs, which is 12% of the years on average.
"2" scores: TRFES and Maximum Flow scored "2" because schedules for Extremely Wet and Wet years meet or exceed 8,500 cfs, which is 40% of the years on average.

Attribute #4, Objective 3

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to exceed 6,000 cfs. 40% Inflow scored "0" because dam releases of 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).
"1" scores: No alternatives scored "1" on this objective.
"2" scores: TRFES and Maximum Flow scored "2" because both alternatives meet or exceed 6,000 cfs in Extremely Wet, Wet and Normal years, which is 60% of the years on average.

Attribute #4, Objective 4

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to exceed 8,500 cfs. 40% Inflow scored "0" because 8,500 cfs releases are only expected in 6% of the years (see Table 40%INFLOW).
"1" scores: Maximum Flow scored "1" because schedules for Extremely Wet years exceed 8,500 cfs, which is only 12% of the years on average.
"2" scores: TRFES scored "2" because flow schedules for Extremely Wet and Wet years meet or exceed 8,500 cfs, which is 40% of the years on average.

Attribute #5, Objective 1

"0" scores: State Permit, No Action, and 40% Inflow scored "0" because these alternatives moved the leas amount of fine sediment through the system (See Table SEDIMENT BUDGET).
"1" scores: Mechanical Restoration scored "1" because limited amounts of fine sediment will be removed locally by excavating riparian berms from the project sites, and upper watershed restoration is expected to reduced fine sediment input into the river by 8-17%.
"2" scores: TRFES and Maximum Flow scored "2" because both supply sufficient flows to transport the majority of fine sediment entering the mainstem channel and to mobilize fine sediment stored in the channelbed subsurface.

Attribute #5, Objective 2

"0" scores: State Permit, No Action, and Mechanical Restoration and 40% Inflow scored "0" because there is not enough water to route sufficient amounts of coarse sediment through the system, resulting in a surplus of 1,000,000 ton over a 30 year period (see Table SEDIMENT BUDGET).
"1" scores: No alternatives scored "1" on this objective.
"2" scores: TRFES scored "2" because this alternative routes coarse sediment through the system without creating a sediment deficit. Maximum Flow scored "2" because it routes all coarse sediment through the system and could create a deficit (see Table SEDIMENT BUDGET); this deficit is largely compensated by gravel/cobble introduction.

Go To TOC

Attribute #5, Objective 3

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 6,000 cfs. 40% Inflow scored "0" because dam releases of at least 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).

"1" scores: No alternatives scored "1" on this objective.

"2" scores: TRFES and Maximum Flow scored "2" because both alternatives meet or exceed 6,000 cfs in Extremely Wet, Wet and Normal years, which is 60% of the years on average.

Attribute #5, Objective 4

"0" scores: State Permit, No Action, and Mechanical Restoration and 40% Inflow scored "0" because dam releases are not scheduled to meet 6,000 cfs.

"1" scores: TRFES scored "1" because flows exceed 6,000 cfs in Extremely Wet and Wet years, but do not exceed 14,000 cfs, which is necessary to substantially mobilize and route coarse material downstream.

"2" scores: Maximum Flow scored "2" because flows exceed both 6,000 and 14,000 cfs, which should mobilize and route most size classes of delta deposits.

Attribute #6, Objective 1

"0" scores: State Permit, No Action, and Mechanical Restoration, scored "0" because dam releases are not scheduled to meet 6,000 cfs. The 40% Inflow alternative scored "0" because dam releases of at least 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).

"1" scores: TRFES and Maximum Flow scored "1" because scheduled flow magnitudes may be sufficient to initiate channel migration, but scheduled flow duration insufficient to maintain rate of channel migration.

"2" scores: No alternative scored "2" for this objective.

Attribute #6, Objective 2

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 6,000 cfs. The 40% Inflow alternative scored "0" because dam releases of at least 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).

"1" scores: No alternative scored "1" for this objective.

"2" scores: TRFES and Maximum Flow scored "2" because magnitude/duration of flows and sediment supply are sufficient to build coarse alternate bars as channel migrates, and therefore maintain channel width.

Attribute #6, Objective 3

"0" scores: State Permit, No Action, and Mechanical Restoration 40% Inflow and TRFES scored "0" because dam releases are not scheduled to meet 30,000 cfs.

"1" scores: No alternative scored "1" for this objective.

Go To TOC

"2" scores: Maximum Flow scored "2" because 30,000 cfs release is scheduled for the first 3 Extremely Wet years. This will exceed flow threshold for channel avulsions.

Attribute #7, Objective 1

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 6,000 cfs. 40% Inflow scored "0" because dam releases of at least 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).

"1" scores: No alternative scored "1" for this objective.

"2" scores: TRFES and Maximum Flow scored "2" because both alternatives meet or exceed 6,000 cfs in Extremely Wet, Wet and Normal years, which is 60% of the years on average.

Attribute #7, Objective 2

"0" scores: State Permit, No Action, and Mechanical Restoration, scored "0" because dam releases are not scheduled to exceed 8,500 cfs. 40% Inflow scored "0" because dam releases of 8,500 cfs are only expected in 4% of the years (see Table 40%INFLOW).

"1" scores: Maximum Flow scored "1" because schedules for Extremely Wet years exceed 8,500 cfs, which is 12% of the years on average.

"2" scores: TRFES scored "2" because schedules for Extremely Wet and Wet years meet or exceed 8,500 cfs, which is 40% of the years on average. Maximum Flow scored "1" because schedules for Extremely Wet years exceed 8,500 cfs, which is 12% of the years on average.

Attribute #7, Objective 3

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to exceed 6,000 cfs and an oversupply of both fine and coarse sediment exists with these alternatives (see Table SEDIMENT BUDGET). The 40% Inflow scored "0" because dam releases of 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW), and an oversupply of both fine and coarse sediment exists with this alternative (see Table SEDIMENT BUDGET).

"1" scores: No alternative scored "1" for this objective.

"2" scores: TRFES and Maximum Flow scored "2" because flows exceeding 6,000 cfs in Extremely Wet, Wet and Normal years will deposit fine sediment onto upper bars and floodplains, and creating new floodplains and low terraces.

Attribute #8, Objective 1

"0" scores: State Permit, No Action, and Mechanical Restoration, 40% Inflow and TRFES scored "0" because dam releases are not scheduled to meet 30,000 cfs.

"1" scores: No alternative scored "1" for this objective.

"2" scores: Maximum Flow scored "2" because 30,000 cfs releases meet the threshold for significant alternate bar mobilization and reshaping.

Go To TOC

Attribute #8, Objective 2

"0" scores: State Permit, No Action, and Mechanical Restoration, 40% Inflow and TRFES scored "0" because dam releases are not scheduled to meet 14,000 cfs.

"1" scores: The TRFES alternative may provide limited coarse bedload redistribution past some bedload impedance reaches in Extremely Wet water years.

"2" scores: Maximum Flow scored "2" because releases in excess of 14,000 cfs are capable of redistributing coarse bedload past bedload impedance reaches

Attribute #8, Objective 3

"0" scores: State Permit, No Action, and Mechanical Restoration, the 40% Inflow and TRFES alternatives scored "0" because dam releases are not scheduled to exceed 24,000 cfs.

"1" scores: No alternative scored "1" for this objective.

"2" scores: Maximum Flow scored "2" because releases in excess of 24,000 cfs are capable of attaining sufficient flow depth on floodplain surfaces to initiate significant scour.

Attribute #8, Objective 4

"0" scores: State Permit and No Action scored "0" because dam releases are not scheduled to exceed 11,000 cfs AND there are no mechanical measures planned to maintain side channels for any of these alternatives.

"1" scores: Mechanical Restoration scored "1" because constructed side channels are to be mechanically maintained. The TRFES alternative scored ‘1’ because an 11,000 cfs release in Extremely Wet years may be sufficiently frequent to maintain and/or rejuvenate constructed channels. The 40% Inflow scored "0" because dam releases of 11,000 cfs are expected in 1% of the years (see Table 40%INFLOW) AND constructed side channels are to be mechanically maintained.

"2" scores: Maximum Flow scored "2" because 30,000 cfs releases cfs in Extremely Wet years are expected to maintain and rejuvenate natural and constructed side channels.

Attribute #8, Objective 5

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because 11,000 cfs releases are not scheduled The 40% Inflow scored "0" because dam releases of 11,000 cfs are only expected in 1% of the years (see Table 40%INFLOW)

"1" scores: TRFES scored "1" because dam releases equal to 11,000 cfs are only scheduled in Extremely Wet years and the shallow inundation depth of floodplain/low terraces will create only marginal fine sediment deposition.

"2" scores: Maximum Flow scored "2" because 30,000 cfs releases will inundate floodplains and low terraces to a sufficient depth encouraging fine sediment deposition.

Go To TOC

Attribute #9, Objective 1

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because low baseflows will expose bar surfaces to germination during the season of seed viability in June and July).

"1" scores: 40% Inflow, TRFES and Maximum Flow scored "1" because partial inundation of bar surfaces during the season of seed viability will not be completely effective preventing germination on bar surfaces.

"2" scores: No alternative scored "2" for this objective.

Attribute #9, Objective 2

"0" scores: State Permit, No Action, and 40% Inflow scored "0" because dam releases are not scheduled to meet 6,000 cfs. The 40% Inflow scored "0" because dam releases of at least 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).

"1" scores: Mechanical Restoration scored "1" because alternative includes mechanical or hand removal of seedlings established on rehabilitation sites, but will not remove seedlings in other channel reaches.

"2" scores: TRFES and Maximum Flow scored "1" because both alternatives meet or exceed 6,000 cfs in Extremely Wet, Wet and Normal years, which is 60% of the years on average. This will be sufficiently frequent to eliminate most seedlings throughout the project reach, not just in channel rehabilitation sites.

Attribute #9, Objective 3

"0" scores: State Permit, No Action, and 40% Inflow scored "0" because dam releases are not scheduled to exceed 8,500 cfs. The 40% Inflow scored "0" because dam releases of 8,500 cfs are only expected in 4% of the years (see Table 40%INFLOW). This will allow most second year seedlings to escape scour, becoming even more difficult to remove.

"1" scores: TRFES scored "1" because both alternatives meet or exceed 6,000 cfs in Extremely Wet, Wet and Normal years, which is 40% of the years on average, but will not remove all seedlings. Mechanical Restoration scored "1" because alternative includes mechanical or hand removal of seedlings established on rehabilitation sites, but will not remove seedlings in other channel reaches.

‘2’ scores: Maximum Flow scored ‘2’ because the 30,000 cfs release in Extremely Wet years will be highly effective at removing most established seedlings along reaches of the river.

Go To TOC

Attribute #9, Objective 4

"0" scores: State Permit, No Action, Mechanical Restoration, 40% Inflow **and TRFES** scored "0" because dam releases are not scheduled to exceed 14,000 cfs, and although some alternatives include initial removal of mature alder trees (i.e. when the rehabilitation sites are first constructed), they do not include future removal of trees.

"1" scores: No alternative scored "1" for this objective.

"2" scores: Maximum Flow scored "2" because dam releases of 30,000 cfs are scheduled in Extremely Wet years, which will occur in 12% of the years on average, i.e., one event will not remove all trees maturing on bar features, but a 12% recurrence of these events should be highly effective.

Attribute #9, Objective 5

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 5,000 cfs during seed dispersal during June or July.

"1" scores: The 40% Inflow alternative will provide infrequent, marginal floodplain inundation (and even less frequently during the seed viability season) to facilitate occasional seed deposition, e.g., 5,000 cfs is expected 15% of the years, but not always during seed dispersal.

"2" scores: TRFES and Maximum Flow scored "2" because both alternatives meet or exceed 6,000 cfs in Extremely Wet, Wet and Normal years, which is 60% of the years on average, and will inundate floodplain surfaces during seed viability season.

Attribute #10, Objective 1

"0" scores: State Permit scored "0" because dam releases are not scheduled to meet 1,500 cfs.

"1" scores: No alternative scored "1" for this objective

"2" scores: No Action, Mechanical Restoration, 40% Inflow, TRFES and Maximum Flow scored "2" because dam releases meet or exceed 1,500 cfs in all water year types.

Attribute #10, Objective 2

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 6,000 cfs. 40% Inflow scored "0" because dam releases of 6,000 cfs are only expected in 6% of the years (see Table 40%INFLOW).

"1" scores: No alternative scored "1" for this objective.

"2" scores: TRFES and Maximum Flow scored "2" because both alternatives meet or exceed 6,000 cfs in Extremely Wet, Wet and Normal years, which is 60% of the years on average.

Attribute #10, Objective 3

"0" scores: State Permit, No Action, and Mechanical Restoration scored "0" because dam releases are not scheduled to meet 10,000 cfs. 40% Inflow scored "0" because dam releases of 10,000 cfs are only expected in 1% of the years (see Table 40%INFLOW).

"1" scores: TRFES and Maximum Flow scored "1" because both alternatives are

Go To TOC

scheduled to meet or exceed 10,000 in Extremely Wet years, which occur 12% of the years on average.
"2" scores: No alternative scored "2" for this objective

Attribute #11, Objective 1

"0" scores: State Permit, No Action, Mechanical Restoration, 40% Inflow and TRFES scored "0" because optimal temperature criteria for outmigrating smolts are met less than 50% of the years under median hydrological and meteorological conditions (see tables OUTMIGRATION 1-4).
"1" scores: Maximum Flow scored "1" because optimal temperature criteria for outmigrating smolts are met >50% of the years under median hydrological and meteorological conditions (see tables OUTMIGRATION 1-4).
"2" scores: No alternative scored "2" for this objective.

Attribute #11, Objective 2

"0" scores: State Permit and 40% Inflow scored "0" because the 450 cfs release criteria for meeting the state board temperature objectives are met less than 50 % of the years(see Table STATE OBJECTIVES 1-4).
"1" scores: Maximum Flow scored "1" because the 450 cfs release criteria for meeting the state board temperature objectives are met >50 %, but <90%, of the years(see Table STATE OBJECTIVES 1-4).
"2" scores: No Action, Mechanical Restoration, and TRFES scored "2" because the 450 cfs release criteria for meeting the state board temperature objectives are met >90 % of the years (see Table STATE OBJECTIVES 1-4).

Attribute #11, Objectives 3 and 4

These objectives were not scored because there is no conclusive data available for a change in channel configuration, which is expected to occur for the Mechanical Restoration, 40% Inflow, TRFES, and Maximum Flow. Hence, it is not possible to assess these objectives because it is not possible to define appropriate spawning and rearing flows without knowledge of the future channel configuration.

ATTACHMENT B14

RESULTS OF THE RECLAMATION SACRAMENTO RIVER CHINOOK SALMON LOSS OF EARLY LIFE STAGES AND TEMPERATURE MODEL ANALYSIS

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

PROSIM 7-18-97 -REV.NO ACTION- (TRN_RNA2) - 2020 LEVEL

SACRAMENTO RIVER SALMON LOSS SUMMARY - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	4,249	0.197	1256	3.301
1923	3.606	0.390	1.103	2.290
1924	24.723	2.679	5.341	56.767
1925	3.256	1.221	2.988	3.277
1926	6.306	1.058	4.659	3.705
1927	3.739	0.137	0.934	2.443
1928	0.277	0.933	0.983	2.021
1929	17.315	3.344	1.380	4.707
1930	5.121	0.615	2.610	2.560
1931	32.905	2.483	8.423	96.977
1932	36.792	3.475	4.160	96.930
1933	40.301	3.893	4.183	99.958
1934	34.571	3.219	12.122	98.622
1935	28.063	1.747	2.026	54.645
1936	25.170	3.912	3.510	9.262
1937	3.451	0.760	1.620	3.042
1938	8.686	0.603	1.139	3.272
1939	9.051	1.091	0.956	3.476
1940	3.765	1.378	2.801	2.722
1941	3.446	0.146	0.583	1.823
1942	4.177	0.066	0.558	2.030
1943	4.405	0.221	0.754	2.248
1944	8.680	0.246	0.577	3.582
1945	5.678	0.226	0.981	2.562
1946	2.234	0.360	0.602	1.698
1947	6.139	0.941	1.561	2.476
1948	5.727	0.050	0.482	2.571
1949	2.715	0.837	1.401	2.164
1950	2.564	0.448	1.143	2.787
1951	4.854	0.297	0.922	3.388
1952	3.532	0.164	0.902	2.320
1953	4.354	0.023	0.501	2.262
1954	4.119	0.265	0.651	1.983
1955	7.781	0.691	1.259	4.008
1956	2.948	0.222	1.000	2.137
1957	4.396	0.240	1.308	2.547
1956	11.061	2.353	1.012	4.215
1959	22.887	3.383	2.141	11.328
1960	7.254	0.434	1.376	4.326
1961	9.085	0.196	1.071	4.346
1962	12.964	1.386	1.380	4.186
1963	6.584	0.556	1.412	4.033
1964	10.395	0.269	0.613	3.327
1965	4.024	0.307	1.281	2.622
1966	6.599	0.523	0.686	2.967
1967	15.730	1.396	0.747	6.892
1968	6.071	0.416	1.114	3.995
1969	2.852	0.192	0.875	2.511
1970	5.038	0.527	1.384	4.361
1971	5.689	0.057	0.671	3.507
1972	3.463	0.262	1.514	2.635
1973	3.252	0.759	i.992	3.333
1974	4.579	0.246	1.109	3.205
1975	10.081	0.237	0.961	5.695
1976	17.838	2.189	i.484	9.086
1977	35.814	1.780	19.068	98.910
1978	5.042	0.312	1.718	2.943
1979	5.407	0.369	1.010	3.081
1960	3.300	0.200	0.685	1.868
1981	7.006	0.657	1.740	4.776
1982	2.344	1.177	1.261	1.998
1983	4.944	0.158	0.898	2.596
1984	3.902	0.344	1.083	2.865
1985	3.998	0.686	0.943	2.432
1986	4.640	0.311	1.862	2.443
1987	7.277	0.237	0.649	3.264
1988	17.983	0.748	2.611	7.797
1989	5.242	0.656	1.262	2.912
1990	16.999	1.032	1.216	5.993
AVERAGE	9.659	0.912	1.977	11.930

