SACRAMENTO BASIN FISH HABITAT IMPROVEMENT STUDY

DRAFT ENVIRONMENTAL ASSESSMENT

United States Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
March 1994

GL

United States Department of the Interior

TAKE PRIDE IN AMERICA

BUREAU OF RECLAMATION
Mid-Pacific Regional Office
2800 Cottage Way
Sacramento, California 95825-1898

IN REPLY
REFER TO:

MP-720
PRJ-3.00

SEP 13 1994

Ms. Gale Linck
State Water Resources Control Board
Division of Water Rights
901 P Street
Sacramento CA 95810

Subject: Your September 13, 1994, Request for the Draft Environmental Assessment for the Sacramento Basin Fish Habitat Improvement Study.

Dear Ms. Linck:

As per your request the Draft Environmental Assessment (EA) for the Sacramento Basin Fish Habitat Improvement Study is enclosed.

The Report has received intensive scrutiny through a series of briefings, as well as both internal and interagency team reviews. Appropriate revisions are being made to the Report in response to comments and suggestions received before the execution of a Final Draft.

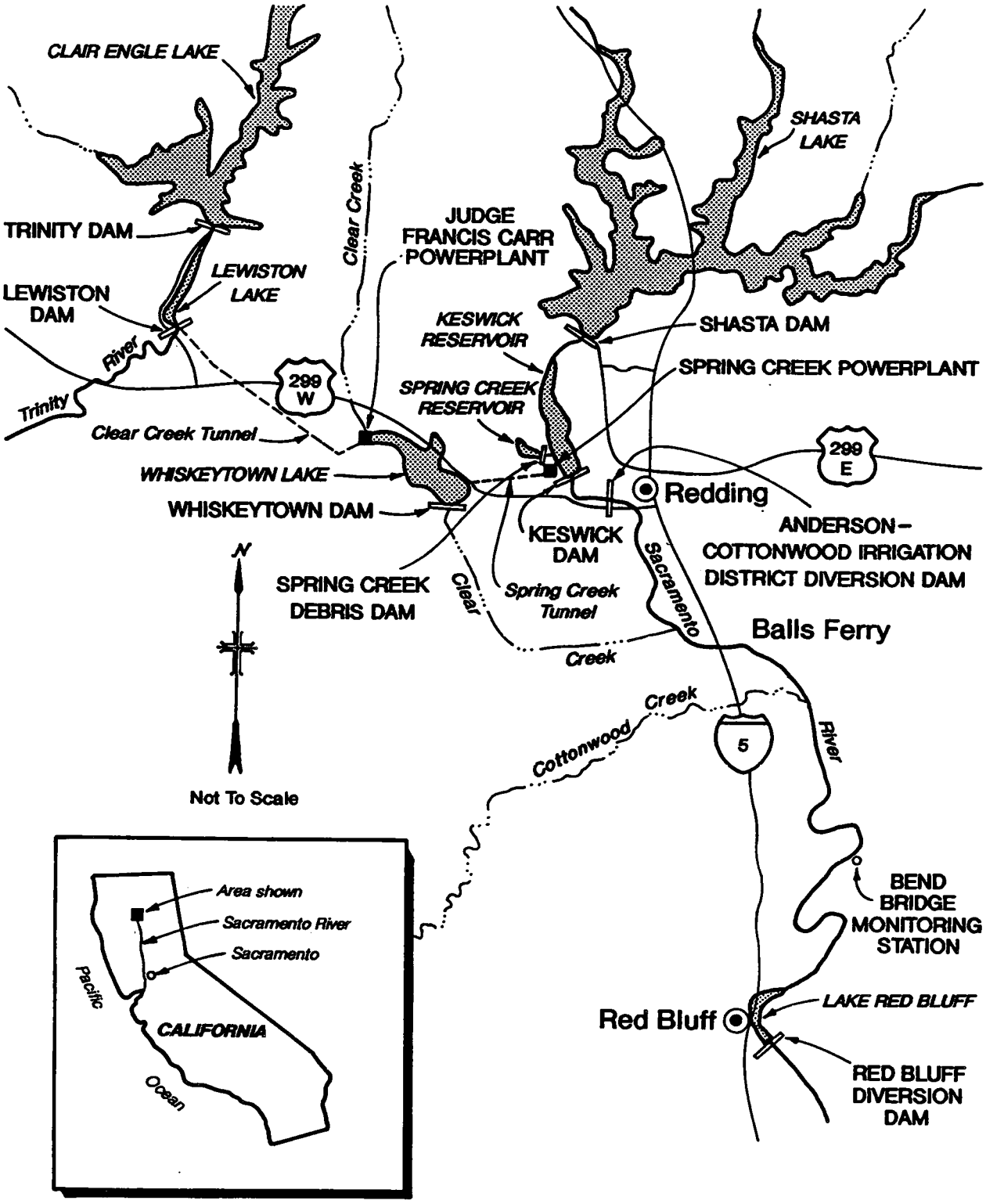
If you have any questions or need additional assistance, please feel free to contact me at (916) 978-5488.

Sincerely,

Federico Barajas

Federico Barajas
Project Manager, SBFHIS

Enclosure



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Chapter I

PURPOSE AND NEED FOR ACTION

The purpose of the Proposed Action is to lower water temperatures in the Sacramento River below 56 degrees Fahrenheit (°F) between Shasta Dam and Red Bluff Diversion Dam (RBDD) from June through October. Under the Proposed Action, the two temporary curtains would be made permanent.

Fish habitat in the Sacramento River has been declining since the high-water years of the mid-1950's. In recent years, the number of winter-run chinook salmon has fallen to the point that the species has been listed as threatened with extinction under the Federal Endangered Species Act and as an endangered species by the State of California. Winter-run chinook salmon numbers have declined by more than 97 percent over a period of less than two decades. From a high of 117,808 winter-run spawners in 1969, the population declined to 1,180 in 1992. Other salmon runs in the Sacramento River have also exhibited significant decline. Spring-run chinook salmon run sizes have averaged around 13,000 annually since 1981 but dropped to 431 in 1992. The fall run is the largest run of chinook salmon in the Sacramento River, with an average spawning population of 108,000 fish since 1980. However, the population decreased to 41,376 in 1992. The late-fall run has averaged 11,000 fish annually since 1981 but decreased to 7,089 in 1991.

Water temperatures above 56 °F are detrimental to chinook salmon spawning and egg incubation. Federal and State fisheries experts believe elevated water temperature and its associated impact on spawning success are a major cause of the declining numbers of salmon in the Sacramento River. River temperature between Keswick Dam and RBDD, the principal spawning area of chinook salmon, is often above 56 °F during the critical months of June through October. The water temperature needs to be lowered to protect the chinook salmon during spawning and egg incubation life stages.

BACKGROUND

On May 2, 1990, the California State Water Resources Control Board (SWRCB) amended the water right permits and licenses held by the U.S. Bureau of Reclamation (Reclamation) for Shasta Dam, Keswick Dam, and Spring Creek Powerplant and established water quality objectives by adopting SWRCB Order WR 90-5. This order sets terms and conditions for temperature control and protection of the Sacramento River fishery. It requires installation of a temperature control device at Shasta Dam, development of alternatives to minimize the warming of water discharged through the Spring Creek Powerplant, and imposes a schedule for preparing environmental documentation, monitoring, and reporting.

On January 10, 1991, SWRCB Order WR 91-1 amended Order WR 90-5. The pertinent requirements of SWRCB Order WR 90-5, as amended by Order WR 91-1, were to:

(1) Submit a plan of study for minimizing the warming of water to be discharged through the Spring Creek Powerplant by March 31, 1992.

(2) Submit designs and a construction schedule for facilities or identify alternatives to minimize the warming of water to be discharged through Spring Creek Powerplant, together with a schedule for National Environmental Policy Act (NEPA) documentation, if required, by September 30, 1993.

(3) Submit a complete final planning report and any required NEPA documentation for facilities or alternatives which will control temperatures in the upper Sacramento River by September 30, 1995.

The geographic area of focus is the Sacramento River from below Shasta Dam to RBDD, the Trinity River from Clair Engle Lake to Lewiston Dam, the Trinity River Diversion from Lewiston Lake to Keswick Reservoir, and tributaries to the Sacramento River between Shasta Dam and RBDD. (See frontispiece map.) Reclamation operates several major hydropower, storage, and diversion facilities within the area.

RELATED STUDIES AND ACTIVITIES

Once each year since 1987, Reclamation, the California Department of Fish and Game (CDFG), the California Department of Water Resources, the U.S. Fish and Wildlife Service (FWS), the U.S. Army Corps of Engineers, the National Marine Fisheries Service (NMFS), and other agencies have met, in accordance with the Sacramento River Temperature Operation Plan of 1987, to establish a temperature reduction plan for selected locations on the Sacramento River downstream from Shasta Dam.