Go To TOC

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

PROSIM 10-13-97 - REV. MAX FLOW (TRN_RMX2) - 2020 LEVEL

SACRAMENTO RIVER SALMON LOSS SUMMARY - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	3.763	1.560	3.326	3.595
1923	5.766	0.632	5.666	2.674
1924	26.373	2.745	19.557	95.295
1925	4.912	1.294	2.975	3.153
1926	7.557	4.266	i1.357	4.500
1927	5.450	0.213	0.961	2.205
1928	6.012	1.265	2.006	2.326
is29	30.605	4.661	2.093	26.072
1930	7.491	1.220	3.976	3.733
1931	34.764	3.029	19.057	96.939
1932	37.774	3.430	13.396	99.565
1933	36.565	3.473	4.175	99,469
1934	35.663	4.004	19.869	99.204
1935	27.642	2.161	2.666	54.556
1936	26.669	4.126	6.157	16.464
1937	4.414	0.697	1.748	2.956
1938	11.010	1.114	1.565	4.619
1939	22.011	3.114	2.562	6.657
1940	5.153	1.366	3.755	2.769
1941	7.428	0.756	1.051	2.029
1942	6.365	0.104	1.113	2.363
is43	4.769	0.493	1.397	2.219
1944	9.661	0.326	1.576	3.626
1945	7.893	0.657	1.812	3.441
1946	2.276	0.562	1.063	1.839
1947	9.467	1.483	5.734	3.159
1946	5.963	0.073	0.765	2.576
1949	2.349	1.466	2.265	2.166
1950	2.902	0.736	2.061	2.631
1951	4.457	0.640	1.024	3.104
1952	4.660	0.322	1.304	3.101
1953	5.635	0.075	1.069	2.963
1954	6.795	0.567	0.844	2.166
1955	6.351	0.696	2.704	4.100
1956	3.796	0.641	3.074	2.617
1957	4.066	0.370	2.026	2.750
1958	17.764	4.771	1.597	6.261
1959	26.291	4.099	5.236	16.757
1960	7.277	0.570	3.147	4.227
1961	6.637	0.400	1.663	3.563
1962	15.746	1.480	1.665	5.516
1963	6.442	1.071	1.961	3.959
1964	14.819	0.510	1.415	5.263
1965	5.035	0.462	3.942	2.975
1966	21.169	1.395	1.543	12.467
1967	15.247	1.676	0.939	6.273
1968	10.991	1.194	4.044	3.480
1969	3.706	0.410	1.356	3.266
1970	12.597	1.049	2.828	4.023
1971	4.664	0.130	1.160	3.463
1972	6.536	0.514	3.450	1.960
1973	2.716	1.657	4.075	3.637
1974	5.746	0.915	1.991	3.764
1975	12.254	0.516	1.406	6.071
1976	18.559	3.110	2.602	9.336
1977	34.680	1.473	63.205	96.506
1976	4.613	0.430	2.714	3.271
1979	4.653	0.969	2.177	3.159
1960	3.660	0.551	1.712	2.719
1981	5.665	0.912	2.664	4.170
1962	2.353	1.300	1.959	2.793
1963	13.369	0.736	1.167	3.601
1964	4.355	0.521	3.413	3.409
1965	3.174	1.171	2.693	3.060
1986	16.500	1.120	3.206	6.327
1967	33.940	1.900	·2.570	93.300
1988	37.027	1.146	20.602	x1.314
1969	15.342	1.250	2.305	6.637
1990	32.065	1.467	6.754	92,604
AVERAGE	12.696	1.390	4.960	17.654

Go To TOC

PROSIM 12-29-97 - REV. FLOW STUDY #2 (TRN_RF2D) - 2020 LEVEL

SACRAMENTO RIVER SALMON LOSS SUMMARY - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	3.305	0.239	1.364	2.634
1923	6.026	1.007	3.780	2.936
1924	25.730	3.195	16.967	91.518
1925	3.786	1.167	3.081	3.414
1926	7.619	2.223	a.395	4.178
1927	3.412	0.157	1.044	2.500
192a	12.234	1.340	1.360	3.016
1929	36.882	5.207	1.718	69.608
1930	11.003	1.606	2.253	3.413
1931	30.644	2.609	10.100	92.712
1932	37.858	3.263	16.021	99.515
1933	39.247	3.906	3.543	99,095
1934	33.760	3.346	9.430	97.062
1935	24.266	1.652	1.646	27.304
1936	25.347	3.785	4.530	11.003
1937	3.925	0.742	1.545	3.188
1938	7.966	0.827	1.326	3.295
1939	14.350	1.967	1.089	4.889
1940	4.018	1.275	3.266	2.958
1941	3.046	0.157	0.600	2.089
1942	3.927	0.076	0.760	2.184
1943	3.751	0.358	1.013	2.176
1944	10.006	0.254	0.822	4.813
1945	6.165	0.410	1.305	2.930
1946	3.128	0.489	0.748	1.994
1947	11.454	1.271	3.662	3.702
1948	5.072	0.068	0.565	2.561
1949	3.551	1.225	1.850	2.612
1950	3.126	0.488	1.222	3.009
1951	5.726	0.508	1.185	4.597
1952	3.794	0.243	1.063	2.731
1953	4.564	0.037	0.609	2.576
1954	5.079	0.272	0.662	2.286
1955	8.420	0.616	1.314	4.547
1956	3.158	0.382	1,491	2.521
1957	4.114	0.433	1.741	2.718
1958	11.294	2.856	1.072	4.452
1959	29.022	4.135	3.276	22.366
1960	10.723	0.489	1.438	5.619
1961	12.645	0.299	1.055	6.531
1962	15.155	1.260	1,412	6.324
1963	5.474	0.845	1.735	3.573
1964	la.527	0.662	0.632	a.056
1965	3.656	0.360	1.872	2.633
1966	10.734	0.956	1.085	4.411
1967	13.072	1.344	0.793	5.075
1966	9.257	0.631	1.476	4.716
1969	3.738	0.319	1.160	3.375
1970	6.124	0.523	1.442	5.544
1971	4.226	0.064	0.962	3.457
1972	4.380	0.345	2.740	3.045
1973	3.075	1.254	2.672	3.676
1974	4.955	0.574	1.613	3.700
1975	9.878	0.303	1.119	5.903
1976	19.600	3.215	1.564	11.359
1977	35.439	1.718	74.561	98.715
1978	4.287	0.383	1.960	3.093
1979	6.166	0.595	1.412	4.017
1980	2.848	0.475	1.125	1.819
1981	7.552	0.792	2.118	5,234
1982	1.954	1.297	1.599	2.282
1983	4.950	0.150	0.956	2.767
1984	3.212	0.428	1.476	2.596
1965	4.737	0.801	1.288	2.505
1966	5.105	0.323	2.507	2.669
1967	22.152	0.985	0.926	13.366
1988	26.731	1.166	3.998	42.016
1989	6.763	0.861	1.464	3.518
1990	30.887	1.789	3.478	74.358
AVERAGE	11.346	1.149	3.497	15.178

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

PROSIM 10-9-97 - REV. % INFLOW (TRN_R401) - 2020 LEVEL

SACRAMENTO RIVER SALMON LOSS SUMMARY - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	3.852	0.241	1.402	3.180
1923	4.072	0.191	2.384	3.047
1924	25.717	2.508	6.737	74.780
1925	3.456	1.144	2.787	3.493
1926	7.300	2.060	8.441	4.378
1927	3.076	0.159	1.041	2.460
1926	10.300	1.141	1.365	2.726
1929	15.724	3.280	1.421	5.182
1930	7.929	1.127	3.695	2.791
1931	32.620	2.375	11.265	96.591
1932	36.644	3.524	13.004	99.700
1933	40.792	3.925	5.602	99.961
1934	34.217	3.224	11.620	97.862
1935	24.789	1.593	1.709	30.820
1936	19.614	2.064	3.545	7.728
1937	3.178	0.739	1.640	3.340
1938	7.142	0.668	1.333	3.247
1939	12.037	1.705	1.009	4.546
1940	4.039	1.268	3.118	2.829
1941	2.973	0.165	0.834	2.119
1942	3.593	0.075	0.612	2.343
1943	4.271	0.354	1.009	2.406
1944	10.201	0.252	0.711	5.103
1945	5.692	0.372	1.210	2.877
1946	2.614	0.487	0.753	1.8136
1947	7.848	1.009	3.402	3.270
1946	5.659	0.055	0.536	2.538
1949	3.061	1.216	1.847	2.642
1950	3.039	0.467	1.263	3.087
1951	4.284	0.502	1.168	3.332
1952	3.727	0.230	1.029	2.649
1953	4.550	0.029	0.589	2.574
1954	6.223	0.291	0.670	2.310
1955	8.374	0.616	1.393	4.547
1956	2.863	0.273	1.422	2.417
1957	4.009	0.499	1.848	2.786
1958	9.753	2.592	1.194	4.258
1959	27.467	3.709	3.109	21.404
1960	9.440	0.433	1.464	5.246
1961	13.460	0.296	1.021	6.667
1962	13.448	1.210	1,390	4.933
1963	5.383	0.613	1.717	3.576
1964	14.734	0.451	0.561	5.052
1965	3.742	0.356	1.897	2.667
1966	9.989	0.743	0.929	3.806
1967	12.391	0.961	0.607	5.116
1966	7.730	0.471	1.372	4.609
1969	3.513	0.277	1.146	3.257
1970	5,652	0.521	1.475	5.007
1971	4.209	0.049	0.969	3.514
1972	4.208	0,336	2.573	2.987
1973	3.099	1.164	2.609	3.624
1974	4.762	0.577	1.676	3.786
1975	9.775	0.272	1.140	5.981
1976	23.496	3.651	1.556	15.339
1977	35.359	1.682	73.219	98.686
1978	4,806	0.379	1.813	2.964
1979	6.329	0.655	1.513	3.710
1960	2.925	0.477	1.098	1.822
1981	7.609	0.794	2.162	5.363
1982	1.912	1.280	1.650	2.322
1963	4.616	0.202	1.086	2.783
1964	3.294	0.446	1.778	2.692
1985	5.191	0.804	1.312	2.586
1986	4.696	0.321	2.456	2.583
1967	i0.665	0.471	0.793	4.417
1968	19.514	0.724	3.560	10.493
1989	6.337	0.750	1.664	3.306
1990	24.292	1.246	1.512	21.808
AVERAGE	10.243	1.013	3.303	12.666

PROSIM 3-12-96 -ORIG. STATE PERMIT- (TRN_AL1B) - 2020 LEVEL

SACRAMENTO RIVER SALMON LOSS SUMMARY - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	4.254	0.190	1.327	3.467
1923	3.914	0.143	0.993	3.005
1924	24.839	2.106	10.432	65.402
1925	3,493	1.322	3.234	3.428
1926	8.369	1.081	4.394	4.084
1927	3.506	0.137	0.997	2.566
1928	4.993	0.639	1.015	1.946
1929	13.950	3.330	0.933	3.614
1930	5.569	0.493	2.642	3.103
1931	30.530	1.978	7.055	90.365
1932	36.279	3.291	4.423	94.814
1933	39,675	3.627	4.968	99.811
1934	34.253	2.342	17.016	98.213
1935	21.921	1.440	1.635	22.104
1936	16.007	1.782	3.869	6.060
1937	3.485	0.767	1.683	3.372
1938	6.103	0.392	1.166	3.068
1939	6.702	0.780	0.609	4.194
1940	3.836	1.400	2.877	2.868
1941	3.298	0.122	0.532	1.674
1942	4.172	0.055	0.588	2.127
1943	4.413	0.158	0.682	2.399
1944	9.698	0.250	0.645	4.910
1945	5.426	0.221	1.016	2.976
1946	2.452	0.328	0.574	1.817
1947	7.231	0.736	1.250	3.089
1948	5.192	0.047	0.495	2.544
1949	2.804	0.780	1.276	2.316
1950	3.108	0.440	1.183	3.137
1951	4.940	0.307	0.976	3.666
1952	3.558	0.142	0.828	2.351
1953	4.183	0.017	0.458	2.243
1954	3.713	0.262	0.622	1.861
1955	7.881	0.642	1.199	4.208
1956	2.580	0.100	1.043	2.256
1957	4.183	0.228	1.396	2.615
1958	10.432	2.233	1.010	4.225
1959	19,106	2.649	1.692	9.875
1960	8.054	0.279	1.154	4.960
1961	10.680	0.220	0.807	5.062
1962	8.811	0.861	1.623	4.046
1963	6.410	0.496	1.304	3.846
1964	8.589	0.188	0.588	3.437
1965	3.821	0.312	1.334	2.713
1966	5.734	0.432	0.939	3.026
1967	11.940	0.755	0.744	4.614
1968	5.885	0.394	1.085	4.075
1969	3.016	0.172	0.909	2.732
1970	5.464	0.528	1.493	4.720
1971	4.204	0.027	0.739	3.131
1972	3.258	0.280	1.956	2.804
1973	3.074	0.734	1.999	3.264
1974	4.915	0.256	1.153	3.468
1975	9.327	0.167	0.919	5,712
1976	16.768	1.725	1.415	9.250
1977	35.493	1.618	11.840	96.602
1976	4.810	0.266	1.677	2.964
1979	4.792	0.359	1.056	3.452
1980	3.062	0.202	0.724	1.864
1981	6.605	0.571	1.650	5.144
1982	1.718	1.014	1.129	1.827
1983	5.034	0.150	0.904	2.741
1984	3.827	0.330	1.015	2.791
1965	4.032	0.691	0.915	2.428
1986	4.407	0.311	1.656	2.526
1987	7.604	0.161	0.740	4.118
1966	18.511	0.658	2.235	8.919
1969	5.999	0.642	1.152	3.075
1990	17.967	0.826	0.921	7.917
AVERAGE	9.074	0.766	1.964	11.819

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

PROSIM REV. MAX FLOW (TRN_RMX2) - REV. NO-ACTION (TRN_RNA2)

SACRAMENTO RIVER SALMON LOSS DIFFERENCE - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	-0.466	1,363	2.070	0.294
1923	2.160	0.242	4.565	0.364
1924	3.650	0.066	14.216	36.528
1925	1.656	0.073	-0.013	-0.124
1926	1.251	3.206	6.698	0.795
1927	1.711	0.076	0.027	-0.236
1926	-0.265	0.332	1.023	0.305
1929	13.290	1.317	0.713	23.365
1930	2.370	0.605	1.366	1.073
1931	1.879	0.546	10.634	1.962
1932	0.962	-0.045	9.236	2.655
1933	-1.736	-0.420	-0.006	-0.469
1934	1.312	0.765	7.747	0.562
1935	-0.221	0.414	0.642	-0.069
1936	3.493	0.214	2.647	7.222
1937	0.963	0.137	0.126	-0.086
1936	2.324	0.511	0.426	1.347
1939	12.960	2.023	1.606	5.161
1940	1.366	0.006	0.954	0.047
1941	3.962	0.612	0.466	0.206
1942	2.166	0.116	0.555	0.333
1943	0.364	0.272	0.643	-0.029
1944	1.161	0.060	1.001	0.046
1945	2.215	0.431	0.631	0.679
1946	0.042	0.202	0.461	0.141
1947	3.346	0.542	4.173	0.663
1946	0.236	0.023	0.303	0.005
1949	-0.366	0.631	0.664	0.024
1950	0.336	0.290	0.916	0.044
1951	-0.397	0.543	0.902	-0.264
1952	1.328	0.156	0.402	0.761
1953	1.461	0.052	0.566	0.701
1954	4.676	0.322	0.193	0.203
1955	-1.430	0.205	1.446	0.092
1956	0.650	0.419	2.074	0.660
1957	-0.330	0.130	0.720	0.203
1956	6.723	2.416'	0.565	4.046
1959	5.404	0.716	3.095	7.429
1960	0.023	0.136	1.769	-0.101
1961	-2.246	0.204	0.612	-0.765
1962	2.764	0.094	0.285	1.330
1963	-0.142	0,515	0.549	-0.074
1964	4.424	0.241	0.602	1.936
1965	1.011	0.155	2.661	0.353
1966	14.570	0.672	0.657	9.500
1967	-0.463	0.260	0.192	-0.619
1968	4.920	0.776	2.930	-0.515
1969	0.656	0.216	0.461	0.777
1970	7.559	0.522	1.444	-0.336
1971	-0.605	0.073	0.469	-0.044
1972	3.075	0.252	1.936	-0.655
1973	-0.534	0.696	2.083	0,504
1974	1.166	0.669	0.662	0.559
1975	2.173	0.279	0.445	2.376
1976	0.721	0.921	1.116	0.252
1977	-0,934	-0.307	64.137	-0,404
1976	-0.229	0.116	0.996	0.326
1979	-0.754	0.600	1.167	0.076
1980	0.380	0.351	1.027	0.651
1961	-1.321	0.255	0.924	-0.606
1962	0,009	0.123	0.698	0.795
1963	8.445	0.576	0.269	1.205
1964	0.453	0.177	2.330	0.524
1965	-0.624	0.483	1.750	0.648
1966	13.660	0.609	1.346	5.884
1967	26.663	1.663	1.921	90.016
1988	19,044	0.396	16.191	91.517
1969	10.100	0.594	1.043	3.925
1990	15.066	0,435	5.536	66.611
AVERAGE	3.038	0.476	2.983	5.724