On May 20, 1988, the Winter-Run Chinook Cooperative Agreement was executed by NMFS, CDFG, Reclamation, and FWS to improve the habitat and stabilize winter-run chinook salmon populations in the Sacramento River basin. The agreement was in effect until May 20, 1992.

In January 1989, an advisory council of designated members prepared the Upper Sacramento River Fisheries and Riparian Habitat Management Plan for the Resources Agency of California. The plan identifies a number of specific measures for restoring riparian habitat and fisheries in the upper Sacramento River. Many of these measures were previously identified in the Winter-Run Chinook Salmon Agreement. Legislation and cooperative agreements among various Federal and State agencies would be required before the other measures could be implemented.

The Operations Criteria and Plan, which covers long-term Central Valley Project (CVP) operation under a range of hydrologic and storage conditions, was finalized in October 1992 as part of formal section 7 consultation procedures between Reclamation and NMFS concerning winter-run chinook salmon in the Sacramento River. On February 12, 1993, NMFS released the biological opinion stating that proposed operation of the two projects could jeopardize the existence of the winter-run chinook. However, operating the projects in accordance with the reasonable and prudent alternatives contained in the opinion would allow continued operation which is not likely to jeopardize this listed race of chinook salmon.

Trinity River Basin Fish and Wildlife Restoration Program and Trinity River Flow Evaluation Study

The FWS is conducting two programs that are related to this Proposed Action: the Trinity River Basin Fish and Wildlife Restoration Program and the Trinity River Flow Evaluation Study.

The objectives of the Trinity River Basin Fish and Wildlife Restoration Program are to restore, through habitat restoration, Trinity River basin anadromous fish stocks to pre-Trinity River Division levels (pre-1960 levels) and, through habitat maintenance, to maintain stocks at those levels.

The goal of the Trinity River Flow Evaluation Study is to monitor the fishery habitat rehabilitation in the Trinity River below Lewiston Dam. There is a 12-year study that began in 1985. It will end with recommendations to the Secretary of the Interior concerning future management options and needs.

Chapter II

THE PROPOSED ACTION AND ALTERNATIVES

Initially, 12 alternatives were identified, and four reasonable alternatives were selected from those 12 for detailed analysis. Important variations in the method of construction were possible with two of the remaining alternatives, and each of these variations was analyzed as an option of the basic alternative. However, it was determined that each of these alternatives with either of two construction options would produce such negative impacts that they were dropped from further consideration, leaving only the No Action Alternative and Proposed Action Alternative as viable. The remaining viable alternative is the underwater temperature control curtains and is hereafter referred to as the Proposed Action.

The Proposed Action was analyzed for its impact on water quality in the Sacramento River, Whiskeytown Lake, and Clear Creek, and its impact on chinook salmon, other anadromous fish, threatened and endangered species, other fish and wildlife, recreation and tourism, and social and economic factors. Details of this analysis can be found in chapter IV of the *Sacramento Basin Fish Habitat Improvement Study Special Report.*

NO ACTION ALTERNATIVE

The No Action Alternative forms the basis of comparison for the Proposed Action. It was assumed that salmon populations under the No Action Alternative would stabilize at current levels and not change appreciably through the 100-year life of this project. Realistically, given the continuation of existing conditions, populations of specific runs would probably decrease over time without improvement in habitat quality. However, there were not sufficient data to develop a reliable estimate of changes in salmon populations with the persistence of existing temperature and other habitat-related problems. Therefore, a stable population was deemed suitable for this effort since the evaluation of alternatives focuses on their relative effectiveness in providing cooler water to the Sacramento River during critical life stages of four races of chinook salmon.

The baseline reflects the influence of the temperature control curtains that have been installed in Lewiston Reservoir. The Lewiston curtains will reduce the temperature of the inflow to Whiskeytown Lake by as much as 2 °F during June, July, and August.

The baseline conditions used in this study were based on PROSIM operations model output, which simulated CVP operations for a 69-year hydrologic period (1922-90). The operations model output was used as input to the temperature model. The effects that the No Action Alternative and the action alternatives would have on Sacramento River temperatures and salmon survival were evaluated using the temperature and salmon mortality models.

PROSIM is a monthly computer simulation of the CVP operations. The PROSIM model simulates the majority of the CVP service area (excluding some portions of the San Joaquin basin) with a network of 55 key locations within the system. The model output of baseline conditions was used as the basis for evaluating the effectiveness of the alternatives in meeting the temperature goals on the Sacramento River. PROSIM provides detailed coverage of the Sacramento River basin, and the effects of operational changes in Shasta, Clair Engle, and Whiskeytown Lakes can be monitored all the way to the Sacramento-San Joaquin Delta. The PROSIM model has been documented in a draft report by Derek Hilts: PROSIM 5.00, Bureau of Reclamation, Sacramento, California, December 25, 1993.

Throughout the discussion, reference is made to representative water years taken from the 69-year period of record (1922-90). This period of record describes monthly hydrologic patterns for each water year. Present conditions, based on a 1995 level of development in the Sacramento River, were superimposed on the period of record to provide an understanding of how effective each proposed alternative would be under similar hydrologic conditions. The representative water years of greatest interest are those from drought periods 1928 to 1937, 1976 and 1977, and 1987 through 1991, due to their applicability to the most recent drought.

PROPOSED ACTION—UNDERWATER TEMPERATURE CONTROL CURTAINS

In an attempt to obtain greater operational flexibility and options to meet temperature requirements on the Sacramento River during periods critical for successful salmon reproduction, Reclamation designed and installed two temporary temperature curtains in Whiskeytown Lake during the spring and summer of 1993. This action was taken as an emergency measure in response to the decline in chinook salmon populations which were aggravated by the prolonged drought. One curtain was placed at the upper end of the lake near Oak Bottom Marina, while the other was located near the Spring Creek Tunnel inlet. The temperature curtains will be fully deployed and operational each year from April through the end of October. During the cool season months of November through March, the curtains could be opened and would not be functioning.

The primary purpose of installing temperature curtains in Whiskeytown Reservoir is to maximize the amount of cold water available for release to the Sacramento River through Spring Creek Tunnel to benefit winter-run chinook salmon. Such cold water would cool the Sacramento River during the late spring, summer, and fall to levels more suitable for winter-run chinook salmon egg and fry life stages.

Under the Proposed Action, the two temporary curtains would be made permanent. Their location would be the same as the temporary curtains if monitoring indicates these are the ideal locations. The proposed locations of the permanent curtains are shown in figure II-1.

Results of the physical temperature modeling in Reclamation's engineering laboratory indicate that the curtain in the area of the Oak Bottom Marina would immediately force the cold Trinity River water from Judge Francis Carr Powerplant (Carr Powerplant) into the coldest, deepest layers of the lake (hypolimnion) and reduce the amount of mixing between the cold inflow and the warm surface layers. This would result in colder water at the bottom of the lake. The curtain near the Spring Creek Tunnel inlet would also reduce the amount of mixing with warm surface layers, resulting in the coldest water possible passing into the tunnel.

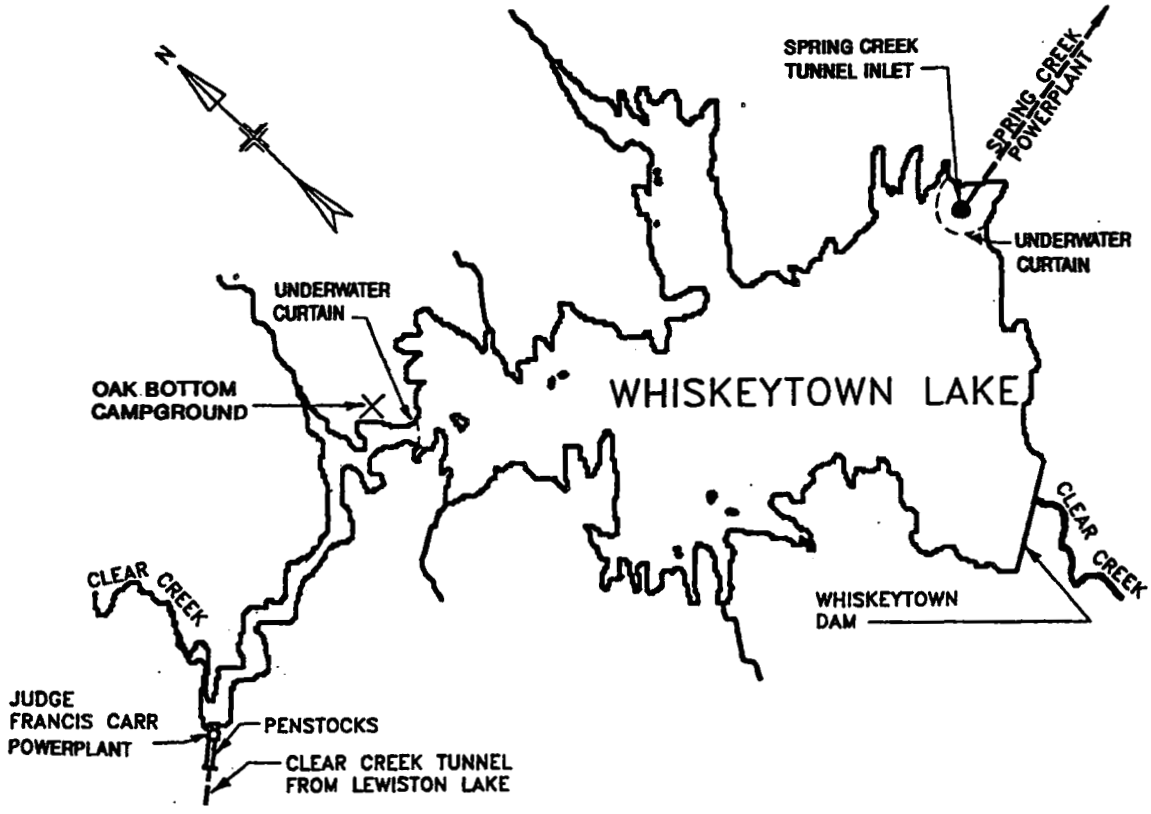

Figure II-1.—Whiskeytown Lake underwater curtains, Proposed Action.