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

PROSIM REV. FLOW STUDY #2 (TRN_RF2D) - REV. NO-ACTION (TRN_RNA2)

SACRAMENTO RIVER SALMON LOSS DIFFERENCE - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	-0.944	0.042	0.106	-0.467
1923	2.420	0.617	2.677	0.646
1924	1.007	0.516	11.626	34.751
1925	0.530	-0.054	0.093	0.137
1926	1.313	1.165	3.736	0.473
1927	-0.327	0.020	0.110	0.057
1926	3.957	0.407	0.377	0.995
1929	19.567	1.943	0.338	64.901
1930	5.662	0.991	-0.357	0.753
1931	-2.061	0.326	1.677	-4.265
1932	1.066	-0.212	11.661	2.565
1933	-1.054	0.013	-0.640	-0.663
1934	-0.811	0.129	-2.692	-1.560
1935	-3.797	-0.095	-0.381	-27.341
1936	0.177	-0.127	1.020	1.741
1937	0.474	-0.016	-0.075	0.146
1936	-0.720	0.224	0.169	0.023
1939	5.307	0.896	0.133	1.413
1940	0.233	-0.103	0.465	0.236
1941	-0.400	0.011	0.217	0.266
1942	-0.250	0.010	0.202	0.154
1943	-0.654	0.137	0.259	-0.072
1944	1.326	0.006	0.245	1.231
1945	0.467	0.104	0.324	0.366
1946	0.694	0.129	0.146	0.296
1947	5.315	0.330	2.101	1.226
1948	0.145	0.016	0.083	-0.010
1949	0.636	0.366	0.449	0.446
1950	0.562	0.040	0.079	0.222
1951	0.672	0.211	0.263	1.209
1952	0.262	0.079	0.161	0.411
1953	0.210	0.014	0.106	0.294
1954	0.960	0.007	0.011	0.303
1955	0.639	-0.075	0.055	0.539
1956	0.210	0.160	0.491	0.364
1957	-0.282	0.193	0.433	0.171
1956	0.233	0.503	0.060	0.237
1959	6.135	0.752	1.135	11.036
1960	3.469	0.065	0.060	1.291
1961	3.560	0.103	-0.016	2.163
1962	2.191	-0.126	0.032	2.136
1963	-1.110	0.269	0.323	-0.460
1964	6.132	0.393	0.019	4.731
1965	-0.368	0.053	0.591	0.011
1966	4.135	0.433	0.199	1.444
1967	-2.656	-0.052	0.046	-1.617
1966	3.186	0.215	0.362	0.723
1969	0.886	0.127	0.305	0.664
1970	1.086	-0.004	0.056	1.163
1971	-1.463	0.007	0.291	-0.050
1972	0.917	0.083	1.226	0.410
1973	-0.177	0.495	0.680	0.343
1974	0.376	0.326	0.504	0.495
1975	-0.203	0.066	0.158	0.206
1976	1.962	1.026	0.060	2.273
1977	-0.375	-0.062	55.493	-0.195
1976	-0.755	0.071	0.242	0.150
1979	0.759	0.226	0.402	0.936
1960	-0.452	0.275	0.440	-0.049
1961	0.546	0.135	0.376	0.456
1962	-0.390	0.120	0.336	0.284
1963	0.006	0.000	0.060	0.171
1964	-0.690	0.084	0,393	-0.269
1965	0.739	0,113	0.345	0.073
1966	0.465	0.012	0.645	0.226
1967	14,675	0.748	0.279	10.102
1966	10.746	0.416	1.307	34.219
1969	3.521	0.205	0.202	0.606
1990	13.888	0.757	2.262	66.365
AVERAGE	1.669	0.237	1.520	3.248

DRAFT

LOSS_4th.xls\SAC_DIFF_RFL2
3/10/98

Go To TOC

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

PROSIM REV.% INFLOW (TRN_R401) - REV. NO-ACTION (TRN_RNA2)

SACRAMENTO RIVER SALMON LOSS DIFFERENCE - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	-0.397	0.044	0.146	-0.121
1923	0.466	-0.199	1.261	0.757
1924	0.994	-0.091	1.396	16.013
1925	0.200	-0.077	-0.201	0,216
1926	0.994	1.022	3.762,	0.673
1927	-0.663	0.022	0.107	0.017
1928	2.023	0.206	0.362	0,705
1929	-1.591	-0.064	0.041	0.475
1930	2.606	0.512	1.065	0.131
1931	-0.065	-0.106	2.642	-0.386
1932	1.852	0.049	6.644	2.770
1933	0.491	0.032	1.419	0.003
1934	-0.354	0.005	-0,502	-0.760
1935	-3.274	-0.157	-0.317	-23.625
1936	-5.556	-1.026	0.035	-1.534
1937	-0.273	-0.021	0.020	0.296
1936	-1.544	0.065	0.194	-0.025
1939	3.766	0.614	0.053	1.070
1940	0.254	-0.090	0.317	0.107
1941	-0.473	0.019	0.251	0.296
1942	-0.584	0.009	0.254	0.313
1943	-0.134	0.133	0.255	0.160
1944	1.521	0.006	0.134	1.521
1945	0.214	0.146	0.229	0.315
1946	0.360	0.127	0.151	0.166
1947	1.709	0.066	1.641	0.794
1946	-0.066	0.005	0.054	-0,033
1949	0.346	0.379	0.446	0.476
1950	0.475	0.039	0.120	0.300
1951	-0.570	0.205	0.246	-0.056
1952	0.195	0.066	0.127	0.329
1953	0.196	0.006	0.088	0.292
1954	2.104	0.026	0.027	0.327
1955	0.593	-0.075	0.134	0.539
1956	-0.065	0.051	0.422	0.280
1957	-0.387	0.259	0.540	0.239
195.5	-1.308	0.239	0.162	0,043
1959	4.600	0.326	0.966	10.076
1960	2.166	-0.001	0.086	0.917
1961	4.375	0.100	-0.050	2.339
	0.484	-0.176	0.010	0.747
1963	-1.201	0.257	0.305	-0.457
1964	4.339	0.162	-0.052	1.725
1965	-0.262	0.051	0.616	0.045
1966	3.390	0.220	0.043	0.639
1967	-3,339	-0.435	0.060	-1.776
1966	1.659	0.055	0.256	0.614
1969	0.661	0.065	0.273	0.746
1970	0.614	-0.006	0.091	0.646
1971	-1.460	-0.006	0.296	0.007
1972	0.745	0.076	1.059	0.352
1973	-0.153	0.405	0.617	0.291
1974	0.163	0.331	0.567	0.561
1975	-0.306	0.035	0.179	0.266
1976	5.660	1.462	0.074	6.253
1977	-0.455	-0.096	54.151	-0.224
1978	-0.234	0.067	0.095	0.021
1979	0.922	0.266	0.503	0.629
1960	-0.375	0.277	0.413	-0.046
1961	0.603	0.137	0.422	0.587
1962	-0.432	0.103	0.389	0.324
1963	-0.126	0.044	0.188	0.167
1964	-0.606	0.102	0.695	-0.193
1965	1.193	0.116	0.369	0.154
1966	0.056	0.010	0.594	0.140
1967	3.406	0.234	0.144	1.133
1988	1.531	-0.024	0.969	2.696
1969	1.095	0.094	0.422	0.394
1990	7.293	0.214	0.296	15.815
AVERAGE	0.564	0.101	1.326	0.736

Go To TOC

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

PROSIM ORIG. STATE PERMIT (TRN_AL1B) - REV. NO-ACTION (TRN_RNA2)

SACRAMENTO RIVER SALMON LOSS DIFFERENCE - %

YEAR	FALL	LATE-FALL	WINTER	SPRING
1922	0.005	-0.007	0.071	0.166
1923	0.306	-0.247	-0.110	0.715
1924	0.116	-0.573	5.091	26.635
1925	0.237	0.101	0.246	0.151
1926	2.063	0.023	-0.265	0.379
1927	-0.233	0.000	0.063	0.143
1926	-3.264	-0.294	0.032	-0.075
1929	-3.365	-0.014	-0.447	-1.093
1930	0.466	-0.122	0.032	0.443
1931	-2.375	-0.505	-1.368	-6.592
1932	-0.513	-0.164	0.263	-2.116
1933	-0.626	-0.266	0.785	-0.147
1934	-0.318	-0.677	4.694	-0.409
1935	-6.142	-0.307	-0.391	-32.541
1936	-9.163	-2.130	0.359	-3.202
1937	0.034	0.007	0.063	0.330
1936	-2.563	-0.211	0.027	-0.204
1939	-0.349	-0.311	-0.147	0.716
1940	0.051	0.022	0.076	0.166
1941	-0.148	-0.024	-0.051	0.051
1942	-0.005	-0.011	0.030	0.097
1943	0.008	-0.063	-0.072	0.151
1944	1.016	0.004	0.066	1.326
1945	-0.252	-0.005	0.035	0.414
1946	0.216	-0.032	-0.026	0.119
1947	1.092	-0.205	-0.311	0.613
1946	-0.535	-0.003	0.013	-0.027
1949	0.069	-0.057	-0.125	0.152
1950	0.544	-0.006	0.040	0.350
1951	0.086	0.010	0.056	0.276
1952	0.026	-0.022	-0.074	0.031
1953	-0.171	-0.006	-0.043	-0.039
1954	-0.406	-0.003	-0.029	-0.122
19.55	0.100	-0.049	-0.060	0.200
1956	-0.366	-0.122	0.043	0.119
1957	-0.213	-0.012	0.090	0.066
1956	-0.629	-0.120	-0.002	0.010
1959	-3.779	-0.734	-0.449	-1.453
1960	0.600	-0.155	-0.224	0.632
1961	1.595	0.024	-0.264	0.714
1962	-4.153	-0.505	0.243	-0.136
1963	-0.174	-0.060	-0.106	-0.165
1964	-1.606	-0.061	-0.025	0.110
1965	-0.203	0.005	0.053	0.091
1966	-0.665	-0.091	0.053	0.059
1967	-3.790	-0.641	-0.003	-2.276
1966	-0.186	-0.022	-0.029	0,060
1969	0.166	-0.020	0.034	0.221
1970	0.426	0.001	0.109	0.359
1971	-1.485	-0.030	0.066	-0.376
1972	-0.205	0.016	0.444	0.169
1973	-0.176	-0.025	0.007	-0,049
1974	0.336	0.010	0.044	0.263
1975	-0.754	-0.070	-0.042	0.017
1976	-1.070	-0.464	-0.069	0.164
1977	-0.321	0.036	-7.220	-0.108
1976	-0.232	-0.024	-0.041	0.021
1979	-0.615	-0.010	0.046	0.371
1960	-0.236	0.002	0.039	-0.004
1961	-0.201	-0.066	-0.090	0.368
1962	-0.626	-0.163	-0.132	-0,171
1963	0.090	-0.006	0.006	0.145
1964	-0.075	-0.014	-0.066	-0.094
1965	0.034	0.003	-0.026	-0.004
1966	-0.233	0.000	-0.006	0.083
1967	0.327	-0.076	0.091	0.834
1966	0.526	-0.090	-0.376	1.122
1969	0.757	-0.014	-0.110	0.163
1990	0.966	-0.206	-0.295	1,924
AVERAGE	-0.565	-0.147	0.007	-0.111

DRAFT

LOSS_4th.xls\SAC_DIFF_120K
3/10/98

Go To TOC

ATTACHMENT B15

ANALYSIS OF THE HARVEST MANAGEMENT ALTERNATIVE OF THE TRINITY RIVER EIS / EIR

Analysis of the Harvest Management Alternative of the Trinity River EIS/EIR

The Fisheries and Channel Restoration Team (FCRT) held a meeting on Sept 12 to resolve the issue of how to analyze the harvest management alternative (HMA) of the Trinity River EIS/EIR. Three methods of analyzing the effectiveness of this alternative in meeting the purpose and need were initiated. The FCRT discussed the various methods and decided that the methodology described below was the most appropriate and the most consistent with the analyses of the other alternatives.

Methods: This analysis combines information used to assess the other alternatives (the attributes and objectives of an alluvial river) in conjunction with harvest rate management methods used to manage Klamath Basin (including Trinity River) fall chinook to provide estimates of harvest and escapement under varying harvest levels. The FCRT estimated that 8% (-5,500 spawners) of the Restoration Program's spawning escapement goals would be met under the No Action Alternative with an annual fishery flow allocation (340,000 af). The only difference between the HMA and the No Action Alternative is that, in the HMA, fishery impacts are managed (reduced) to increase spawning escapement.

To assess the effects of reduced harvest levels, the Harvest Rate Model, which calculates harvest in ocean and inriver fisheries and resulting spawning escapement, was seeded with the appropriate ocean stock size (17,198 age 3; 4,247 age 4; and 416 age 5). At this population level, with ocean and inriver equilibrium harvest rates for the Trinity River chinook stock (0.26 ocean, 0.77 inriver), the spawning escapement would result in an escapement of -5,500 fish (8% of the Restoration Program's chinook spawning goal). Ocean and inriver harvest rates were then reduced by 25%, 50%, 75%, 90% and 100% and the resulting harvest and escapement calculated. The sharing of inriver harvest between the tribal fisheries and non-tribal sport fishery was adjusted to approximate equal sharing between tribal and non-tribal fisheries. An index of production was estimated by adding total harvest and spawning escapement.

Results: Using ocean and inriver harvest rates appropriate for the management of Trinity River chinook and attaining the anticipated escapement of 5,500 consistent with the assessment of the No Action alternative, approximately 10,300 chinook salmon would be harvested by tribal and non-tribal fisheries with a production index of 15,800 (Table 1). Data from specific model runs are presented in Tables 2-2E. Reducing ocean and inriver harvest rates by 25% reduced total harvest by 2,300 (compared to no action/reduction) but only increased spawning escapement by 2,000, and the production index decreased by 300 fish. This trend of reduced harvest impacts resulting in reduced harvest and production index while spawning escapement slightly increased occurred as harvest rates were reduced for ocean and inriver fisheries.

Conclusion: While reducing ocean and inriver harvest rates increased the number of spawners, it did not increase natural production as indicated by the production index. Furthermore, based on the FCRT assessment that 8% of the of the Restoration Program's spawner escapement goal could bet supported

Go To TOC

by the rivrine habitat using the TRAAM under the No Action Alternative, allowing spawning escapements above 8% is likely to oversaturate river habitats. This could result in decreased production due to density-dependent mortality occurring in spawning and rearing habitat that is typical for anadromous salmonid populations.

While other models can be used to show that decreasing harvest could increase production, this entails changing parameters of the stock-recruit relationship which the FCRT team does not believe is appropriate and would lead to an inconsistency in the assessment of alternatives.

In addition, Trinity River coho salmon populations (included in a larger ESU) have been listed under the Endangered Species Act as threatened although harvest for coho has been greatly reduced since 1992. In light of the greatly reduced harvest impact to coho without a corresponding increase in spawning populations indicate that harvest management has not been a primary contributor to the decline of fish populations in recent years. The status of coho salmon populations (relative to chinook populations) better reflects the poor condition of the Trinity River system because coho are highly dependent on the freshwater environment for the first 1 to 1.5 years of their life.

Table 1. Estimated harvest and escapement for Trinity River chinook salmon at varying reductions of ocean and in-river harvest rates (numbers rounded to the nearest 100).[a, bc]

Harvest Reduction	Tribal Harvest	Non-Tribal Harvest	Total Harvest	Spawning Escapement	Production Index [c]	% TRRP Esc. Goal [d]
0%	5,100	5,200	10,300	5,500	15,800	8%
25%	4,000	4,000	8,000	7,500	15,500	11%
50%	2,700	2,800	5,500	9,800	15,300	14%
75%	1,400	1,500	2,900	12,300	15,200	18%
90%	600	500	1,100	13,900	15,000	20%
100%	0	0	0	15,000	15,000	22%

a Number presented here are not intended to represent actual harvest levels but are to be used for comparisons to the results of other alternatives.

b Reductions in ocean and in-river harvest rates were calculated and approximate sharing between tribal and non tribal fisheries was achieved by adjusting the inriver sharing between the tribal fisheries and the inriver sport fishery.

c Production index calculated by adding total harvest and spawning escapement and not an estimate of recruits at a specific age.

d % of the Trinity River Restoration Program's spawner escapement goal based on 68,000 spring and fall chinook spawners.

Go To TOC

Table 2. Harvest Rate Model Output for Chinook Based on Equilibrium Harvest Rates and Harvest Allocated Among Ocean and Inriver Fisheries (No Harvest Reduction).

HARVEST RATE MODEL(DEVELOPED BY USFWS, ARCATA)

OCEAN ADULT HARVEST	4,400 *		
INRIVER ADULT HARVEST	5,900	REDUCTION FACTOR =	0
TRIBAL ADULT HARVEST	5,100 *	TRIBAL SHARE =	0.870
NON-TRIBAL ADULT HARVEST	5,200	RIVER REC SHARE OF	
INRIVER REC. ADULT HARVEST	800 *	NON-TRIBAL HARVEST =	15.4%
NAT SPAWNING ESCAPEMENT	5,500 *		

AGE	OSC	PERCENT LEGAL	SHAKER MORT	PERCENT MATURING	NATURAL MORT	OCEAN HARVEST RATE	TERMINAL HARVEST RATE
3	0.88	80.0%	0.25	63.7%	0.20	0.26	0.77
4	1.00	100.0%	0.25	84.7%	0.20	0.26	0.77
5	1.00	100.0%	0.25	100.0%	0.20	0.26	0.77
		LONG TERM H.R. COMB. FISH/FISH=				0.260	0.770
						0.2600	0.7700

AGE	STOCK STATUS	PREV FALL	POTENTIAL CONTACTS	CONTACTS	OCEAN LANDINGS	SHAKER DEATHS	OCEAN IMPACTS
3	17,198	0	15133	3934	3147	197	3344
4	4,247	0	4246	1104	1104	0	1104
I	416	0	415	108	108	0	108
SUM	21860	0			4359		4556
ADULT					4359		

AGE	REMAIN POP	ADULT RIVER RUN SIZE	RIVER CONTACT RATE	RIVER IMPACT RATE	RIVER DROPOFF RATE	RIVER IMPACTS	RIVER HARVEST
3	13853	8824	0.59	0.45	0.067	4008	3739
4	3142	2661	1.00	0.77	0.067	2048	1910
5	307	307	1.00	0.77	0.067	236	220
SUM	17302	11792				6292	5869

AGE	SPAWNING ESCAPE.	PROP IN NAT AREAS	NATURAL ESCAPE.
3	4816	1.00	4816
4	613	1.00	613
5	71	1.00	71
SUM	5500		5500

ADULT ESCAPEMENT	5500
ADULT NAT ESCAPE.	5500

Go To TOC

Table 2A. Harvest Rate Model Output for Chinook Based on Equilibrium Harvest Rates and Harvest Allocated Among Ocean and Inriver Fisheries with 25% reduction in HRs.