The curtain material would be hypalon rubber, about 1/16 inch (60 mil) thick, 600 feet long by 40 feet deep, and would be positioned vertically. The curtain supports, or booms, would float on the surface, and the curtain would hang beneath. The lake is about 60 feet deep in this area. Anchors on the bank and on the channel bottom would hold the curtain in place. There would be a slot 16 feet wide and 6 feet deep providing boat passage through the curtain. A schematic of the Oak Bottom curtain is shown in figure II-2.

The second curtain would be placed so as to prevent warm surface water from flowing to the area of the Spring Creek Tunnel inlet structure and entering the inlet. The material for this curtain would be the same as for the Oak Bottom curtain. The curtain would be 2,400 feet long by 100 feet deep. The lake is about 150 feet deep in this area. The curtain would be suspended on floating booms and anchored to the shore and the lake bottom. Unlike the curtain arrangement at Oak Bottom Campground, public boat passage through the curtain would not be provided.

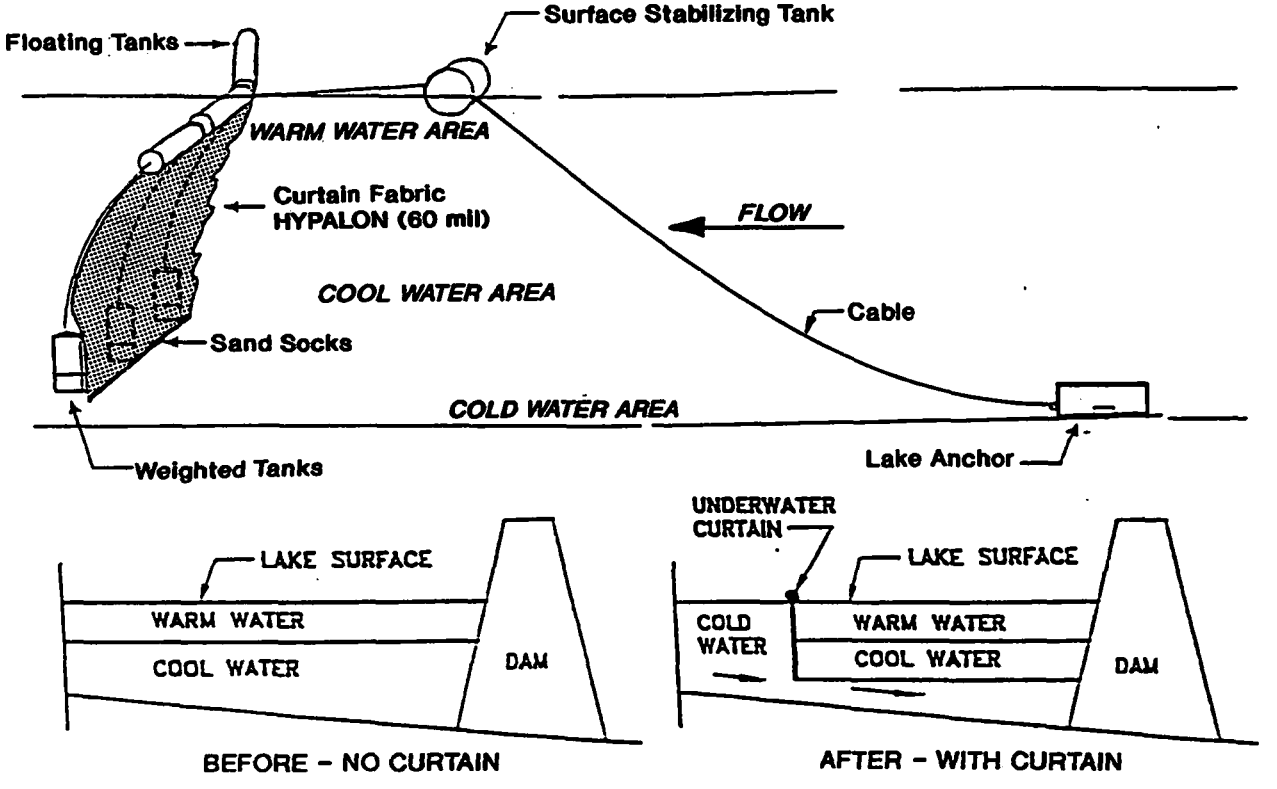

Figure II-2.—Oak Bottom temperature control curtain schematic.

The operation, maintenance, and replacement (OM&R) costs of the two curtains are estimated at $240,000 per year. As curtain material or other components wear out, they would be replaced. Curtains are expected to need replacement after 10 years. The initial cost to construct the two curtains was approximately $2.2 million, but there would be no cost to convert the temporary curtains to permanent status.

Comparison of Proposed Action and No Action Alternative

Table II-1 compares the environmental impacts of the Proposed Action and the No Action Alternative.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER STUDY

The following is a brief description of the alternatives that were considered but eliminated from further study.

UNDERWATER CONDUIT

A small, low diversion dam with a gated sluiceway would be constructed across the channel at the upper end of the lake, downstream from Carr Powerplant. A pumping plant with a gated inlet would be constructed to pump cold water from the diversion dam through a 36,000-foot-long, 21-foot-diameter underwater pipeline to Spring Creek Tunnel inlet. The Spring Creek Tunnel inlet structure would be modified to connect to the new pipeline. (See figure II-3.)

With the sluiceway gate closed, the diversion structure would become a barrier across the channel, forming a forebay for the pumping plant. With the sluiceway gate open, the diversion structure would allow water into Whiskeytown Lake.

Annual OM&R costs for this alternative were estimated at $127,000, and the annual power cost to operate the pump was estimated at $7 million.

Construction Option 1

The lake would not be lowered. All facilities would be constructed and placed underwater. Construction would cost approximately $990 million and would take approximately 3 years to complete.

Table II-1.—Comparison of alternatives

Item	Proposed Action	No Action
Description	Whiskeytown Lake curtains	Baseline
Construction cost	$2.2 million	NA
Annual operation and maintenance cost	$240,000	NA
Temperature—Average decrease from baseline at Keswick in August	0.9 °F	0
Whiskeytown Lake water quality	+1	0
Annual average percent saved of winter-run chinook	1.10	0
Annual average percent saved of all chinook runs	0.763	0
Other anadromous fish	0	0
Threatened and endangered species		
Winter-run chinook	+2	0
Eagles	0	0
Other fish and wildlife	0	0
Power generation	+1	0
Resident fish		
Whiskeytown Reservoir	+1	0
Sacramento River	+1	0
Recreation and tourism		
Blocks boat access	yes	no
Increases potential recreation-related accidents	yes	no

Note: 0 = no impact, +1 = slight positive impact, +2 = moderate positive impact, NA = not applicable.

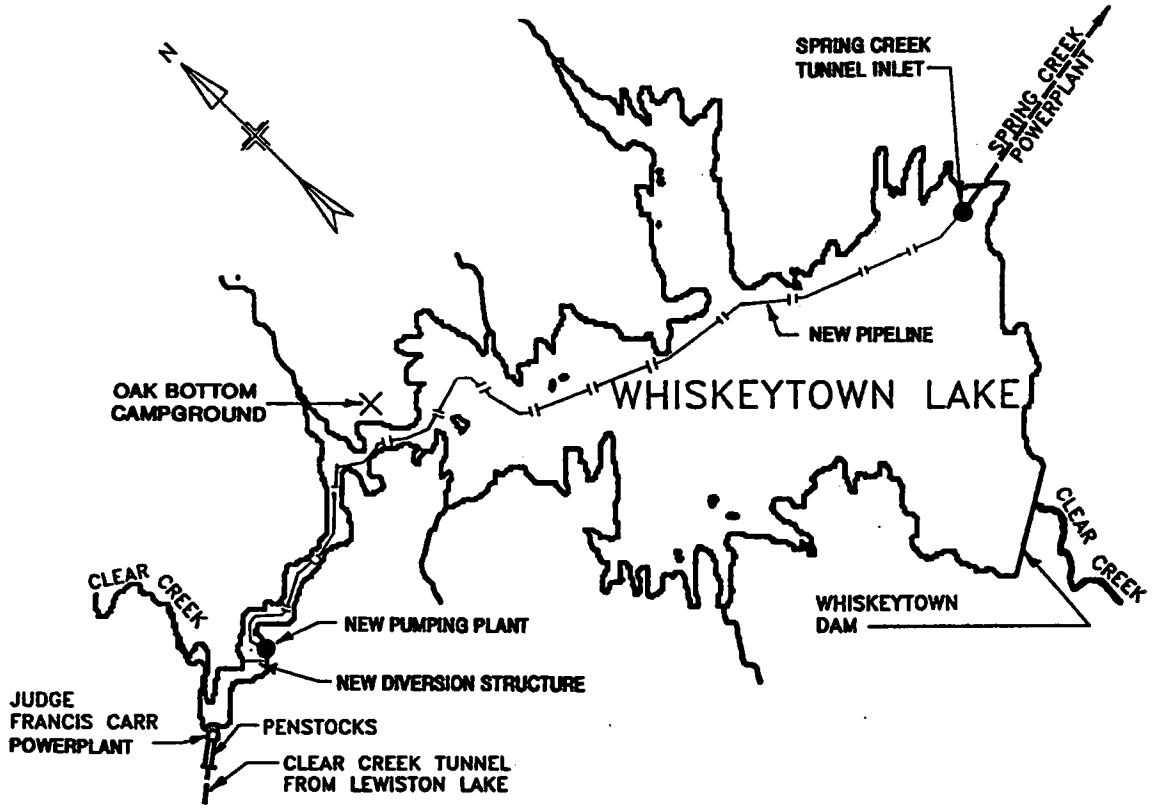

Figure II-3.—Whiskeytown Lake underwater conduit.

Construction Option 2

The lake would be lowered about 140 feet for approximately 1 year, and facilities would be constructed on the dry lakebed. Construction would cost $398 million and take approximately 2 years to complete. An additional $4 million would be required for furnishing water to the nearby communities, making the total cost $402 million.

This alternative was eliminated from further consideration for the following reasons:

(1) Because of the required 3-year construction time of option 1, there would be a potential during years with below normal precipitation for significant mortality of chinook eggs and sac-fry present in the Sacramento River. In addition, it may be impossible to meet the 3,250-cubic-foot-per-second (cfs) minimum flow requirement below Shasta Dam, resulting in dewatering of redds and subsequent egg and sac-fry losses.

(2) Wildlife around Whiskeytown Lake, such as bald eagles, would likely be disturbed during construction to the point that nesting areas, depending on proximity to construction areas, could be abandoned. Bald eagles and other

wildlife species would also likely be significantly disturbed by the drawdown of the reservoir. The initial drawdown would concentrate fish and probably increase their availability to eagles and other fish predators for a short period of time.

(3) Under construction option 2, the significant drawdown of Whiskeytown Lake would result in extreme warming of the lake, which could reach lethal temperatures for coldwater species such as trout and kokanee. Warm water temperatures may also increase the outbreak of fish diseases. Surface area for food production for fish would be greatly reduced. Reduced food supplies and crowding in the remaining pool may increase competition and predation, leading to increased fish mortality.

(4) Water released to Clear Creek during construction is expected to be significantly warmer. Such warm temperatures may lead to mortality of trout and salmon eggs and sac-fry, and if warm enough, adult mortality.

(5) Under construction option 2 (Whiskeytown Lake lowered), water would not be imported from the Trinity River at any time during the 2-year construction period. Power generation at Carr and Spring Creek Powerplants would be eliminated during this period.

(6) All water-based recreation at the lake would be eliminated during the 2-year construction period of option 2, and land-based recreation associated with the lake, such as picnicking, camping, or hiking lake-view trails, would be negatively impacted.

(7) All recreational users of the lake would have an extremely negative reaction to losing the use of the lake during construction of option 2. Political pressure to keep the lake from being lowered would be extreme.

(8) Area businesses, including the Whiskeytown concessionaire and store, as well as some in Redding, would suffer a decrease in business activity which could result in the closing of some businesses.

(9) The annual sailing regatta would not be held for the 2 years of option 2, and this would result in the loss of considerable revenue to the area. The sailing regatta is one of the biggest in the Nation.

SIPHON

This alternative would require construction of a new inlet structure and two pipelines on the bed of Whiskeytown Lake to deliver cold water from the deeper portions of the lake to the existing Spring Creek Tunnel inlet structure. (See figure II-4.)

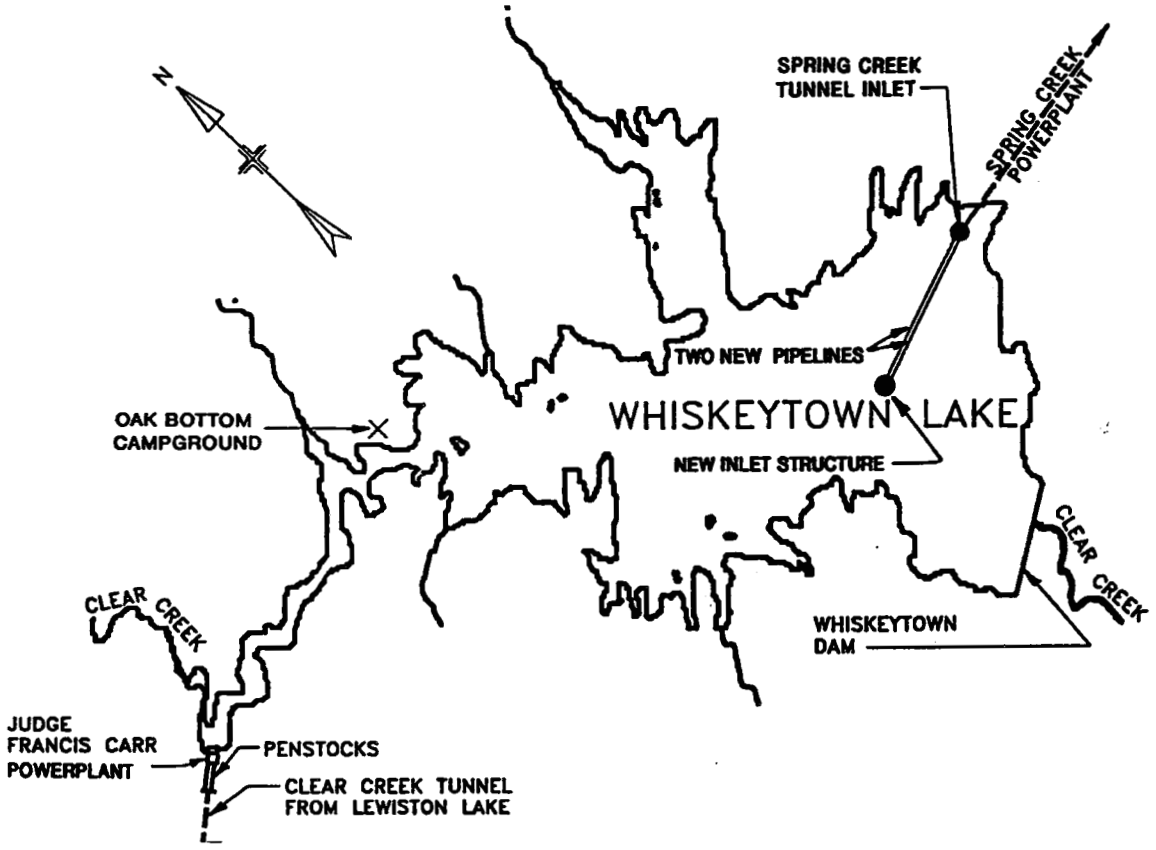

Figure II-4.—Whiskeytown Lake underwater siphon.

The new inlet structure would move the colder water from the lake bottom through two 21-foot-diameter pipelines, each 3,800 feet long, to the existing inlet.

The existing inlet structure would be modified so that the two new pipelines would create a siphon effect when joined to the tunnel. Installation of the new pipelines would have little effect on turbine operation at the Spring Creek Powerplant and no effect at Carr Powerplant. Laboratory physical modeling would probably be necessary to determine the most efficient location and method of operation.

Annual OM&R costs were estimated at $10,000. Construction costs depend on the method of construction. There are two construction scenarios.

Construction Option 1

The lake would not be lowered. All facilities would be constructed and then placed underwater. Construction would cost approximately $150 million and would take approximately 2 years to complete.