HARVEST RATE MODEL(DEVELOPED BV USFWS, ARCATA)

========= ========= ========= ========= =======

OCEAN ADULT HARVEST	3,300 *		
INRIVER ADULT HARVEST	4,700 *	REDUCTION FACTOR =	25%
TRIBAL ADULT HARVEST	4,000 *	TRIBAL SHARE =	0.845
NON-TRIBAL ADULT HARVEST	4,000 ,	RIVER REC SHARE OF	
INRIVER REC. ADULT HARVEST	700 *	NON-TRIBAL HARVEST =	17.5%
NAT SPAWNING ESCAPEMENT	7,500		

========= ========= ========= ========= =======

AGE	OSC	PERCENT LEGAL	SHAKER MORT	PERCENT MATURING	NATURAL MORT	OCEAN HARVEST RATE	TERMINAL HARVEST RATE
3	0.88	80.0%	0.31	63.7%	0.20	0.20	0.58
4	1.00	100.0%	0.00	84.7%	0.20	0.20	0.58
5	1.00	100.0%	0.00	100.0%	0.20	0.20	0.58
		LONG TERM H.R. COMB. FISH/FISH=				0.195	0.578
						0.2600	0.7700

AGE	STOCK STATUS	PREV FALL	POTENTIAL CONTACTS	CONTACTS	OCEAN LANDINGS	SHAKER DEATHS	OCEAN IMPACTS
3	17,198	0	15133	2951	2360	la3	2543
4	4,247	0	4246	828	828	0	828
5	416	0	415	al	81	0	al
SUM	21860	0			3269		3452
ADULT					3269		

AGE	REMAIN POP	ADULT RIVER RUN SIZE	RIVER CONTACT RATE	RIVER IMPACT RATE	RIVER DROPOFF RATE	RIVER IMPACTS	RIVER HARVEST
3	14654	9334	0.59	0.34	0.067	3180	2966
4	3418	2895	1.00	0.58	0.067	1671	1559
5	334	334	1.00	0.58	0.067	192	179
SUM	18406	12563				5043	4704

AGE	SPAWNING ESCAPE.	PROP IN NAT AREAS	NATURAL ESCAPE.
3	6154	1.00	6154
4	1224	1.00	1224
5	142	1.00	142
SUM	7520		7520

ADULT ESCAPEMENT	7520
ADULT NAT ESCAPE.	7520

Go To TOC

Table 2B. Harvest Rate Model Output for Chinook Based on Equilibrium Harvest Rates and Harvest Allocated Among Ocean and Inriver Fisheries w/ 50% reduction in HRs.

HARVEST RATE MODEL(DEVELOPED BY USFWS, ARCATA)

OCEAN ADULT HARVEST	2,200		
INRIVER ADULT HARVEST	3,300	REDUCTION FACTOR =	50%
TRIBAL ADULT HARVEST	2,700	TRIBAL SHARE =	0.830
NON-TRIBAL ADULT HARVEST	2,800	RIVER REC SHARE OF	
INRIVER REC. ADULT HARVEST	600 *	NON-TRIBAL HARVEST =	21.4%
NAT SPAWNING ESCAPEMENT	9,800		

AGE	OSC	PERCENT LEGAL	SHAKER MORT	PERCENT MATURING	NATURAL MORT	OCEAN HARVEST RATE	TERMINAL HARVEST RATE
3	0.88	80.0%	0.25	63.7%	0.20	0.13	0.39
4	1.00	100.0%	0.25	84.7%	0.20	0.13	0.39
5	1.00	100.0%	0.25	100.0%	0.20	0.13	0.39
		LONG TERM H.R. COMB. FISH/FISH=				0.130	0.385
						0.2600	0.7700

AGE	STOCK STATUS	PREV FALL	POTENTIAL CONTACTS	CONTACTS	OCEAN LANDINGS	SHAKER DEATHS	OCEAN IMPACTS
3	17,198	0	15133	1967	1573	99	1672
4	4,247	0	4246	552	552	0	552
5	416	0	415	54	54	0	54
SUM	21860	0			2179		2278
ADULT					2179		

AGE	REMAIN POP	ADULT RIVER RUN SIZE	RIVER CONTACT RATE	RIVER IMPACT RATE	RIVER DROPOFF RATE	RIVER IMPACTS	RIVER HARVEST
3	15526	9890	0.59	0.23	0.067	2246	2095
4	3694	3128	1.00	0.39	0.067	1204	1123
5	361	361	1.00	0.39	0.067	138	128
SUM	19581	13379				3588	3346

AGE	SPAWNING ESCAPE.	PROP IN NAT AREAS	NATURAL ESCAPE.		
3	7644	1.00	7644	ADULT ESCAPEMENT	9791
4	1924	1.00	1924	ADULT NAT ESCAPE.	9791
5	223	1.00	223		
SUM	9791		9791		

Go To TOC

Table 2C. Harvest Rate Model Output for Chinook Based on Equilibrium Harvest Rates and Harvest Allocated Among Ocean and Inriver Fisheries w/ 75% reduction in HRs.

HARVEST RATE MODEL(DEVELOPED BY USFWS, ARCATA)

OCEAN ADULT HARVEST	1,100 *		
INRIVER ADULT HARVEST	1,800 *	REDUCTION FACTOR =	75%
TRIBAL ADULT HARVEST	1,400 *	TRIBAL SHARE =	0.800
NON-TRIBAL ADULT HARVEST	1,500 *	RIVER REC SHARE OF	
INRIVER REC. ADULT HARVEST	400 *	NON-TRIBAL HARVEST =	26.7%
NAT SPAWNING ESCAPEMENT	12,300	15200	

AGE	OSC	PERCENT LEGAL	SHAKER MORT	PERCENT MATURING	NATURAL MORT	OCEAN HARVEST RATE	TERMINAL HARVEST RATE
3	0.88	80.0%	0.25	63.7%	0.20	0.07	0.19
4	1.00	100.0%	0.25	84.7%	0.20	0.07	0.19
5	1.00	100.0%	0.25	100.0%	0.20	0.07	0.19
		LONG TERM H.R. COMB. FISH/FISH=				0.065	0.193
						0.2600	0.7700

AGE	STOCK STATUS	PREV FALL	POTENTIAL CONTACTS	CONTACTS	OCEAN LANDINGS	SHAKER DEATHS	OCEAN IMPACTS
3	17,198	0	15133	983	786	49	835
4	4,247	0	4246	276	276	0	276
5	416	0	415	27	27	0	27
SUM	21860	0			1089		1138
ADULT					1089		

AGE	REMAIN POP	ADULT RIVER RUN SIZE	RIVER CONTACT RATE	RIVER IMPACT RATE	RIVER DROPOFF RATE	RIVER IMPACTS	RIVER HARVEST
3	16362	10422	0.59	0.11	0.067	1183	1103
4	3970	3362	1.00	0.19	0.067	647	603
5	388	388	1.00	0.19	0.067	74	69
SUM	20720	14172				1904	1775

AGE	SPAWNING ESCAPE.	PROP IN NAT AREAS	NATURAL ESCAPE.
3	9239	1.00	9239
4	2715	1.00	2715
5	314	1.00	314
SUM	12268		12268

ADULT ESCAPEMENT 12268
ADULT NAT ESCAPE. 12268

Go To TOC

Table 2D. Harvest Rate Model Output for Chinook Based on Equilibrium Harvest Rates and Harvest Allocated Among Ocean and Inriver Fisheries w/90% reduction in HRs.

HARVEST RATE MODEL(DEVELOPED BY USFWS, ARCATA)

OCEAN ADULT HARVEST	400 *		
INRIVER ADULT HARVEST	700 *	REDUCTION FACTOR =	90%
TRIBAL ADULT HARVEST	600 *	TRIBAL SHARE =	0.830
NON-TRIBAL ADULT HARVEST	500 *	RIVER REC SHARE OF	
INRIVER REC. ADULT HARVEST	100 *	NON-TRIBAL HARVEST =	20.0%
NAT SPAWNING ESCAPEMENT	13,900		

AGE	OSC	PERCENT LEGAL	SHAKER MORT	PERCENT MATURING	NATURAL MORT	OCEAN HARVEST RATE	TERMINAL HARVEST RATE
3	0.88	80.0%	0.25	63.7%	0.20	0.03	0.08
4	1.00	1000%	0.25	84.7%	0.20	0.03	0.08
5	1.00	100.0%	0.25	100.0%	0.20	0.03	0.08
		LONG TERM H.R. COMB. FISH/FISH=				0.026	0.077
						0.2600	0.7700

AGE	STOCK STATUS	PREV FALL	POTENTIAL CONTACTS	CONTACTS	OCEAN LANDINGS	SHAKER DEATHS	OCEAN IMPACTS
3	17,198	0	15133	393	314	20	334
4	4,247	0	4246	110	110	0	110
5	416	0	415	10	10	0	10
SUM	21860	0			434		454
ADULT					434		

AGE	REMAIN POP	ADULT RIVER RUN SIZE	RIVER CONTACT RATE	RIVER IMPACT RATE	RIVER DROPOFF RATE	RIVER IMPACTS	RIVER HARVEST
3	16863	10741	0.59	0.05	0.067	487	454
4	4136	3503	1.00	0.08	0,067	269	250
I	405	405	1.00	0.08	0.067	31	28
SUM	21404	14649				787	732

AGE	SPAWNING ESCAPE.	PROP IN NAT AREAS	NATURAL ESCAPE.
3	10254	1.00	10254
4	3234	1.00	3234
5	374	1.00	374
SUM	13862		13862

ADULT ESCAPEMENT	13862
ADULT NAT ESCAPE.	13862

Go To TOC

Table 2E. Harvest Rate Model Output for Chinook Based on Equilibrium Harvest Rates and Harvest Allocated Among Ocean and Inriver Fisheries - NO Harvest

HARVEST RATE MODEL(DEVELOPED BY USFWS, ARCATA)

========= ========= ========= ========= =======

OCEAN ADULT HARVEST	0 *		
INRIVER ADULT HARVEST	0 *	REDUCTION FACTOR =	100%
TRIBAL ADULT HARVEST	0 *	TRIBAL SHARE =	0.870
NON-TRIBAL ADULT HARVEST	0 *	RIVER REC SHARE OF	
INRIVER REC. ADULT HARVEST	0 *	NON-TRIBAL HARVEST =	#DIV/0!
NAT SPAWNING ESCAPEMENT	15,000		

========= ========= ========= ========= =======

AGE	OSC	PERCENT LEGAL	SHAKER MORT	PERCENT MATURING	NATURAL MORT	OCEAN HARVEST RATE	TERMINAL HARVEST RATE
3	0.88	80.0%	0.25	43.7%	0.20	0.00	0.00
4	1.00	100.0%	0.25	84.7%	0.20	0.00	0.00
5	1.00	100.0%	0.25	100.0%	0.20	0.00	0.00
		LONG TERM H.R. COMB, FISH/FISH=				0.000	0.000
						0.2600	0.7700

AGE	STOCK STATUS	PREV FALL	POTENTIAL CONTACTS	CONTACTS	OCEAN LANDINGS	SHAKER DEATHS	OCEAN IMPACTS
3	17,198	0	15133	0	0	0	0
4	4,247	0	4246	0	0	0	0
5	416	0	415	0	0	0	0
SUM	21860	0			0		0
ADULT					0		

AGE	REMAIN POP	ADULT RIVER RUN SIZE	RIVER CONTACT RATE	RIVER IMPACT RATE	RIVER DROPOFF RATE	RIVER IMPACTS	RIVER HARVEST
3	17197	10954	0.59	0.00	0.067	0	0
4	4246	3596	1.00	0.00	0.067	0	0
5	415	415	1.00	0.00	0.067	0	0
SUM	21858	14965				0	0

AGE	SPAWNING ESCAPE.	PROP IN NAT AREAS	NATURAL ESCAPE.		
3	10954	1.00	10954	ADULT ESCAPEMENT	14965
4	3596	1.00	3596	ADULT NAT ESCAPE.	14965
5	415	1.00	415		
SUM	14965		14965		

Go To TOC

ATTACHMENT B16

ASSESSMENT OF THE OCEAN TROLL HARVEST LEVELS FOR THE TRINITY RIVER EIS / EIR

Assessment of ocean troll harvest levels for the Trinity River EIS/EIR

Previous attempts to project available harvest of the ocean troll fishery for each EIS/EIR alternative have not provided credible results because the methodology did not account for shifts in harvest impacts from one area to another that occur at different stock abundances. The numbers of fish that are available for harvest vary in different coastal zones, and salmon stock size determines the allowable harvest in each zone. As any particular stock size increases or decreases, relative numbers of fish available for harvest in each zone shifts. The following analysis was undertaken to derive harvest estimates for the ocean troll fishery incorporating appropriate factors to adjust for shifts in harvest impacts based on the magnitude of allowable harvest.

Methodology

Ocean Troll Landing Data

Ocean troll landings for California and Oregon were obtained from the Review of 1997 Ocean Salmon Fisheries (PFMC1998) from 1976 to 1997 (Table 1). Harvest management areas identified for the Trinity River EIS/EIR and the corresponding catch areas reported in the Review of 1997 Ocean Salmon Fisheries (PFMC1998) are presented in Table 2.

Average chinook salmon landings were generated for three periods:

A. 1976-1997. Average landings for this period include the variability of ocean troll harvest levels that have occurred due to varying stock abundance levels and fishery management actions. These data include years before and after the reallocation of Klamath Basin fall-run chinook salmon (KBFCS) that provided the inriver Tribal fishery 50% of the allowable harvest. Data were broken into the periods before and after this reallocation, which occurred in 1991, in the following periods (B and C).

B. 1976-1990. Ocean troll fishery was the dominant harvester of KBFCS and relatively large troll fisheries existed in the Klamath Management Zone (KMZ) and adjacent ports.

C. 1991-1997. This period reflects the harvest magnitude of the ocean troll fishery after the reallocation of KBFCS that provided the inriver Tribal fishery 50% of the allowable harvest and reduced the numbers of fish available for the ocean troll and other non-tribal fisheries in the coastal areas near the Klamath River. Harvest restrictions were implemented in Coos Bay, KMZ, and Fort Bragg to reduce the impacts of the ocean troll fishery on KBFCS, and allow larger numbers of fish to return to the Klamath Basin.

Go To TOC

Large ocean troll fisheries remained in northern Oregon and San Francisco/Monterey areas. Ocean stock sizes during the period were highly variable: very low in the early 1990's and high during the latter years of this period.

Trinity River Naturally Produced Fall-Run Chinook Salmon Ocean Troll Harvest Levels

Numbers of Trinity River naturally produced chinook salmon available for harvest for each fishery and each alternative were estimated by the TREIS/EIR Fish and Channel Restoration Team (FCRT). These estimates included both spring- and fall-run chinook salmon while the data used in the Klamath River Ocean Harvest model (KOHM) only accounts for KBFCS harvest impacts. Klamath Basin spring chinook are accounted for in the KOHM as contributions from other stocks. To use the estimates from the FCRT with data used in the KOHM, the number of TRNFC available for the ocean troll fishery was calculated by multiplying the number of chinook salmon for each alternative by the ratio of fall-run chinook salmon to total chinook salmon (62,000/68,000 = 0.9118) (Table 3). This ratio reflects the relative numbers of fall-run chinook to fall and spring-run chinook, as stated in the Trinity River Restoration Program's escapement goals and subsequently used by the by the FCRT in their estimates.

Klamath Basin Fall-Run Chinook Salmon Ocean Troll Harvest Levels

The number of Trinity River naturally produced fall-run chinook (TRNFC) for each alternative was then expanded to account for other fall-run chinook salmon produced from the Klamath Basin (of both natural and hatchery origin). In the initial methodology, the number of TRNFC available for harvest in the ocean troll fishery for each alternative was expanded by a dividing it by 0.1459 (the proportion of TRNFC contribution to KBFCS escapement). This method assumed that the proportion of TRNFC to KBFCS would remain constant under all alternatives, and that other KBFCS populations increase at the same rate as TRNFC. Although restoration activities undertaken on the Trinity River may have some positive affect on salmonid populations in the lower Klamath River (below the confluence with the Trinity River), it is unlikely that they would affect populations to the level that these assumptions are appropriate: a constant contribution rate of TRNFC would not occur. Also, the projected numbers of KBFCS available for harvest in the ocean troll fishery became unreasonably large for the Trinity River Flow Evaluation and Maximum Flow alternatives.

In order to correct the problems associated with the initial methodology, the number of KBFCS available for harvest by the ocean troll fishery was estimated by assuming that the production from the Klamath Basin, excluding TRNFC, was constant for each alternative and equal to the number available for the No Action alternative. To this number (18,100), the number of TRNFC was added for each alternative to estimate the total number of KBFCS available for harvest by the ocean troll fishery (Table 4).