Construction Option 2

The lake would be lowered about 200 feet for approximately 1 year, and facilities would be constructed on the dry lakebed. Construction would cost $60 million and take approximately 1 year to complete. An additional $4 million would be required for furnishing water to the nearby communities, making the total cost $64 million.

This alternative was eliminated from further consideration for the following reasons:

(1) Because of the required 2-year construction time of option 2, there would be a potential during years with below normal precipitation for significant mortality of chinook eggs and sac-fry present in the Sacramento River. In addition, with a lack of precipitation, it may be impossible to meet the 3,250-cfs minimum flow requirement below Shasta Dam, resulting in dewatering of redds and subsequent egg and sac-fry losses.

(2) Construction impacts to bald eagles and other wildlife around Whiskeytown Lake, as well as impacts to the lake fishery and to Clear Creek, would be similarly severe as those described under items 2, 3, and 4, "Underwater Conduit."

(3) All power generation would be lost at Carr and Spring Creek Powerplants for 1 year under either construction option.

(4) All water-based recreation at Whiskeytown Lake would be eliminated during the 1-year construction period of option 2, and land-based recreation associated with the lake, such as picnicking, camping, and hiking lake-view trails, would be negatively impacted.

(5) Impacts to area businesses and the local economy would be similar to those described in items 7, 8, and 9, "Underwater Conduit," except that the duration of impact would be for 1 year instead of 2 years.

INSULATE PENSTOCKS

This alternative would minimize the heating of water being transported through the existing penstocks by covering the penstocks or coating the exposed portions with insulation.

This approach would reduce heating of water traveling through the penstocks by only 0.1 to 0.2 °F. The cost of insulating the pipes would be excessive for the slight savings in heat gain because it would be necessary to periodically strip the insulation to apply corrosion-resistant paint to the pipes. Maintenance of covered penstocks would present safety problems. Therefore, this alternative was dropped from further consideration.

ADDITIONAL ALTERNATIVES CONSIDERED

Four additional alternatives that were determined to be long term regarding development and implementation were considered but were well outside the scope of this study. These alternatives are: (1) constructing offstream storage, (2) constructing a shuttered temperature control device at Trinity Dam, (3) reopening historic salmon spawning habitat in Sacramento River tributaries, and (4) developing minimum carryover storage for Clair Engle Lake.

They did not receive detailed analysis because they were beyond the scope of the present study. In addition, detailed consideration and development of all four alternatives for their potential fishery resource value are specifically required under Title 34 of Public Law 102-575 and will be addressed as part of that requirement.

Chapter III

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

WATER QUALITY

Affected Environment

Temperature

Water temperature in the upper Sacramento River varies with location and distance downstream of Keswick Dam depending upon annual hydrologic conditions and operation of the Shasta and Trinity Divisions (which include Whiskeytown Dam) of the CVP. Water released from Keswick Dam generally warms as it travels downstream during the summer and early fall months. Water temperatures between Keswick Dam and RBDD are primarily influenced by ambient air temperature, tributary inflows, volume of water released from Keswick Dam, total reservoir storage, the location of the reservoir thermocline, the ratio of Spring Creek Powerplant release to Shasta Dam release, and depth of release from both Shasta and Trinity Dam.

Figure III-1 summarizes the water temperature record from July 1991 through September 1992 at Keswick Dam, Balls Ferry, Bend Bridge, and Red Bluff. These sites are on the reach of the Sacramento River where salmon spawning success needs to be improved. The data show that there is considerable variation in temperature in terms of both season of the year and distance from Keswick Dam. But even at Keswick Dam, the temperature exceeded the goal of 56 °F during September, October, and November 1991 and had climbed to just above 56 °F again in September 1992.

Temperatures downstream from the Keswick station peaked during September 1991 and October 1992. The temperature peaked at Keswick during November 1991 and October 1992. At Bend Bridge and RBDD, the temperature dropped below 56 °F during only December, January, February, and March. During the critical month of September, the temperature at RBDD reached 63 °F in 1991. In 1992, the high temperature was 62 °F at Bend Bridge.

During the 2 years for which autumn data are available, the average temperature at the four stations did not go below the goal of 56 °F. However, all stations except Keswick showed temperatures greater than the goal during April, and most remained that way until the end of the monitoring record in September. The data indicate that Keswick can maintain a release temperature of 56 °F or less during most of the year. Releases of water at temperatures greater than 56 °F began during September of both 1991 and 1992.

Figure III-2 shows the difference in temperature between stations on the Sacramento River mainstem between Keswick Dam and RBDD. A value above zero indicates that

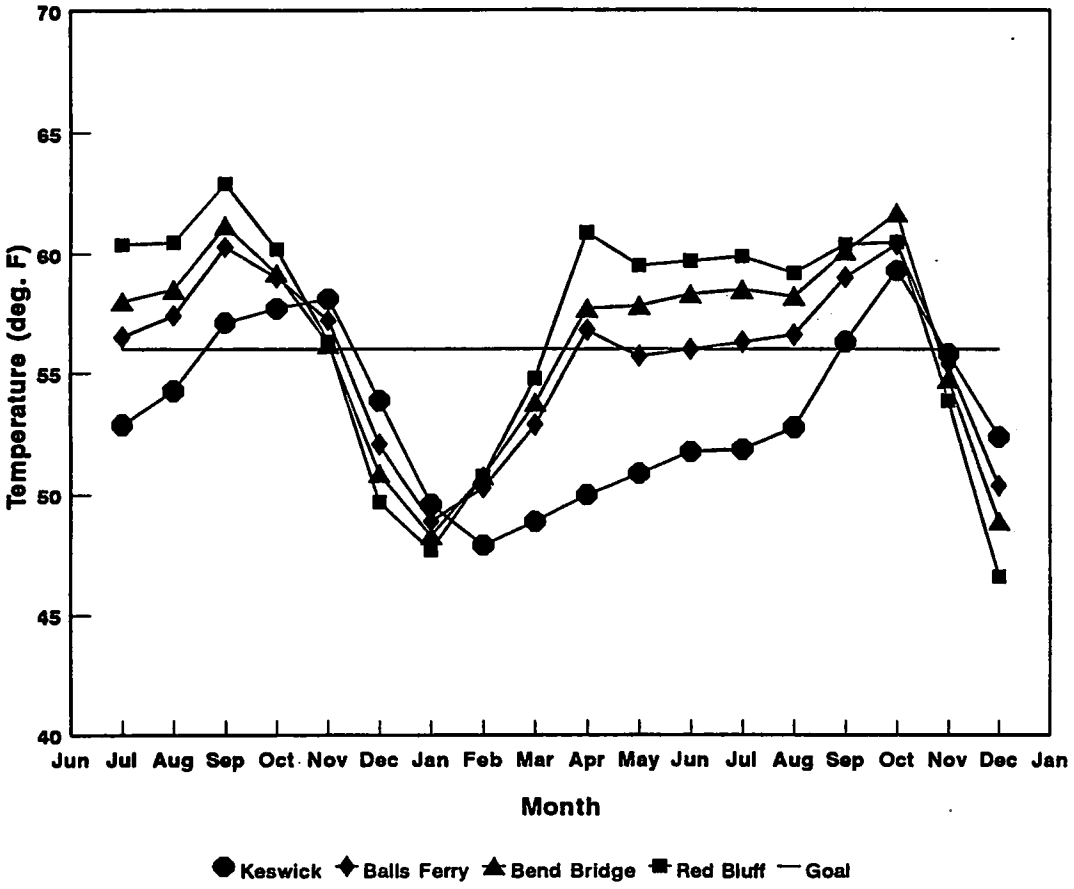

Figure III-1.—Mean monthly temperatures of the Sacramento River at four sites during 1991-92.

the water warmed as it flowed downstream from the first named station to the second. A value below zero indicates that the water cooled as it flowed downstream between the two stations.

During the summer and fall, the greatest temperature increase occurred between Keswick Dam and Balls Ferry. From July through December 1991, the largest average monthly temperature increase occurred during July. During 1992, the largest temperature increase between stations was 7 °F and occurred during April. There are no data available for the spring of 1991, so it is not known whether there was a similar temperature increase early in that year. There are data available for only one entire winter season. The data show that during 1991 and 1992, there were 9 months when the water of the Sacramento River warmed as it flowed downstream and 3 months when it cooled.