Go To TOC

Number (thousands) of TRNFC available for harvest under the No Action Alternative	= 3.1
Number (thousands) of Klamath Basin fall-run chinook salmon available for harvest under the No Action Alternative	= 21.2
Number (thousands) of Klamath Basin fall-run chinook salmon available for harvest under the No Action Alternative excluding TRNFC	= 18.1

Ocean Troll Fishery Harvest Model (OTFHM)

A spreadsheet model was developed to estimate chinook salmon harvest by the ocean troll fishery by port and these data were summarized by harvest area for each alternative (Appendix A). The model was calibrated for the No Action alternative using the average chinook salmon landings for each port for the 1991-1997 period and KBFCS contribution data derived from the KOHM database. Landings from the 1991-1997 period were used because these best represent ocean troll fishery management based on the current harvest allocation scheme. The model was calibrated by adjusting the contribution rates until the total estimated landings of KBFCS was equal to 21,200 (the number of KBFCS available for harvest under the No Action alternative). This was done by adjusting the KBFCS contribution to the ocean troll fishery by multiplying the contribution data from the KOHM by 2.02 (= 21.2/10.52). These calibrations were necessary because the data used for contribution rates and landings were from different time periods.

The OTFHM was initialized with the average chinook salmon landings for each port for the 1991 to 1997 period. It was assumed that for all alternatives, the landings in the Northern Oregon (Columbia, Tillimook, Newport) and San Francisco (San Francisco, Monterey) harvest areas would remain constant because the fisheries in these areas were less affected by restraints due to KBFCS abundance than the harvest areas nearer to the Klamath River. The harvest in areas nearer to the Klamath River during this time period had been restricted to decrease harvest impacts on KBFCS. For this analysis, harvest in these areas were increased with increasing availability of KBFCS. For each alternative, landings were adjusted by iteration so the total landings of KBFCS was equal to the projected number of KBFCS available for that harvest. Landings for the ports of Coo Bay, Brookings, Crescent City, Eureka, and Fort Bragg were increased by the same factor until the total landings of KBFCS was equal to the number available for that alternative. Total landings were calculated by dividing the number of KBFCS harvested by the adjusted contribution rate for each port. These data were then summarized into the harvest areas for the Trinity River EIS/EIR economic analysis.

Go To TOC

Estimation of Chinook Salmon Harvest Levels

Projected harvest of Klamath Basin fall-run chinook salmon (Table 5), total salmon landings (Table 6), and difference in total landings from the No Action alternative (Table 7) were summarized by management area and alternative.

Estimation of Chinook Salmon Harvest Levels -State Permit Alternative

The FCRT assessment of Trinity River naturally produced chinook salmon available for harvest under the State Permit alternative indicated that habitat conditions would be so poor that it was unlikely that there would be fish available for harvest by the various fisheries and that the anadromous fishery resources of the Trinity River would be listed under the Endangered Species Act. To assess the State Permit alternative, it was assumed that the ocean harvest rate would be reduced by 50% from that allowed under the No Action alternative and landings were calculated using the OTFHM as for other alternatives (Table 8).

Go To TOC

Table 1. Chinook salmon landings (100s of fish) by port areas along Oregon and California coasts (CC= Crescent City, EKA= Eureka, FTB= Fort Bragg, SF= San Francisco, MONT= Monterey). Source: PFMC Review of Ocean Fisheries Report- 1997, Appendix A.

	Port Area				
	Columbia R	Tilamook	Newport	Coos Bay	Brookings
Average 1976-1980	15.3	11.2	46.6	85.6	73.9
Average 1981-1985	5.6	5.9	27.9	63.5	42.6
1986	6.1	14.1	88.0	240.0	53.7
1987	4.6	41.4	87.6	350.4	39.8
1988	1.6	32.8	129.0	268.5	31.6
1989	2.9	30.4	70.7	232.5	16.8
1990	2.3	12.5	39.3	175.8	2.2
1991	0.9	9.5	33.5	30.5	0.2
1992	1.5	7.3	94.7	6.2	0.0
1993	0.4	6.3	64.2	10.5	0.0
1994	0.0	1.7	18.1	4.0	1.5
1995	0.0	9.7	174.4	26.6	3.3
1996	0	13.1	127.8	25.6	8.6
1997	0	2.4	118.7	24.8	3.6
Average (79-97)	5.7	12.1	64.5	97.3	33.8
Average (76 -90)	8.1	14.4	52.5	134.2	48.4
Average (91-97)	0.4	7.1	90.2	18.3	2.5
	CC	EKA	FTB	SF	MONT
Average 1976-1980	44.3	166.3	143.9	174.7	89.5
Average 1981-1985	38.8	48.9	110.8	180.0	84.1
1986	14.0	36.7	272.4	302.3	200.2
1987	33.5	54.7	341.2	355.6	91.2
1988	15.6	46.4	424.7	624.7	187.8
1989	5.5	17.5	144.2	255.8	108.0
1990	1.4	6.3	79.6	199.1	137.1
1991	0.0	4.7	35.5	174.8	79.8
1992	0.0	0.0	0.0	66.5	97.0
1993	0.0	0.0	19.9	155.0	104.7
1994	0.0	0.0	5.2	219.9	70.5
1995	0.0	0.0	8.7	357.5	313.1
1996	0.3	8.5	22.9	167.4	181.5
1997	0.0	1.4	3.8	254.3	228.0
Average (76-97)	22.1	56.9	119.6	223.0	121.2
Average (76-90)	32.4	82.5	169.0	234.1	106.2
Average (91-97)	0.0	2.1	13.7	199.3	153.5

Table 2. Trinity River EIS/EIR harvest management areas and corresponding PFMC catch areas.

Trinity River EIS/EIR Harvest Management Areas	PFMC Catch Areas
Northern/Central Oregon	Columbia River, Tillamook, Newport, Coos Bay
KMZ-Oregon	Brookings
KMZ-California	Crescent City, Eureka
Mendocino	Fort Bragg
San Francisco	San Francisco
Monterey	Monterey

Table 3. Number (in thousands) of Trinity River naturally produced chinook salmon (spring- and fall-run) and numbers of fall-run chinook salmon only available for harvest in the ocean troll fishery for each TREIS/EIR alternative.

Alternative[1]	Naturally Produced Spring- and Fall-Run Chinook Salmon	Naturally Produced Fall-Run Chinook Salmon
No Action	3.4	3.1
Mechanical Restoration	7.4	6.7
40% Flow	9.8	8.9
Trinity River Flow Evaluation	28.7	26.2
Maximum Flow	34.5	31.5

1. State Permit Alternative does not have any allowable harvest.

Go To TOC

Table 4. Number (in thousands) of Trinity River naturally produced fall-run chinook salmon and the number (in thousands) of Klamath Basin fall-run chinook salmon available for harvest in the ocean troll fishery for each TREIS/EIR alternative.

Alternative[1]	Naturally Produced Trinity River Fall-Run Chinook Salmon	Klamath Basin Fall-Run Chinook Salmon [2]	Klamath Basin Fall-Run Chinook Salmon [3]
No Action	3.1	21.2	21.2
Mechanical Restoration	6.7	46.2	24.9
40% Flow	8.9	61.2	27.1
Trinity River Flow Evaluation	26.2	179.4	44.3
Maximum Flow	31.5	215.6	49.6

1. State Permit Alternative does not have any allowable harvest.
2. Allowable harvest of Klamath Basin fall-run chinook salmon for the ocean troll fishery based on a constant proportion of Trinity River naturally produced fall-run chinook salmon.
3. Allowable harvest of Klamath Basin fall-run chinook salmon for the ocean troll fishery based on a constant number of other non-Trinity River naturally produced fall-run chinook salmon and variable number of Trinity River naturally produced fall-run chinook salmon.

Table 5. Projected Harvest (thousands of fish) of Klamath Basin Fall-Run Chinook Salmon in the Ocean Troll Fishery for each Trinity River EIS/EIR alternative.

Harvest Area	No Action	Mechanical Restoration	40% Flow	TRFES	Maximum Flow
N/C OR	8.5	11.3	13.0	26.2	30.3
KMZ-OR	0.3	0.5	0.6	1.5	1.8
KMZ-CA	0.3	0.4	0.5	1.3	1.5
Fort Bragg	0.9	1.4	1.7	4.1	4.9
San Francisco	6.3	6.3	6.3	6.3	6.3
Monterey	4.9	4.9	4.9	4.9	4.9
Total	21.2	24.9	27.1	44.3	49.6

Go To TOC

Table 6. Projected Harvest (thousands of fish) of Chinook Salmon in the Ocean Troll Fishery for each Trinity River EIS/EIR alternative.

Harvest Area	No Action	Mechanical Restoration	40% Flow	TRFES	Maximum Flow
N/C OR	116.1	126.3	132.4	180.2	195.0
KMZ-OR	2.5	3.8	4.7	11.1	13.0
KMZ-CA	2.1	3.3	4.0	9.6	11.3
Fort Bragg	13.7	21.4	26.0	61.8	72.8
San Francisco	199.3	199.3	199.3	199.3	199.3
Monterey	153.5	153.5	153.5	153.5	153.5
Total	487.2	507.8	520.0	615.5	644.9

Table 7. Difference from the No Action Alternative in Projected Harvest (thousands of fish) of Chinook Salmon in the Ocean Troll Fishery for each Trinity River EIS/EIR alternative.

Harvest Area	No Action	Mechanical Restoration	40% Flow	TRFES	Maximum Flow
N/C OR	-----	10.3	16.4	64.2	78.9
KMZ-OR	-----	1.4	2.2	8.6	10.6
KMZ-CA	-----	1.2	1.9	7.5	9.2
Fort Bragg	-----	7.7	12.3	48.1	59.1
San Francisco	-----	0.0	0.0	0.0	0.0
Monterey	-----	0.0	0.0	0.0	0.0
Total	-----	20.5	32.8	128.3	157.7

Go To TOC

Table 8. Projected Harvest (thousands of fish) of Chinook Salmon in the Ocean Troll Fishery for Trinity River EIS/EIR State Permit alternative.

Harvest Area	Klamath Basin Fall-Run Chinook Salmon	Total Chinook Salmon Harvest (mixed stock)
N/C OR	2.5	71.0
KMZ-OR	0.0	0.0
KMZ-CA	0.0	0.0
Fort Bragg	0.0	0.0
San Francisco	4.6	144.7
Monterey	3.5	111.5
Total	10.6	327.1

Go To TOC

of Attachment B16.

Appendix A1. Trinity natural fall chinook, Klamath Basin fall chinook, and total chinook landing for ocean troll fishery by port area for each alternative for the Trinity River EIS. (continued)

40% harvest of 8.9 TFNFC and 27.1 KBFC

		Klam Basin	
	Trin Nat	FC	Total
N/C OR	1.90	13.03	132.45
KMZ-OR	0.09	0.63	4.66
KMZ-CA	0.08	0.54	4.03
FTB	0.25	1.74	25.99
SF	0.92	6.31	199.34
MONT	0.71	4.86	153.51
Total	3.95	27.10	519.98

				Harv Exp	1.895			
		Avg(76-97)	Avg(76-90)	Avg(91-97)	Harv	Klam Contrib (adjusted)	Klamath Harvest	Trin Nat Harv
NOR	Columbia	5.67	8.13	0.40	0.40	0.04	0.01	0.00
	Tillimook	12.12	14.45	7.14	7.14	0.04	0.25	0.04
	Newport	64.48	52.47	90.20	90.20	0.04	3.18	0.46
CSB	Coos Bay	97.31	134.18	18.31	34.71	0.28	9.58	1.40
KMZ-OR	Brookings	33.81	48.44	2.46	4.66	0.13	0.63	0.09
KMZ-CA	Crescent City	22.08	32.37	0.04	0.08	0.13	0.01	0.00
	Eureka	56.92	82.51	2.09	3.95	0.13	0.53	0.08
FTB	Fort Bragg	119.62	169.04	13.71	25.99	0.07	1.74	0.25
SF	SF	223.02	234.07	199.34	199.34	0.03	6.31	0.92
MONT	Monterey	121.22	106.15	153.51	153.51	0.03	4.86	0.71
Total		756.25	881.81	487.21	519.98		27.10	3.95

TRFES harvest of 26.2 TFNFC and 44.3 KBFC

		Klam Basin	
	Trin Nat	FC	Total
N/C OR	3.82	26.21	180.23
KMZ-OR	0.22	1.49	11.07
KMZ-CA	0.19	1.29	9.59
FTB	0.60	4.14	61.77
SF	0.92	6.31	199.34
MONT	0.71	4.86	153.51
Total	6.46	44.30	615.51

				Harv Exp	4.504			
		Avg(76-97)	Avg(76-90)	Avg(91-97)	Harv	Klam Contrib (adjusted)	Klamath Harvest	Trin Nat Harv
NOR	Columbia	5.67	8.13	0.40	0.40	0.04	0.01	0.00
	Tillimook	12.12	14.45	7.14	7.14	0.04	0.25	0.04
	Newport	64.48	52.47	90.20	90.20	0.04	3.18	0.46
CSB	Coos Bay	97.31	134.18	18.31	82.49	0.28	22.77	3.32
KMZ-OR	Brookings	33.81	48.44	2.46	11.07	0.13	1.49	0.22
KMZ-CA	Crescent City	22.08	32.37	0.04	0.19	0.13	0.03	0.00
	Eureka	56.92	82.51	2.09	9.39	0.13	1.27	0.18
FTB	Fort Bragg	119.62	169.04	13.71	61.77	0.07	4.14	0.60
SF	SF	223.02	234.07	199.34	199.34	0.03	6.31	0.92
MONT	Monterey	121.22	106.15	153.51	153.51	0.03	4.86	0.71
Total		756.25	881.81	487.21	615.51		44.30	6.46

of Attachment B16

Appendix A. Trinity natural fall chinook, Klamath Basin fall chinook, and total chinook landing for ocean troll fishery by port area for each alternative for the Trinity River EIS.

No Action harvest of 3.1 TRNFC and 21.2 KBFC

	Trin Nat	Klam Basin FC	Total
N/C OR	1.24	8.50	116.06
KMZ-OR	0.05	0.33	2.46
KMZ-CA	0.04	0.29	2.13
FTB	0.13	0.92	13.71
SF	0.92	6.31	199.34
MONT	0.71	4.86	153.51
Total	3.09	21.20	487.21

		Avg(76-97)	Avg(76-90)	Avg(91-97)	Harv	Klam Contrib (adjusted)	Klamath Harvest	Trin Nat Harv
NOR	Columbia	5.67	8.13	0.40	0.40	0.0353	0.01	0.00
	Tillimook	12.12	14.45	7.14	7.14	0.0353	0.25	0.04
	Newport	64.48	52.47	90.20	90.20	0.0353	3.18	0.46
CSB	Coos Bay	97.31	134.18	18.31	18.31	0.2760	5.05	0.74
KMZ-OR	Brookings	33.81	48.44	2.46	2.46	0.1348	0.33	0.05
KMZ-CA	Crescent City	22.08	32.37	0.04	0.04	0.1348	0.01	0.00
	Eureka	56.92	82.51	2.09	2.09	0.1348	0.28	0.04
FTB	Fort Bragg	119.62	169.04	13.71	13.71	0.0671	0.92	0.13
SF	SF	223.02	234.07	199.34	199.34	0.0316	6.31	0.92
MONT	Monterey	121.22	106.15	153.51	153.51	0.0316	4.86	0.71
Total		756.25	881.81	487.21	487.21		21.20	3.09

Mechancial Restoration harvest of 6.7 TRNFC and 24.9 KBFC

Harv Exp 1.561

	Trin Nat	Klam Basin FC	Total
N/C OR	1.65	11.34	126.33
KMZ-OR	0.08	0.52	3.84
KMZ-CA	0.07	0.45	3.32
FTB	0.21	1.44	21.41
SF	0.92	6.31	199.34
MONT	0.71	4.86	153.51
Total	3.63	24.90	507.75

		Avg(76-97)	Avg(76-90)	Avg(91-97)	Harv	Klam Contrib (adjusted)	Klamath Harvest	Trin Nat Harv
NOR	Columbia	5.67	8.13	0.40	0.40	0.04	0.01	0.00
	Tillimook	12.12	14.45	7.14	7.14	0.04	0.25	0.04
	Newport	64.48	52.47	90.20	90.20	0.04	3.18	0.46
CSB	Coos Bay	97.31	134.18	18.31	28.59	0.28	7.89	1.15
KMZ-OR	Brookings	33.81	48.44	2.46	3.84	0.13	0.52	0.08
KMZ-CA	Crescent City	22.08	32.37	0.04	0.07	0.13	0.01	0.00
	Eureka	56.92	82.51	2.09	3.26	0.13	0.44	0.06
FTB	Fort Bragg	119.62	169.04	13.71	21.41	0.07	1.44	0.21
SF	SF	223.02	234.07	199.34	199.34	0.03	6.31	0.92
MONT	Monterey	121.22	106.15	153.51	153.51	0.03	4.86	0.71
Total		756.25	881.81	487.21	507.8		24.90	3.6

of Attachment B16.