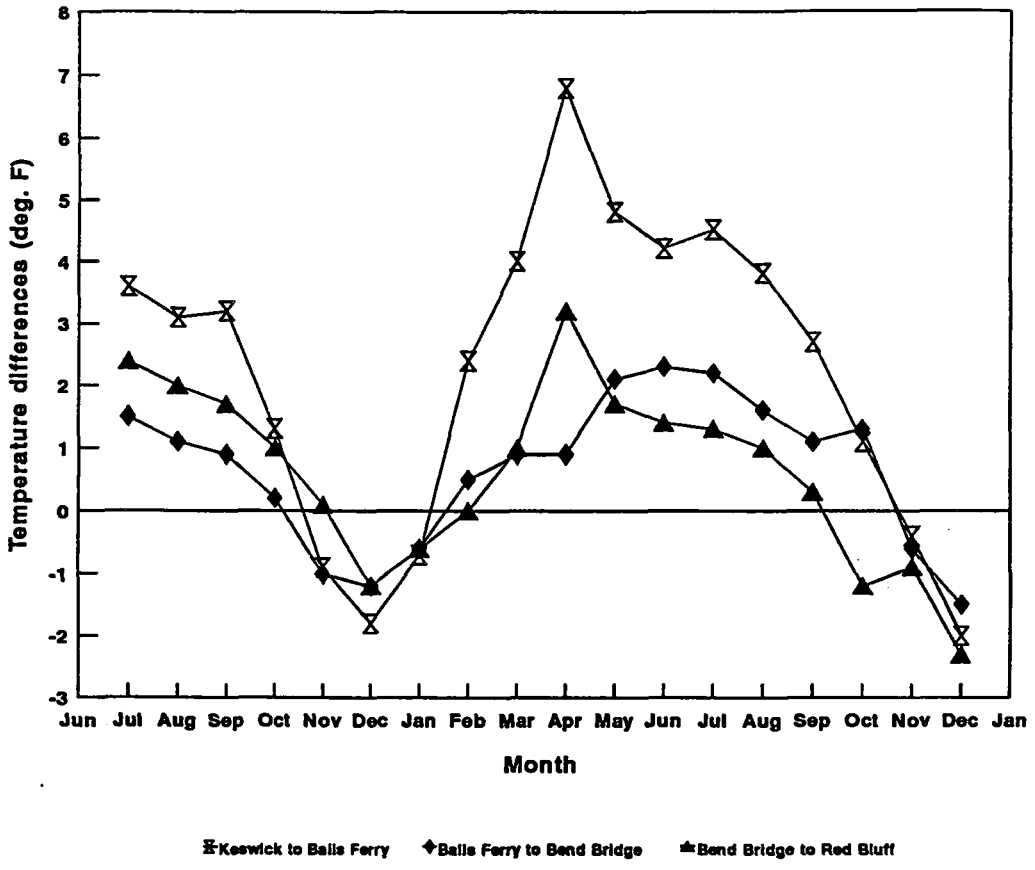

Figure III-2.—Differences in mean monthly temperature between monitoring stations in the Sacramento River from Keswick Dam to RBDD during 1991-92.

Reclamation has developed a temperature model of the Sacramento River from Shasta Dam to the Sacramento Delta. The model output of baseline conditions was used as the basis for evaluating the effectiveness of the alternatives in meeting the temperature goals on the Sacramento River. The model has been previously documented by Rowell (1990) and by Reclamation (1991).

Periods for which hydrologic records are available for this study vary among the stations, which include Shasta Dam, Keswick Dam, Balls Ferry, Bend Bridge, and RBDD. The simulated mean monthly temperatures of the Sacramento River at four sites between Keswick Dam and RBDD are shown in figure III-3 and represent baseline conditions. Baseline conditions were established for the study under the

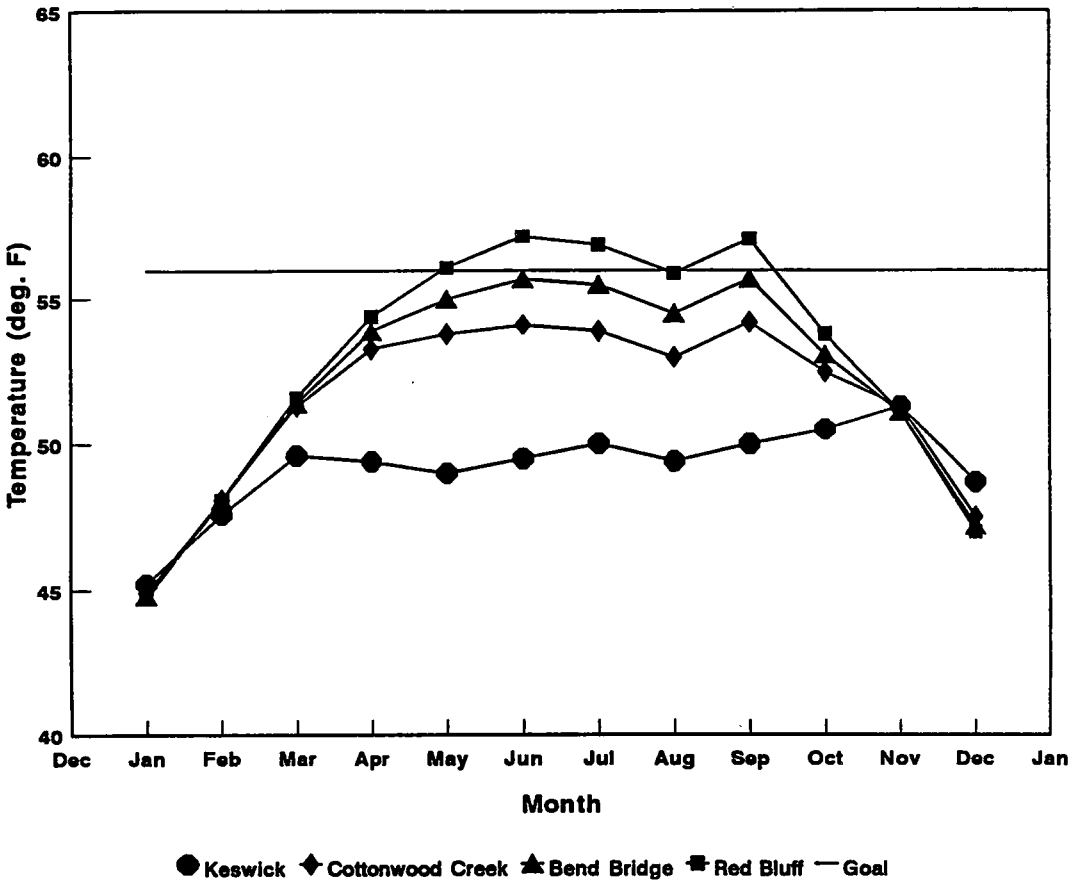

Figure III-3.—Simulated mean monthly temperature of Sacramento River (1922-90) from Keswick Dam to Red Bluff, baseline conditions.

assumption that the temperature control device (TCD) will be operating at Shasta Dam and that the temperature control curtain is in place at the narrows in Lewiston Lake.

In all months, the mean monthly temperature of the river remains below the goal of 56 °F downstream to Bend Bridge. At Red Bluff, the goal is exceeded in most of the warmer months of the year. The mean monthly temperature for at least 1 month of the year is greater than the goal of 56 °F in 57 of the 69 simulated years. At all subsequent sites downstream, the goal is exceeded in all of the 69 simulated years. The model results of each of the alternatives was compared to the baseline at each of the stations to evaluate success in meeting the temperature goal. The temperature goal under the terms of California SWRCB Orders WR 90-5 and WR 91-1 applies to Reclamation activities between Keswick Dam and RBDD.

Turbidity

Reclamation has monitored the turbidity of the Sacramento River on a continuous basis since April 1990. However, because the turbidity monitors are difficult to maintain, there were extended periods when data were not collected. Therefore, the characterization of Sacramento River turbidity is based on U.S. Geological Survey (USGS) water quality data collected at the Keswick Dam gauge.

The USGS data include bimonthly samples of turbidity. Those data are summarized in figure III-4. The maximum value in the recent USGS data is 10 Jackson turbidity units (JTU's), which was observed in January 1991. The next highest turbidity, 4 JTU's, was observed in May 1991. The turbidity levels to be maintained in the Sacramento River below Keswick Dam have been established on the basis of levels in the Sacramento, Pit, and McCloud Rivers, upstream from Shasta Lake. The data indicate that turbidity is reduced through Shasta Dam.