Appendix A Trinity natural fall chinook, Klamath Basin fall chinook, and total chinook landing for ocean troll fishery by port area for each alternative for the Trinity River EIS. (continued)

Max Flow harvest of 31.5 TFNFC and 49.6 KBFC

	Klam Basin		
	Trin Nat	FC	Total
N/C OR	4.42	30.28	194.96
KMZ-OR	0.26	1.76	13.04
KMZ-CA	0.22	1.52	11.30
FTB	0.71	4.88	72.80
SF	0.92	6.31	199.34
MONT	0.71	4.86	153.51
Total	7.24	49.60	644.95

				Harv Exp	5.308			
		Avg(76-97)	Avg(76-90)	Avg(91-97)	Harv	Klam Contrib (adjusted)	Klamath Harvest	Trin Nat Harv
NOR	Columbia	5.67	8.13	0.40	0.40	0.04	0.01	0.00
	Tillimook	12.12	14.45	7.14	7.14	0.04	0.25	0.04
	Newport	64.48	52.47	90.20	90.20	0.04	3.18	0.46
CSB	Coos Bay	97.31	134.18	18.31	97.21	0.28	26.83	3.91
KMZ-OR	Brookings	33.81	48.44	2.46	13.04	0.13	1.76	0.26
KMZ-CA	Crescent City	22.08	32.37	0.04	0.23	0.13	0.03	0.00
	Eureka	56.92	82.51	2.09	11.07	0.13	1.49	0.22
FTB	Fort Bragg	119.62	169.04	13.71	72.80	0.07	4.88	0.71
SF	SF	223.02	234.07	199.34	199.34	0.03	6.31	0.92
MONT	Monterey	121.22	106.15	153.51	153.51	0.03	4.86	0.71
Total		756.25	881.81	487.21	644.95		49.60	7.24

State Permit harvest of 1.0 TFNFC and 10.6 KBFC

	Klam Basin		
	Trin Nat	FC	Total
N/C OR	0.37	2.50	70.96
KMZ-OR	0.00	0.00	0.00
KMZ-CA	0.00	0.00	0.00
FTB	0.00	0.00	0.00
SF	0.67	4.58	144.72
MONT	0.51	3.53	111.45
Total	1.55	10.60	327.14

				Harv Exp	0.726			
		Avg(76-97)	Avg(76-90)	Avg(91-97)	Harv	Klam Contrib (adjusted)	Klamath Harvest	Trin Nat Harv
NOR	Columbia	5.67	8.13	0.40	0.29	0.04	0.01	0.00
	Tillimook	12.12	14.45	7.14	5.19	0.04	0.18	0.03
	Newport	64.48	52.47	90.20	65.49	0.04	2.31	0.34
CSB	Coos Bay	97.31	134.18	18.31	0.00	0.28	0.00	0.00
KMZ-OR	Brookings	33.81	48.44	2.46	0.00	0.13	0.00	0.00
KMZ-CA	Crescent City	22.08	32.37	0.04	0.00	0.13	0.00	0.00
	Eureka	56.92	82.51	2.09	0.00	0.13	0.00	0.00
FTB	Fort Bragg	119.62	169.04	13.71	0.00	0.07	0.00	0.00
SF	SF	223.02	234.07	199.34	144.72	0.03	4.58	0.67
MONT	Monterey	121.22	106.15	153.51	111.45	0.03	3.53	0.51
Total		756.25	881.81	487.21	327.14		10.60	1.55

ATTACHMENT B17

RESERVOIR FISHERIES EVALUATION REPORT

Trinity River Restoration Project

Reservoir Fisheries Evaluation

Prepared for.

CH2M HILL
2525 Airpark Drive
Redding, CA 9600 l-2443
Contact: Mark Oliver
530/243-5886

Prepared by.

Jones & Stokes Associates, Inc.
2600 V Street, Suite 100
Sacramento: CA 95814-1914
Contact: Gregg Roy
915/737-3000

May 25. 1999

Go To TOC

This document should be cited as :

Jones & Stokes Associates, Inc. 1998. Trinity River restoration project reservoir fisheries evaluation. May 25, 1999. (JSA 95-068.) Sacramento, CA. Prepared for CH2M HILL, Redding, CA.

Go To TOC

Table of Contents

List of Acronyms

List of Citations

Go To TOC

TRINITY RIVER RESTORATION PROJECT
RESERVOIR FISHERIES EVALUATION

Habitat for warmwater and coldwater reservoir fish species could be affected by the Trinity River Restoration Project. This report provides the conclusions of a quantitative assessment of changes in warmwater fish habitat in Trinity Lake and a qualitative assessment of changes in coldwater fish habitat in Trinity and Lewiston Lakes.

The impact evaluation includes two baseline conditions, the No-Action Alternative and existing conditions. Each project alternative was compared to the No-Action Alternative. For the comparison to existing conditions, only changes expected under the Preferred Alternative were evaluated.

Affected Environment

Trinity Lake

Trinity Lake has a maximum storage of 2.5 million acre-feet (af) of water and a maximum depth of 440 feet. As is typical with most California reservoirs, Trinity Lake is characterized by steep sides, with the upper 20% of the lake containing gentle slopes (Coleman 1978). The maximum surface area of the lake is 16,500 acres, with an irregular shoreline of about 145 miles.

Trinity Lake is relatively unproductive, with low standing crops of zooplankton. Thermal stratification of the lakewater (separation into layers of different temperatures) occurs between May and November, whereas the lake is nearly isothermal (similar water temperatures at all depths) during the rest of the year. The banks of Trinity Lake are highly erosive and, under windy conditions, contribute to high turbidity (i.e., high levels of suspended sediment) in the littoral (shoreline) areas. (Coleman 1978.)

Trinity Lake has been planted with both warmwater and coldwater fish species. Warmwater species include largemouth bass, smallmouth bass, white catfish, brown bullhead, and green sunfish. Coldwater species include brown, brook, and rainbow trout and kokanee salmon. Kokanee salmon were originally planted in Trinity Lake and are now a self-sustaining population.

Nongame species that are native to the Trinity River watershed and occur in the reservoir include Klamath speckled dace, Klamath smallscale sucker, Pacific lamprey, and at least one species of sculpin (Oscar Larson and Associates n.d.).

Many fish species inhabiting Trinity Lake have the potential to be affected by the project. This impact analysis evaluates largemouth bass, smallmouth bass, rainbow trout, and kokanee salmon because their response to reservoir conditions is representative of the response by other reservoir fish species and they are the species most sought after by sport anglers.

Warmwater Species

Largemouth Bass

Largemouth bass were first introduced into California in 1874 and have since spread to most suitable waters, providing an important sport fishery in reservoirs (Moyle 1976). They are normally found in warm, quiet waters with beds of aquatic vegetation and low turbidity. Although largemouth bass were originally planted in Trinity Lake, the population is now sustained naturally.

Spawning activity usually begins in April, when water temperature reaches 61°F (Kohler et al. 1993), but may continue through June. Males build nests in sand, gravel, or debris-littered bottoms at a depth of 3-6 feet. The eggs adhere to the substrate and hatch in 2-5 days. The sac fry usually spend 5-8 days in and around the nest.

Smallmouth Bass

Smallmouth bass were first introduced into California in 1874 (Moyle 1976). They have become established in large, temperature-stratified reservoirs and are normally found in cool waters near the upstream end of impoundments. Smallmouth bass were originally planted in Trinity Lake but the population is now sustained naturally.

Spawning activity usually begins in April, when water temperatures are between 55°F and 61°F. Males build nests in sand, gravel, or debris-littered bottoms at depths of 1-3 feet, although nests may occur as deep as 23 feet (Edwards et al. 1983). The male guards the nest until the eggs hatch in 3-10 days. The sac fry usually spend 3-4 days in the nest. The male herds and guards the fry for an additional 1-3 weeks; then the fry disperse into shallow water (Moyle 1976).

Factors Affecting Fish Abundance

Factors affecting fish abundance include fluctuation in reservoir elevation and habitat. Fluctuating water level is frequently identified as the main condition affecting production for warmwater fish species. Habitat availability, also associated with surface-level fluctuation, has been identified as a primary environmental problem affecting warmwater fish production in reservoirs. The effects of angling on reservoir fish communities are not well understood, although overfishing of naturally reproducing populations of game fishes seldom limits abundance (Moyle 1976).

Reservoir Elevation Fluctuations

Water-level fluctuation in reservoirs is perhaps the most significant environmental factor affecting fish productivity. The effects of fluctuating water levels are largely

Go To TOC

responsible for other fishery management problems, such as limited habitat and shoreline erosion.

Water-level changes affect physical, chemical, and biological parameters, which in turn directly or indirectly affect fish populations. Reservoir drawdowns reduce water depth and influence the degree of thermal stratification and the resulting temperature, oxygen, and total dissolved solids profiles.

The timing of drawdown may affect the reproductive success of littoral-spawning fishes, including bass species, by altering their habitat and influencing reproductive behavior (e.g., abandonment of nests). Survival may also be affected: eggs in nests exposed by falling water levels are desiccated; juveniles may be forced to move to less desirable habitat, increasing vulnerability to predators. Rising reservoir levels may submerge active nests during spring; if the nests become submerged under more than 15 feet of water, the mortality of eggs approaches 100% (Stuber et al. 1982).

Plants that provide habitat for fish may become inaccessible, depending on drawdown and reservoir surface elevation. Long-term or annual variability in water level may lead to changes in the composition of reservoir flora and fauna. Exposed reservoir basins generally require 3 years to revegetate.

Habitat

The presence and condition of fish habitat in reservoirs affects the production of warmwater fish species. Spawning, rearing, and food availability are dependent on sufficient habitat provided by structural diversity and rooted aquatic vegetation.

Structural diversity (e.g., submerged trees, brush, rocks, and boulders) provides shelter and feeding areas for fish. During the construction of many reservoirs, the potential for structural diversity was lowered because trees and brush were cleared from the reservoir basin. Clearing of vegetation in many reservoirs has resulted in rocks and boulders being the only habitat available, especially for bass and other sunfish.

The absence of established, rooted aquatic vegetation is another common problem in reservoirs. A variety of factors, including fluctuating water levels and shoreline erosion, affect establishment of vegetation. Sheltered areas with vegetative cover provide essential habitat for juvenile fish during spring and summer drawdown.

Coldwater Species

Rainbow Trout

Rainbow trout are the most abundant and widespread salmonid in Northern California reservoirs. They are adaptable to a wide variety of aquatic habitats.

Go To TOC

The cold, deep water of reservoirs provides suitable rearing habitat for rainbow trout, although they do not spawn in reservoirs. Rainbow trout spawn in tributary streams in spring, and juvenile trout migrate down spawning streams to enter the reservoir. The optimum temperature range for growth and completion of most life-history stages is 55-70°F. (Moyle 1976.)

Hatchery trout are stocked in Trinity Lake during April and May of each year to maintain a sport fishery; a total of 30,000 rainbow trout were planted in 1997. The determination of when to plant trout, and how many, is based on factors such as reservoir water temperature, availability of hatchery fish, results from experimental mark-and-recapture studies, reservoir surface acreage, and other hatchery management priorities. Naturally reproducing rainbow trout have been observed in both reservoirs during some years; however, the percentage contribution of this naturally sustained population to the total population in the lakes is unknown. (Aguilar pers. comm.)

Kokanee Salmon

Kokanee salmon are the nonanadromous or landlocked form of sockeye salmon. They spawn between early August and early February, with the exact timing being determined by the genetic background of the fish and by stream and reservoir temperatures. Spawning requires a water temperature of 43-55°F. Most spawning occurs in tributary streams, but some lake spawning has been reported. Fry emerge from the nests in April through June and immediately move downstream to the reservoir. Kokanee salmon will inhabit surface waters of the reservoirs as long as the water temperature is below 59°F. As surface waters warm, the fish gradually move deeper. (Moyle 1976.)

Kokanee salmon were introduced into Trinity Lake in 1963 and continue to reproduce naturally. Angling for kokanee salmon has become popular only in recent years, and the population is still underexploited. Because of low fishing mortality, low zooplankton density, and competition with catchable-size hatchery rainbow trout, the Trinity Lake kokanee salmon population is composed of small, stunted individuals (Moyle 1976, Coleman 1978).

Effects of Reservoir Operations on Coldwater Fish Abundance

Typically, the primary production in reservoirs is associated with storage. Increased storage and the corresponding increase in surface area results in greater species diversity, greater total biomass, and greater abundance of plankton and fish because the available habitat area is increased. Primary production occurs near the water surface, and the total surface area is directly affected by reservoir operations.

Fluctuating water levels may affect thermal stratification, which in turn may influence the extent of water mixing, the oxygen content of cool water strata, and the distribution of nutrients. The temperature regime will affect biological production in the reservoir and the distribution and survival of plankton and fish.

Go To TOC

Drawdowns during the spawning period can result in nest desiccation or nest disturbance by increasing the exposure of nests to wave action. During the rearing period for bass, reservoir drawdowns decrease the amount of available habitat and concentrate the fish into a smaller habitat area, which could increase the rate of predation.

Lewiston Reservoir

Lewiston Reservoir has a total storage capacity of 14,600 af and a surface area of approximately 610 acres, with 15 miles of shoreline. Trinity Lake discharges cold, bottom water to Lewiston Reservoir. Because Lewiston Reservoir is fairly shallow, thermal stratification can develop quickly when the discharge from Trinity Lake is low. When water is diverted from Lewiston Reservoir to the Sacramento River basin, large, rapid changes in surface temperatures at Lewiston Reservoir can occur as a result of increased releases from Trinity Lake. Water from Lewiston Reservoir is also discharged to the Trinity River.

Lewiston Reservoir contains primarily planted rainbow trout, brook trout, and brown trout. Slightly more than 39,000 trout (primarily rainbow, but also brown and brook trout) were planted in Lewiston Lake in 1997 (Calkins pers. comm.). Fish are released in Lewiston Lake once every 3 weeks between April and September. Some warmwater fish and kokanee salmon may enter Lewiston Reservoir from Trinity Lake, but these populations are not sustained (Frederiksen, Kamine and Associates, 1980).

Methodology

For each alternative considered in this analysis, data on end-of-month reservoir storage was generated by the U.S. Bureau of Reclamation's (Reclamation's) Project Operation Simulation (PROSIM) hydrologic model. The monthly reservoir storage values from the hydrology model were used in elevation/storage area relationships to calculate monthly values for water surface area, water surface fluctuation (elevation changes), and habitat exposure (or length of time that reservoir slopes are dry).

Warmwater Species

A spreadsheet model (reservoir model) was used to assess the effects of reservoir operations on warmwater species. The reservoir model calculates a separate spawning habitat index for largemouth and smallmouth bass and a rearing habitat index for both species together. Each habitat index ranges from 0 to 1, where 0 indicates that habitat is unavailable and 1 represents the maximum amount of habitat available for the reservoir. The quantity of habitat available to young bass is dependent on reservoir shape, reservoir elevation, and the depths that fish can use for spawning and rearing.

Spawning and rearing indices were calculated from monthly water storage for Trinity Lake simulated over the 1922-1991 period. Known elevation/storage area relationships for Trinity Lake were used in combination with simulated reservoir storage to calculate water surface area, water elevation change, and periods of exposure. The indices were weighted by a timing factor (i.e., monthly importance based on fish life-stage needs) to arrive at a monthly habitat index for each species. The 12 monthly habitat indices were added to produce an annual index for each water year.

Coldwater Species

The evaluation on the effects of reservoir operations under each alternative on salmonid species is qualitative. For coldwater species, increasing the reservoir surface area generally increases the amount of available habitat. Operations that maintain higher reservoir levels during March through October are assumed to increase habitat availability and benefit coldwater reservoir species.

Significance Criteria

The California Environmental Quality Act (CEQA) requires that an EIR contain an assessment of project impacts on environmental resources and evaluate the magnitude, or significance, of those impacts. For this analysis, an impact on reservoir fisheries is considered significant when project alternatives would:

- substantially degrade aquatic ecosystem processes,
- substantially change structural characteristics of the aquatic ecosystem, or
- substantially degrade conditions affecting or potentially affecting the abundance of a fish species having economic or social value.

The reservoir fisheries assessment methods were based on the best available information regarding the response of fish species to fluctuating reservoir elevations. However, fish population responses to changes in reservoir operations and variable hydrology is not well understood. Significance thresholds are phrased in either qualitative or quantitative terms, indicating potential changes from either the No-Action Alternative or existing conditions.

Changes in hydrology and reservoir operations result in variability in the annual spawning and rearing indices. To provide a means for assessing the significance of a change in these indices, target ranges were calculated for the No-Action Alternative and existing conditions. The target range is the mean index for the 70-year simulation of the No-Action Alternative or existing conditions ± 1 standard deviation. If a skewed distribution results in a standard deviation that exceeds the minimum or maximum index, the minimum or maximum index for the No-Action Alternative or existing conditions is used as the lower or upper boundary of the target range.

Under the No-Action Alternative and existing conditions, some of the calculated indices for the 70-year simulation fall outside the target range. The frequency with which the indices are outside the target range for the No-Action Alternative and existing conditions is compared to the frequency with which the indices are outside the target range for each of the action alternatives. If the frequency with which the indices fall below the target range for an alternative is greater (i.e., 10% more) than the frequency with which the indices fall below the target range for the No-Action Alternative or existing conditions, a significant adverse impact was identified. Conversely, if the frequency with which the indices are above the high end of the target range is greater than the frequency for the No-Action Alternative or existing conditions, a beneficial impact was identified.

Impact Evaluation of Alternatives Compared to the No-Action Alternative

The following discussion provides results of the evaluation of effects on warmwater and coldwater fish species for the Trinity River Mainstem Fishery Restoration Project for each project alternative compared to the No-Action Alternative.

No-Action Alternative

Trinity Lake

Warmwater Species

Spawning and rearing habitat for largemouth and smallmouth bass in Trinity Lake are currently approximately half of the amount that could be available under reservoir operations that maximize fish habitat. The average annual spawning indices for largemouth and smallmouth bass under the No-Action Alternative are 0.41 and 0.54, respectively. The average annual rearing index for both species is 0.55.

Coldwater Species

Because coldwater fish generally do not spawn in Trinity Lake, rearing life stages are most affected by reservoir operations. Average water surface elevation are lower than the maximum, indicating that surface area and rearing habitat availability are lower than they could be under reservoir operations that maximize fish habitat. The average monthly lake-level elevation over the 70-year hydrologic period for Trinity Lake under the No-Action Alternative is shown in Table 1.

Lewiston Lake

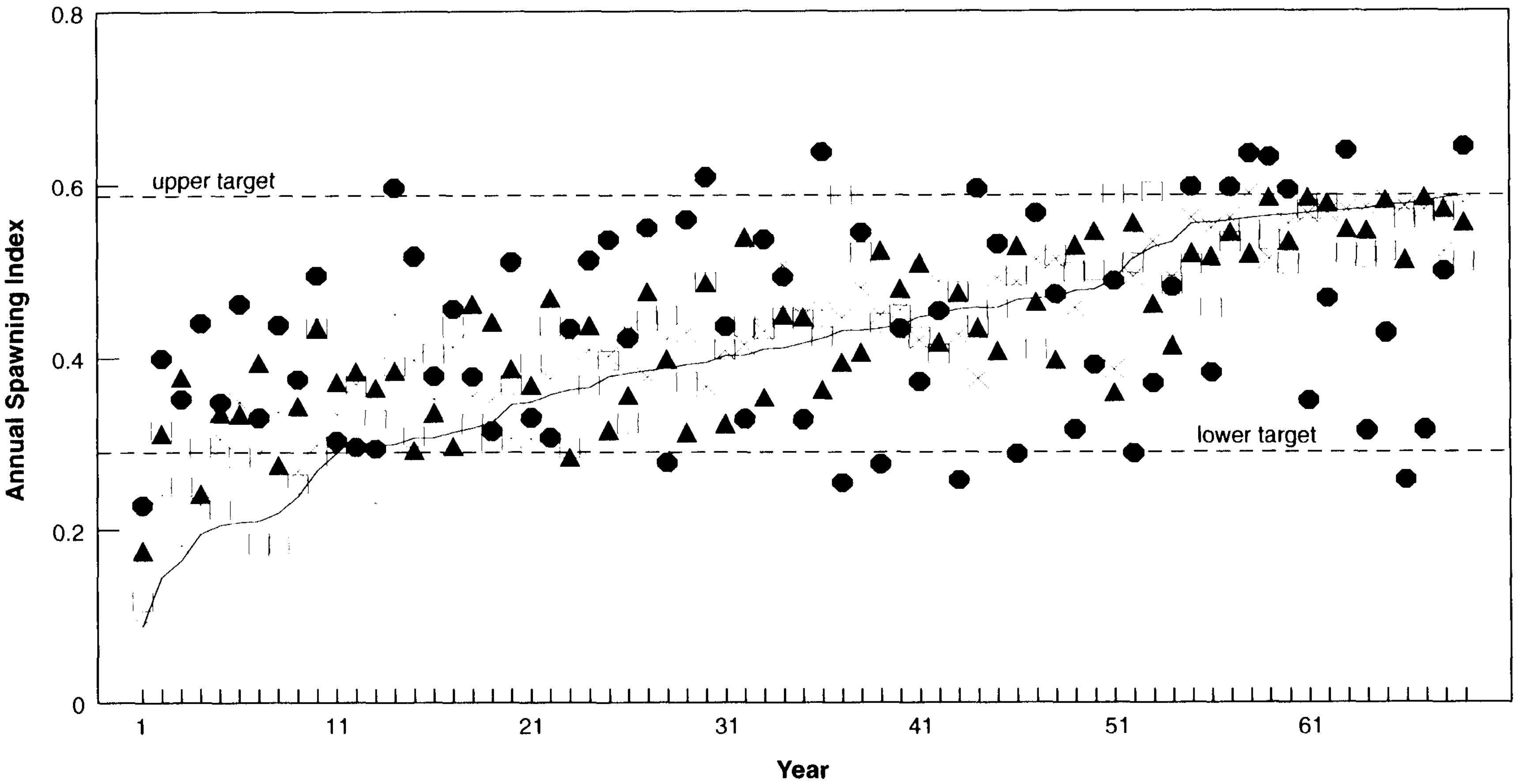
Fish habitat conditions under the No-Action Alternative would be the same as described for existing conditions because Lewiston Reservoir would continue to be operated as a re-regulating reservoir and the coldwater fish planting program is assumed to continue.

Table 1. Average Monthly Elevations for Trinity Lake under the No-Action and Action Alternatives

Month	No-Action	Maximum Flow	Flow Study	Percent Inflow	State Permit
October	2,280	2,276	2,282	2,283	2,289
November	2,281	2,280	2,284	2,285	2,291
December	2,285	2287	2,289	2,289	2,295
January	2,290	2,287	2,295	2,294	2,301
February	2,299	2,288	2,304	2,301	2,309
March	2,309	2,290	2,314	2,308	2,319
April	2,319	2,292	2,325	2,316	2,330
May	2,319	2,286	2,323	2,321	2,335
June	2,311	2,284	2,319	2,317	2,330
July	2,298	2,279	2,307	2,306	2,317
August	2,287	2,275	2,295	2,294	2,303
September	2,282	2,273	2,284	2,286	2,293

Note: Averages are based on the 70-year hydrologic period (1922-1991).

Go To TOC

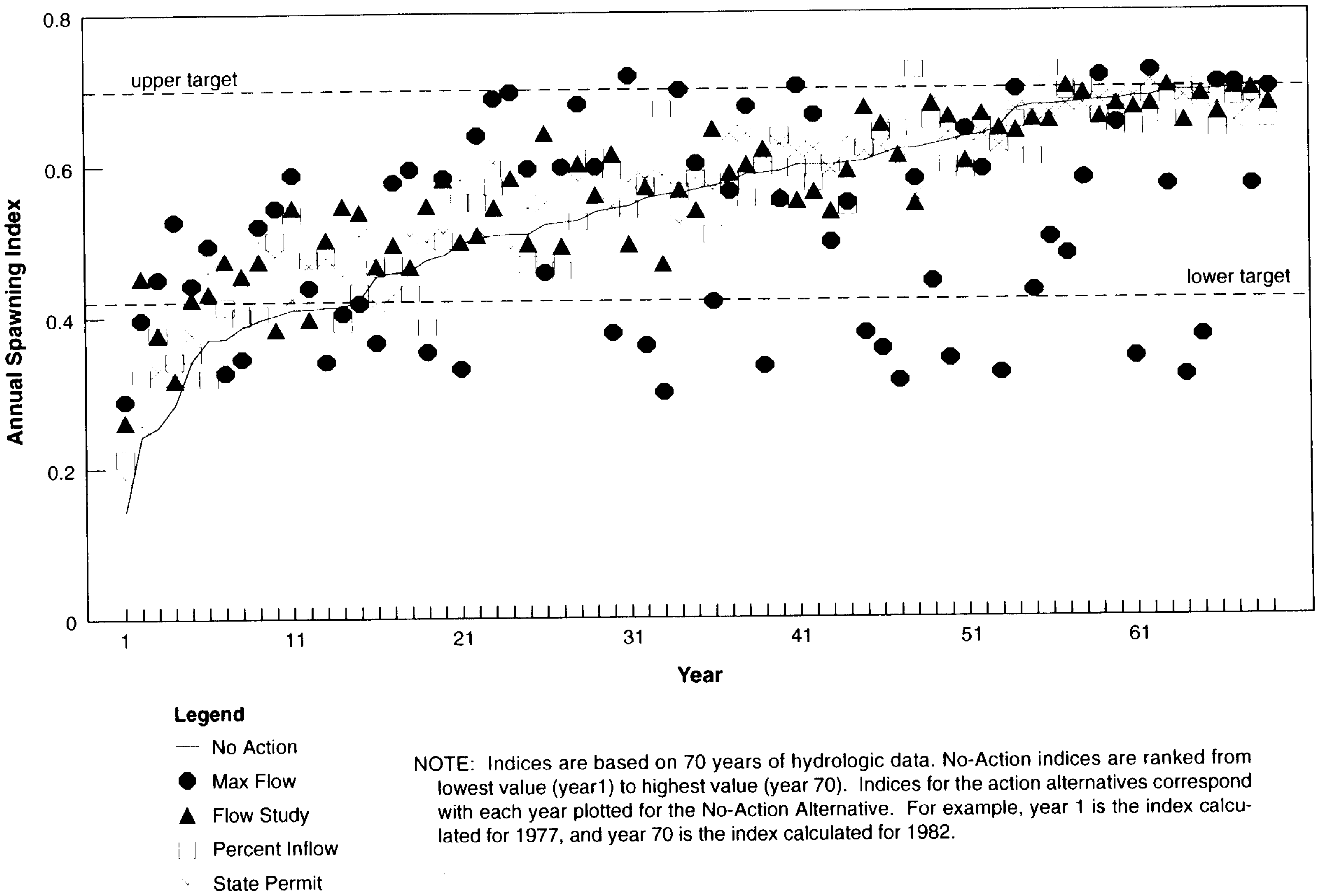


Legend

- No Action
- Max Flow
- Flow Study
- Percent Inflow
- State Permit

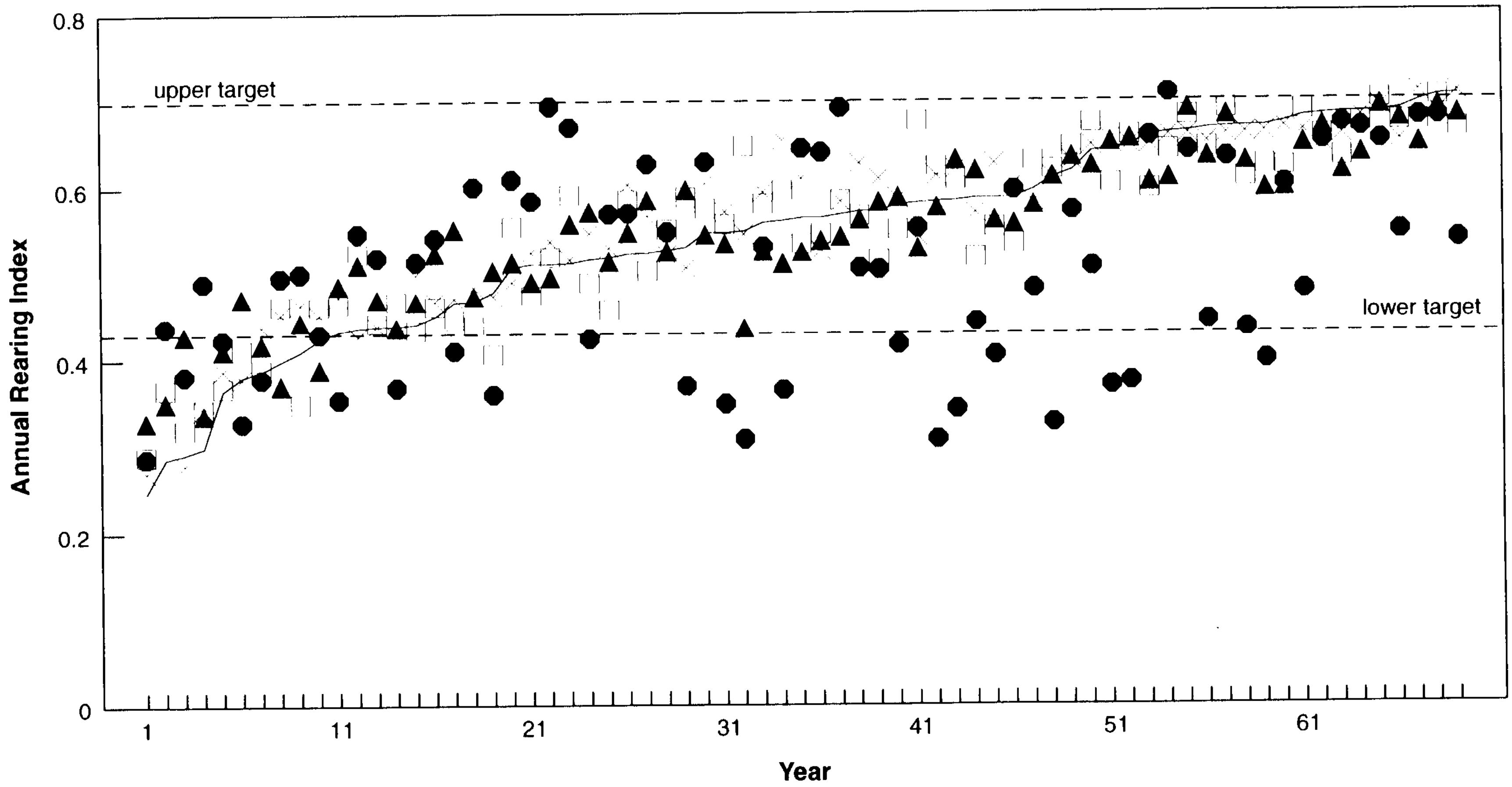
NOTE: Indices are based on 70 years of hydrologic data. No-Action indices are ranked from lowest value (year1) to highest value (year 70). Indices for the action alternatives correspond with each year plotted for the No-Action Alternative. For example, year 1 is the index calculated for 1977, and year 70 is the index calculated for 1980.

Figure 1
Largemouth Bass Spawning Indices



NOTE: Indices are based on 70 years of hydrologic data. No-Action indices are ranked from lowest value (year1) to highest value (year 70). Indices for the action alternatives correspond with each year plotted for the No-Action Alternative. For example, year 1 is the index calculated for 1977, and year 70 is the index calculated for 1982.

Figure 2
Smallmouth Bass Spawning Indices



Legend

- No Action
- Max Flow
- Flow Study
- Percent Inflow
- State Permit

NOTE: Indices are based on 70 years of hydrologic data. No-Action indices are ranked from lowest value (year1) to highest value (year 70). Indices for the action alternatives correspond with each year plotted for the No-Action Alternative. For example, year 1 is the index calculated for 1977, and year 70 is the index calculated for 1983.

Figure 3
Rearing Indices for both Largemouth Bass and Smallmouth Bass

Maximum Flow Alternative

Trinity Lake

Warmwater Species

Under the Maximum Flow Alternative, Trinity Lake would be drawn down more frequently and to lower levels than under the No-Action Alternative (Table 1). The resulting reservoir fluctuations and reduced surface area would generally result in a decrease in habitat availability for warmwater species.

Conditions for largemouth bass spawning under the Maximum Flow Alternative would decline during May and June and would improve slightly for this life stage during April, July, and August. Smallmouth bass spawning would decline during May and June and improve slightly during April and August. Conditions for rearing for both species would decline from April to June and improve slightly in August.

Compared to the No-Action Alternative, indices for smallmouth bass spawning and rearing for both species would fall below the target range 10% or more of the time than under the No-Action Alternative (Figures 1-3). The change in operations under this alternative would result in a significant adverse impact 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 1). Adverse impacts on coldwater fish would occur from February to December, whereas increased lake levels in January would lead to improved conditions. Although coldwater fish species may be adversely affected, this impact would likely be less than significant because trout populations are currently supported by hatchery production. The stocking frequency and intensity would be determined on the basis of creel census surveys conducted by the California Department of Fish and Game.

Lewiston Lake

Coldwater fish habitat conditions at Lewiston Lake 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.

Flow Study Alternative

Trinity Lake

Warmwater Species

Conditions for largemouth bass spawning under the Flow Study Alternative would improve slightly in May and July compared to the No-Action Alternative. Conditions for smallmouth bass spawning would improve in April and May and be the same as those under the No-Action Alternative for the remainder of the period. Rearing habitat for both species would improve slightly in August and decline in September.

Impacts on largemouth and smallmouth bass are considered less than significant because the spawning indices for largemouth bass and the rearing indices for both species would not fall below the target range 10% or more of the time (Figures 1-3).

Coldwater Species

Under this alternative, Trinity Lake elevations would frequently be higher than those under the No-Action Alternative, increasing the amount of habitat area available for fish year round (Table 1). Coldwater fish are likely to benefit under this alternative.

Lewiston Lake

Coldwater fish habitat conditions at Lewiston Lake under the Flow Study 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 Flow Study Alternative.

Percent Inflow with Channel Restoration Alternative

Trinity Lake

Warmwater Species

Under the Percent Inflow Alternative, conditions for largemouth bass spawning would improve slightly during July compared to the No-Action Alternative. Conditions for smallmouth bass spawning would improve slightly during April and July. Conditions for both largemouth and smallmouth bass rearing would decline a bit during April but improve slightly in August relative to those under the No-Action Alternative. The impacts on largemouth and smallmouth bass are considered less than significant because the indices for each species would not fall below the target level 10% or more of the time compared to the No-Action Alternative (Figures 1-3).

Coldwater Species

Under this alternative, Trinity Lake elevations would frequently be higher than those under the No-Action Alternative, increasing the amount of habitat area available for fish year round (Table 1). Coldwater fish are likely to benefit under this alternative.

Lewiston Lake

Coldwater fish habitat conditions at Lewiston Lake under the Percent Inflow with Channel 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 stocking program is assumed to continue, no impacts on coldwater fisheries are expected under the Percent Inflow with Channel Restoration Alternative.

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 Lake would be the same as under the No-Action Alternative.

Harvest Control Alternative

Reservoir storage and flows under the Harvest Control 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 Lake would be the same as under the No-Action Alternative.

State Water Permit Alternative

Trinity Lake

Warmwater Species

Under this alternative, Trinity Lake would be drawn down less frequently than under the No-Action Alternative. Conditions for largemouth bass spawning would improve between May and July, and conditions for smallmouth bass spawning would improve during May and June. Rearing conditions for both species would improve in August but decline slightly in September and November. However, because the spawning and rearing indices for both species would not be above the target frequency 10% or more of the time compared to the No-Action Alternative, the changes in conditions would not result in a significant beneficial impact on warmwater species (Figures 1-3).