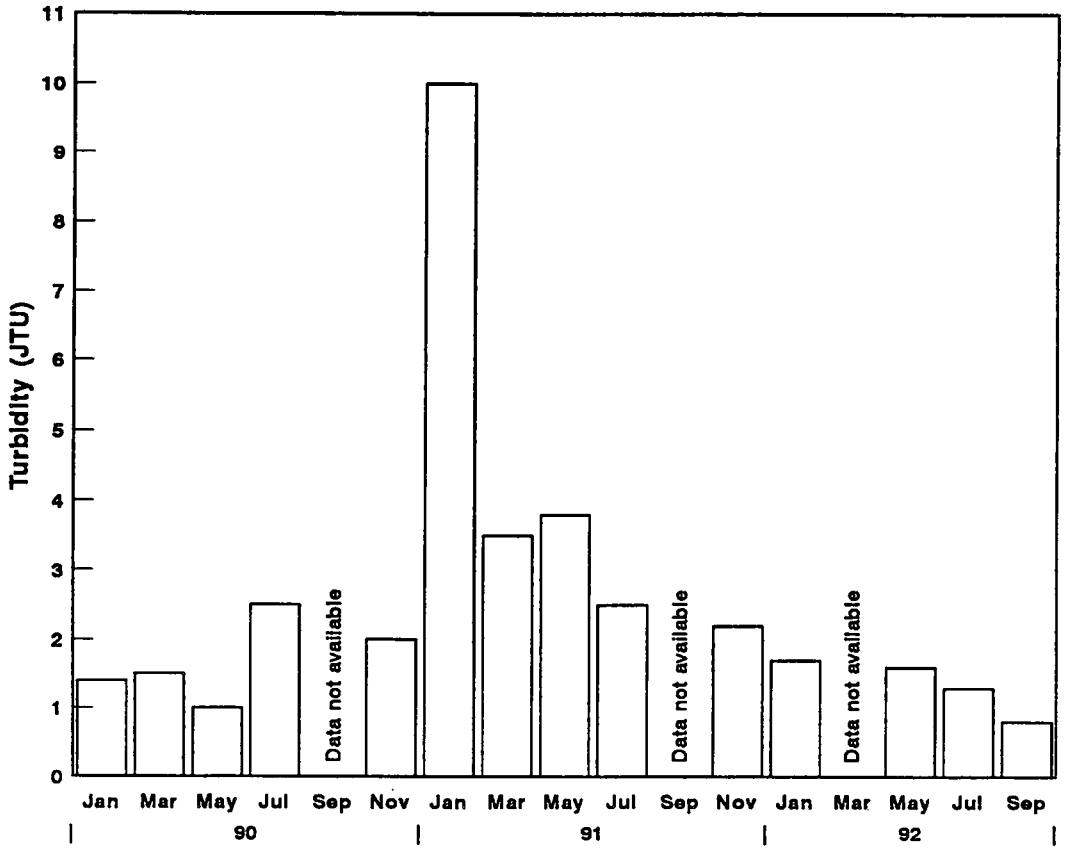

Figure III-4.—Turbidity of the Sacramento River at Keswick Dam, USGS data, 1990-92.

Dissolved Oxygen

The California SWRCB Orders WR 90-5 and WR 91-1 require that a minimum of 7 milligrams per liter (mg/L) of dissolved oxygen (DO) be maintained at all times from Keswick Dam downstream to Hamilton City. During the months of June through August, the minimum DO is 9 mg/L. The data shown in figure III-5 indicate that the DO has remained above the levels required in the California SWRCB Orders WR 90-5 and WR 91-1, based on the USGS data shown in the plot. The only time that the DO fell below the 9-mg/L level was in November 1990. The 7-mg/L concentration has not been approached recently. There is general consensus that DO is not a problem in the Sacramento River.

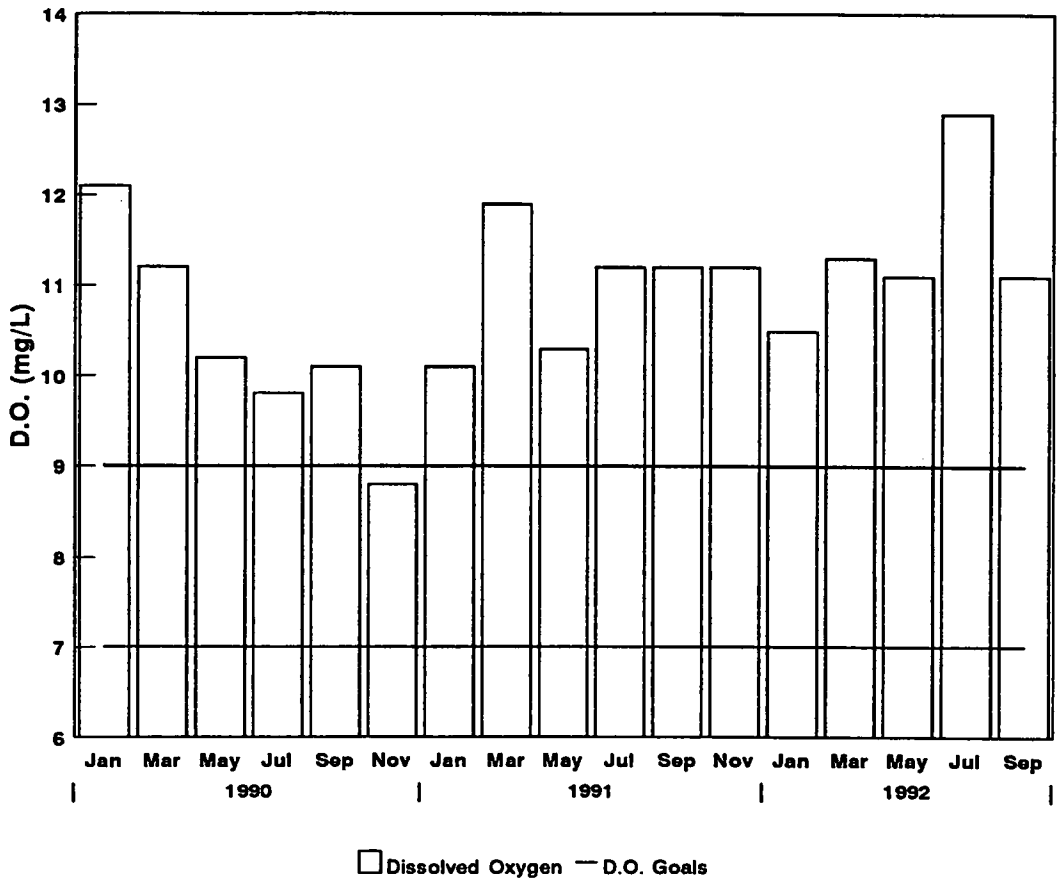

Figure III-5.—Dissolved oxygen concentrations in the Sacramento River at Keswick Dam during 1990-92.

Environmental Consequences

Detailed analyses of the Proposed Action and two other alternatives as discussed in chapter II have been documented in the Special Report and in several technical appendices.

No Action Alternative

A No Action Alternative is presented as a baseline condition for purposes of comparison. For this analysis, it was assumed that the Shasta temperature control device would be in place and operating and that the permanent curtain would be in place at the Lewiston Lake narrows.

Sacramento River.—The effect of the Lewiston curtain was simulated in the monthly model by applying cooling factors (the amount of temperature changes produced by the Lewiston curtain) to the computed Carr Powerplant temperatures. These cooling factors were based on estimates of curtain performance developed from the daily monitoring of intake temperatures at Clear Creek Tunnel. The cooling factors are shown in table III-1.

Table III-1.—Lewiston curtain cooling factors

Jan, Feb, Mar, Nov, Dec	0.0 °F
Apr, May, Sep, Oct	1.5 °F
Jun, Jul, Aug	2.0 °F

Simulated mean monthly temperatures of the Sacramento River at four sites between Keswick Dam and RBDD as shown in figure III-3 reflect baseline conditions. These are discussed under "Affected Environment" and are indicative of temperature conditions that would be present in the Sacramento River under the No Action Alternative.

Whiskeytown Lake.—The No Action Alternative reflects the influence of the temperature control curtains that have been installed in Lewiston Reservoir. The Lewiston curtains will reduce the temperature of the inflow to Whiskeytown Lake by the cooling factors shown in table III-1. The reduced inflow temperature would be expected to cause the inflow to dive deeper in the lake, strengthening the lake's stratification.

Clear Creek.—The flows in Clear Creek are almost completely controlled by Whiskeytown Dam. Only a small amount of water is gained between the dam and the Sacramento River. Releases at Whiskeytown Dam are from the bottom of the dam and are nearly always between 50 and 100 cfs.

Temperatures reflect the bottom temperatures of the lake, and other quality measures of the releases also reflect the conditions of the lake. Limited water quality data are available for Clear Creek below Whiskeytown Dam. Based on data collected near the dam, the water quality is good. The DO averages over 8 mg/L, or about 90 percent of saturation, although concentrations less than 5 mg/L, or less than 50 percent of saturation, have been observed. The specific conductance measurement of total dissolved solids (TDS) has been around 60 microsiemens per centimeter.[1] There has been no evidence of any contaminants in the releases from Whiskeytown Dam.

The lower temperature inflows to Whiskeytown Lake due to the Lewiston Lake curtains would be routed downstream to Clear Creek, but the temperature reductions would be dampened somewhat. The cooling would be less than 1 to 2 °F in the summer months.

Proposed Action

Sacramento River.—The cooling effects of the Oak Bottom and Spring Creek curtains were based on curtain performance estimates derived from preliminary results of a physical laboratory model of the Oak Bottom curtain and Whiskeytown Lake. The maximum cooling was assumed to be 5.0 °F—the conservative end of the estimated range. These fluctuations account for possible reservoir operational dampening effects over time. The monthly cooling factors are shown in table III-2.