Coldwater Species

Under this alternative, Trinity Lake elevations would frequently be higher than those under the No-Action Alternative, increasing the amount of habitat area available for fish year round (Table 1). Coldwater fish are likely to benefit under this alternative.

Lewiston Lake

Coldwater fish habitat conditions at Lewiston Lake under the State Water Permit 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 State Water Permits Alternative.

Impact Evaluation of the Preferred Alternative Compared to Existing Conditions

The following discussion provides results of the evaluation of effects on warmwater and coldwater fish species for the Trinity River Mainstem Fishery Restoration Project for the Preferred Alternative compared to existing conditions.

Existing Conditions

Trinity Lake

Warmwater Species

Under existing conditions, warmwater fish can use only about half of the potential spawning and rearing habitat in Trinity Lake. The average annual spawning indices for largemouth and smallmouth bass under existing conditions are 0.41 and 0.55, respectively. The average annual rearing index for both species together is 0.55.

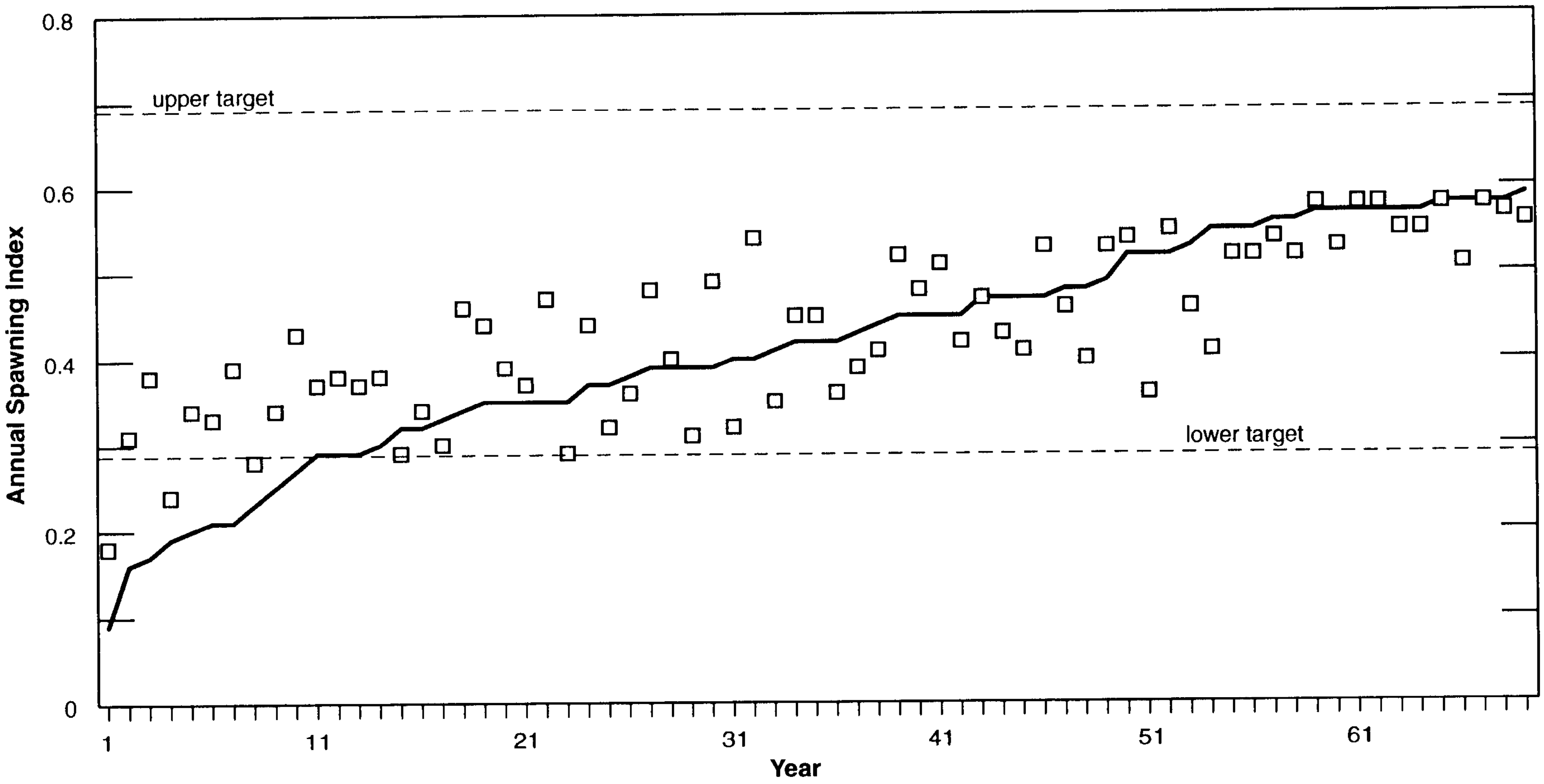
Coldwater Species

Coldwater fish species rear in Trinity Lake and are affected by changes in reservoir elevation. Under existing conditions, the surface area and amount of rearing habitat available are smaller than they could be under reservoir operations that maximize fish habitat. The average monthly lake-level elevation over the 70-year hydrologic period for Trinity Lake under existing conditions is shown in Table 1.

Lewiston Lake

Fish habitat conditions under existing conditions are the same as described above for the No-Action Alternative. Lewiston Reservoir is operated as a re-regulating reservoir, receiving cold water from low-level releases from Trinity Lake. Coldwater fish species are stocked in Lewiston Lake.

Go To TOC



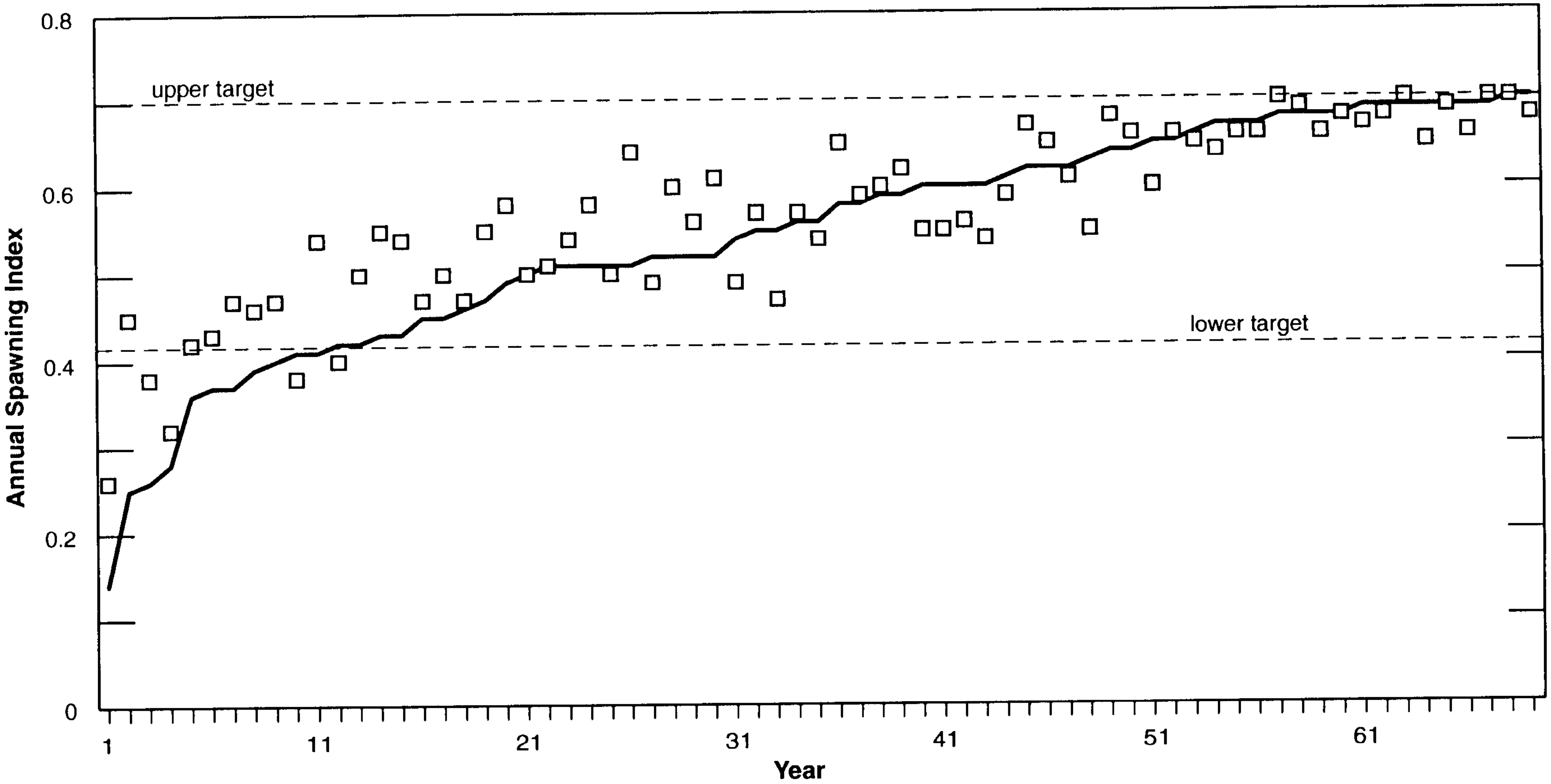
Legend

— Existing Conditions

□ Preferred Alternative

NOTE: Indices are based on 70 years of hydrologic data. Existing Conditions indices are ranked from lowest value (year1) to highest value (year 70). Indices for the action alternatives correspond with each year plotted for the Existing Conditions Alternative. For example, year 1 is the index calculated for 1977, and year 70 is the index calculated for 1983.

Figure 4
Largemouth Bass Spawning Indices



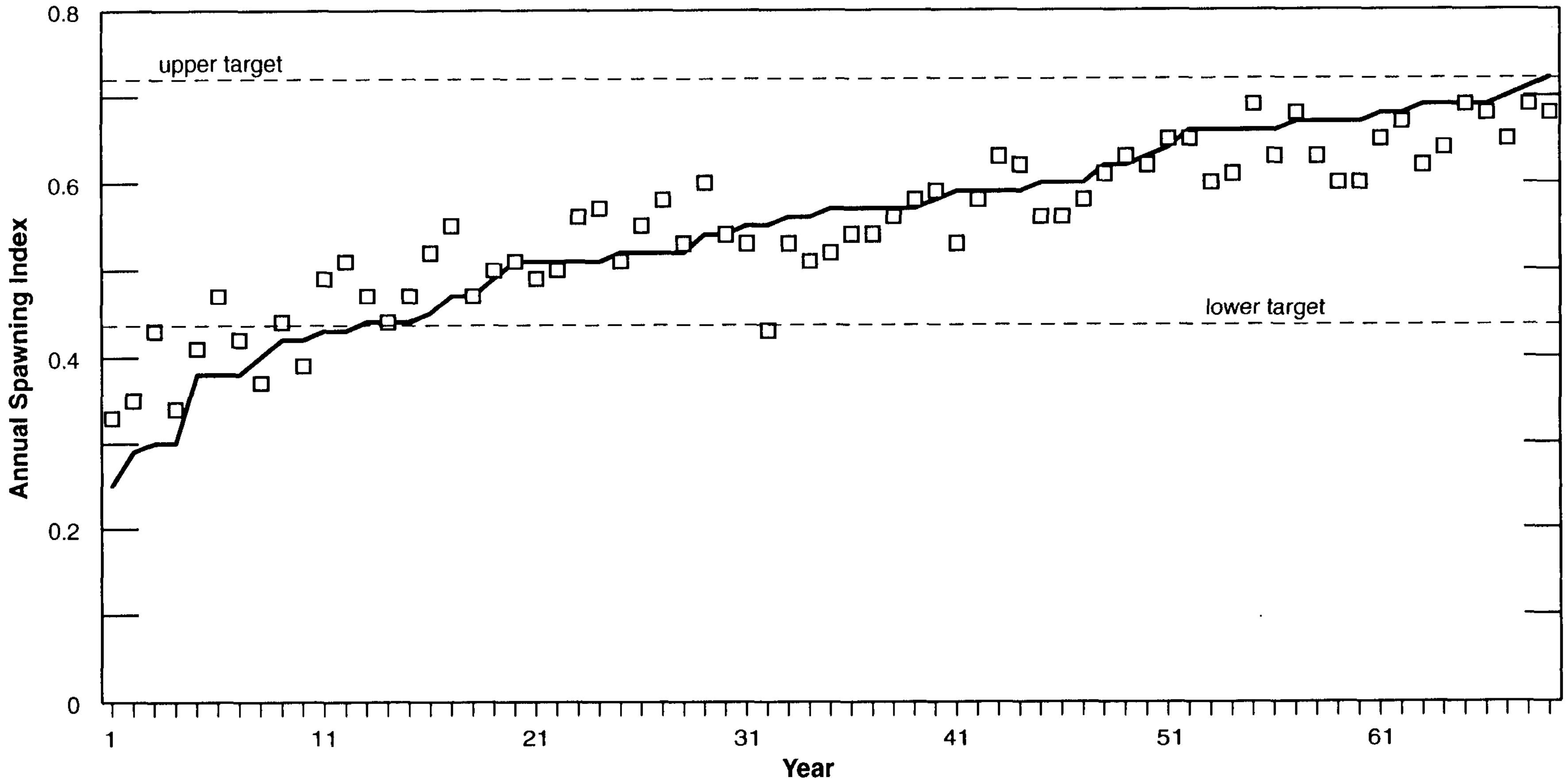
Legend

— Existing Conditions

□ Preferred Alternative

NOTE: Indices are based on 70 years of hydrologic data. Existing Conditions indices are ranked from lowest value (year1) to highest value (year 70). Indices for the action alternatives correspond with each year plotted for the Existing Conditions Alternative. For example, year 1 is the index calculated for 1977, and year 70 is the index calculated for 1983.

Figure 5
Smallmouth Bass Spawning Indices



Legend

— Existing Conditions

□ Preferred Alternative

NOTE: Indices are based on 70 years of hydrologic data. Existing Conditions indices are ranked from lowest value (year1) to highest value (year 70). Indices for the action alternatives correspond with each year plotted for the Existing Conditions Alternative. For example, year 1 is the index calculated for 1977, and year 70 is the index calculated for 1983.

Figure 6
Rearing Indices

Table 2. Average Monthly Elevations for Trinity Lake under Existing Conditions and the Preferred Alternative

Month	Existing Conditions	Preferred Alternative
October	2,282	2,282
November	2,283	2,284
December	2,287	2,289
January	2,293	2,295
February	2,302	2,304
March	2,312	2,314
April	2,323	2,325
May	2,325	2,323
June	2,319	2,319
July	2,306	2,307
August	2,293	2,295
September	2,287	2,284

Note: Averages are based on the 70-year hydrologic period (1922-1991).

Go To TOC

Preferred Alternative

Trinity Lake

Warmwater Species

Trinity Lake would rarely be lower under the Preferred Alternative than under existing conditions. Conditions for largemouth bass spawning would improve slightly during May and July relative to existing conditions. Smallmouth bass spawning would decrease slightly from February through April and also in August, but would increase from May through July compared to existing conditions. Rearing conditions for both species would not differ between the two alternatives.

Impacts on largemouth and smallmouth bass are considered less than significant because the spawning and rearing indices for both species would not fall below the target range 10% or more of the time (Figures 4-6).

Coldwater Species

Under the Preferred Alternative, Trinity Lake elevations would typically be higher than those under existing conditions, increasing the amount of habitat area available for fish year round (Table 2). Coldwater fish are likely to benefit under this alternative.

Lewiston Lake

Coldwater fish habitat conditions in Lewiston Lake under the Preferred Alternative are expected to be the same as those under existing conditions. Because Lewiston Lake 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.

Literature Cited

Printed References

Coleman, M. E. 1978. Composition and horizontal distribution of net zooplankton and their association with environmental variables in Clair Engle Reservoir, California. Master's thesis. Humboldt State University. Arcata, CA.

Edwards, E. A., G. Gebhart, and O. E. Maughan. 1983. Habitat suitability information: smallmouth bass. (FWS/OBS-82/10.36.) U.S. Fish and Wildlife Service. Fort Collins, CO.

Frederiksen, Kamine and Associates. 1980. Proposed Trinity River basin fish and wildlife management program. Prepared for Water and Power Resources Services, Sacramento, CA.

Kohler, C. C., R. J. Sheehan, and J. J. Sweatman. Largemouth bass hatching success and first-winter survival in two Illinois reservoirs. North American Journal of Fisheries Management 13:125-133.

Moyle, P. B. 1976. Inland fishes of California. University of California Press. Berkeley, CA.

Oscar Larson & Associates. n.d. Trinity Lake hydroelectric projects cumulative environmental impact report. Eureka, CA. Prepared for Trinity County Planning Department, Weaverville, CA.

Stuber, R. J., G. Gebhart, and O. E. Maughan. 1982. Habitat suitability index models: largemouth bass. (FWS/OBS-82/10.16.) U.S. Fish and Wildlife Service. Fort Collins, CO.

Trinity, County of. Department of Transportation and Planning. 1992. Temperature modeling of Lewiston Lake with the BETTER two-dimensional reservoir flow mixing and heat exchange model. June 16, 1992. Weaverville, CA. Prepared by Jones & Stokes Associates, Inc. (JSA 88-136), Sacramento, CA.

Personal Communications

Aguilar, Bernard. Associate fisheries biologist. California Department of Fish and Game, Trinity Fisheries Unit, Region 1, Lewiston, CA. December 27, 1996 - telephone conversation; January 22, 1997 - memorandum.

Calkins, Russ. Fish hatchery manager. Crystal Lake Hatchery, Castle, CA. March 24, 1998 - telephone conversation.

Go To TOC

List of Tables

List of Figures

List of Miscellaneous Stuff