Table III-2.—Whiskeytown curtain cooling factors

Jan, Feb, Mar, Apr, Dec	0.0 °F
May, Nov	2.0 °F
Jun, Oct	3.0 °F
Sep	4.0 °F
Jul, Aug	5.0 °F

The Proposed Action was compared to the No Action Alternative, or baseline, at four stations from Keswick Dam to Red Bluff to evaluate success in meeting the temperature goal.

[1] Siemens is a unit of conductance. It is used as a simple measure of the TDS of a solution. The TDS is, on average, 0.7 times the specific conductance.

Implementation of the Proposed Action would not produce dramatic temperature changes in the Sacramento River from that already occurring as a result of the presence of Shasta Dam. The major reduction in water temperature will be accomplished at Shasta Dam. The primary result will be the ability to extend the period of cool water (less than or equal to 56 °F) releases into Keswick Reservoir from the Spring Creek Tunnel and Powerplant into summer and fall, particularly during prolonged drought conditions. The temperature curtains also have a side benefit of not reducing the Sacramento River temperature in the winter and early spring, when, under current conditions, the water is cooler than desirable.

Tables III-3 through III-7 show predicted mean monthly water temperatures for June through August averaged for the 69-year hydrologic study period (1922-90). Results shown in the tables compare the predicted mean monthly water temperature for the Proposed Action with the No Action Alternative during months critical to salmon egg and fry survival.

Model predictions result in slightly cooler temperatures during June (table III-3). Both the Proposed Action and No Action Alternatives exceed the 56-°F temperature goal by about 1 degree at Red Bluff.

Table III-3.—Predicted mean monthly water temperature
1995 level of development
(June)

	Keswick	Cottonwood	Bend Bridge	Red Bluff
Proposed Action	49.1	53.8	55.5	57.0
No Action (base)	49.5	54.1	55.7	57.2

[1] The 1995 level of development represents conditions in the Sacramento River that are anticipated to be present in 1995. This assumes that the Shasta TCD will be installed and operating.

During July (table III-4), the Proposed Action would result in temperatures that are consistently 0.8 °F to 1.0 °F cooler at all locations than No Action.

Table III-4.—Predicted mean monthly temperature
1995 level of development
(July)

	Keswick	Cottonwood	Bend Bridge	Red Bluff
Proposed Action	48.9	52.9	54.6	56.1
No Action (base)	50.0	53.9	55.5	56.9

In August (table III-5), the Proposed Action would reduce average temperatures by 0.7 to 0.9 °F. For the base, 56 °F was exceeded in August in 23 years and in 12 years for the Proposed Action.

Table III-5.—Predicted mean monthly temperature
1995 level of development
(August)

	Keswick	Cottonwood	Bend Bridge	Red Bluff
Proposed Action	48.5	52.2	53.8	55.2
No Action (base)	49.4	53.0	54.5	55.9

At Red Bluff during September (table III-6), mean monthly temperatures are predicted to approach 57.1 °F for No Action. The Proposed Action would cool the river by 0.6 to 0.9 °F on a long-term average basis.

Table III-6.—Predicted mean monthly water temperature
1995 level of development
(September)

	Keswick	Cottonwood	Bend Bridge	Red Bluff
Proposed Action	49.1	53.5	55.1	56.5
No Action (base)	50.0	54.2	55.7	57.1

The predicted October (table III-7) mean monthly water temperature shows none of the river locations equaling or exceeding the 56-°F temperature goal.

Table III-7.—Predicted mean monthly water temperature
1995 level of development
(October)

	Keswick	Cottonwood	Bend Bridge	Red Bluff
Proposed Action	49.8	51.9	52.6	53.3
No Action (base)	50.5	52.5	53.1	53.8

Figures III-6 through III-8 show the mean monthly simulated temperatures for the Proposed Action and No Action Alternatives at Keswick Dam for selected dry years during the period of 1922-90. The temperature goal for the predicted October mean monthly water temperature is 56 °F and is shown as a straight line on the figures. Under the Proposed Action, the temperature remains well below the goal until November, when the temperature exceeds the goal by about 2 °F. As shown in the figure, the curtains reduce the temperature when compared to the baseline during May-November, with the largest reductions in June-September.

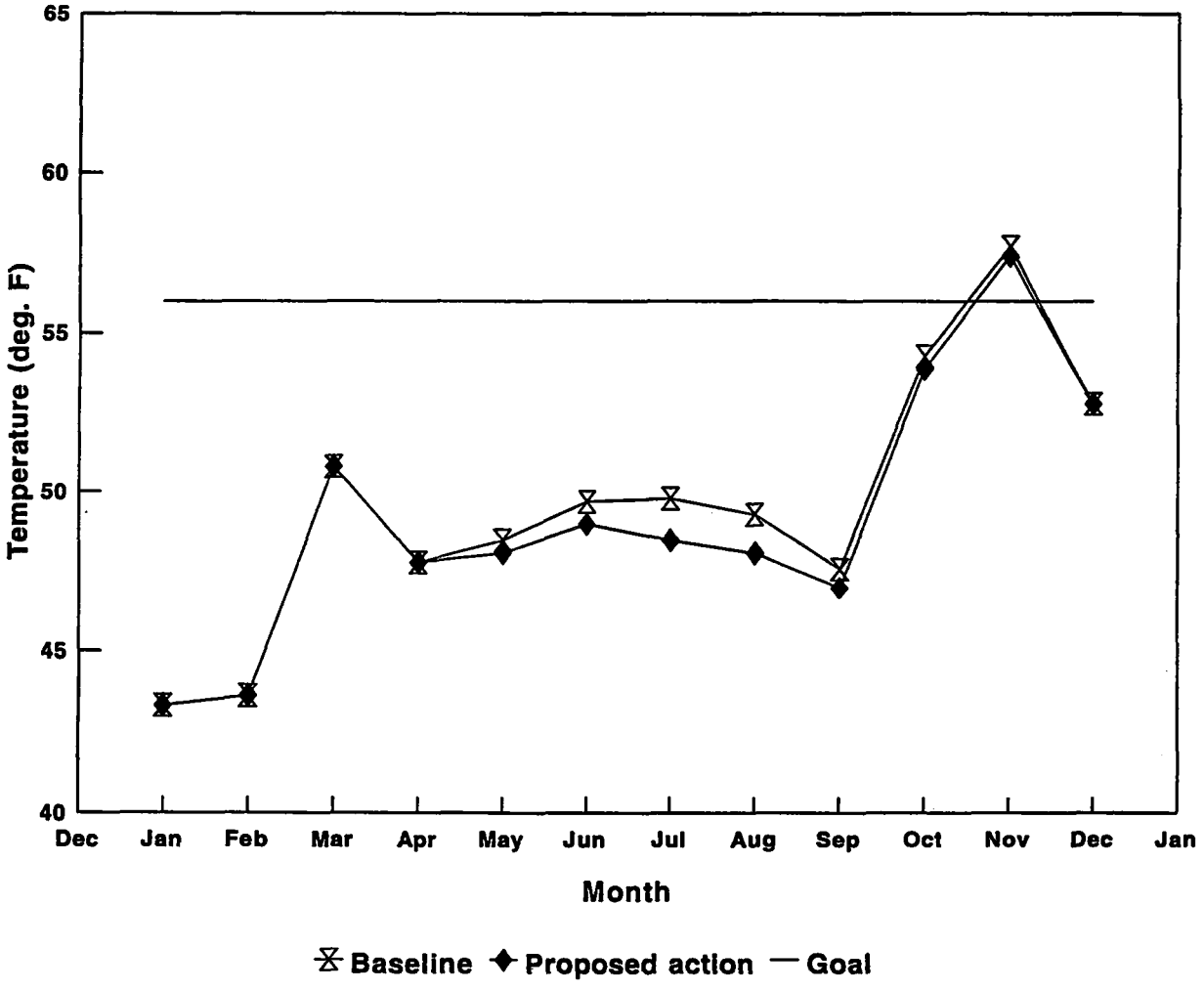

Figure III-6.—Comparison of alternatives at Keswick Dam (1929).

Figure III-7 shows a similar comparison of alternatives based on the 1931 temperature simulation, which is the fourth driest year at Keswick Dam. The mean monthly temperatures of the Proposed Action and No Action Alternative exceed the temperature goal by several degrees in 1931, beginning in August and continuing through October. The curtains lower the temperature during May-November, with the greatest benefit (about 2 °F) occurring in July-August.

The sixth driest year in the 1922-90 record is 1977. The simulation results of 1977 are shown in figure III-8. The pattern of mean monthly temperatures is very much like that of 1931, with the temperature goal being exceeded beginning in August and continuing through October. The peak temperatures of both alternatives during 1977 are about 1 °F lower than they were in the 1931 simulation. The curtains yield a lower temperature than the baseline in each of the 3 months that the goal is exceeded.

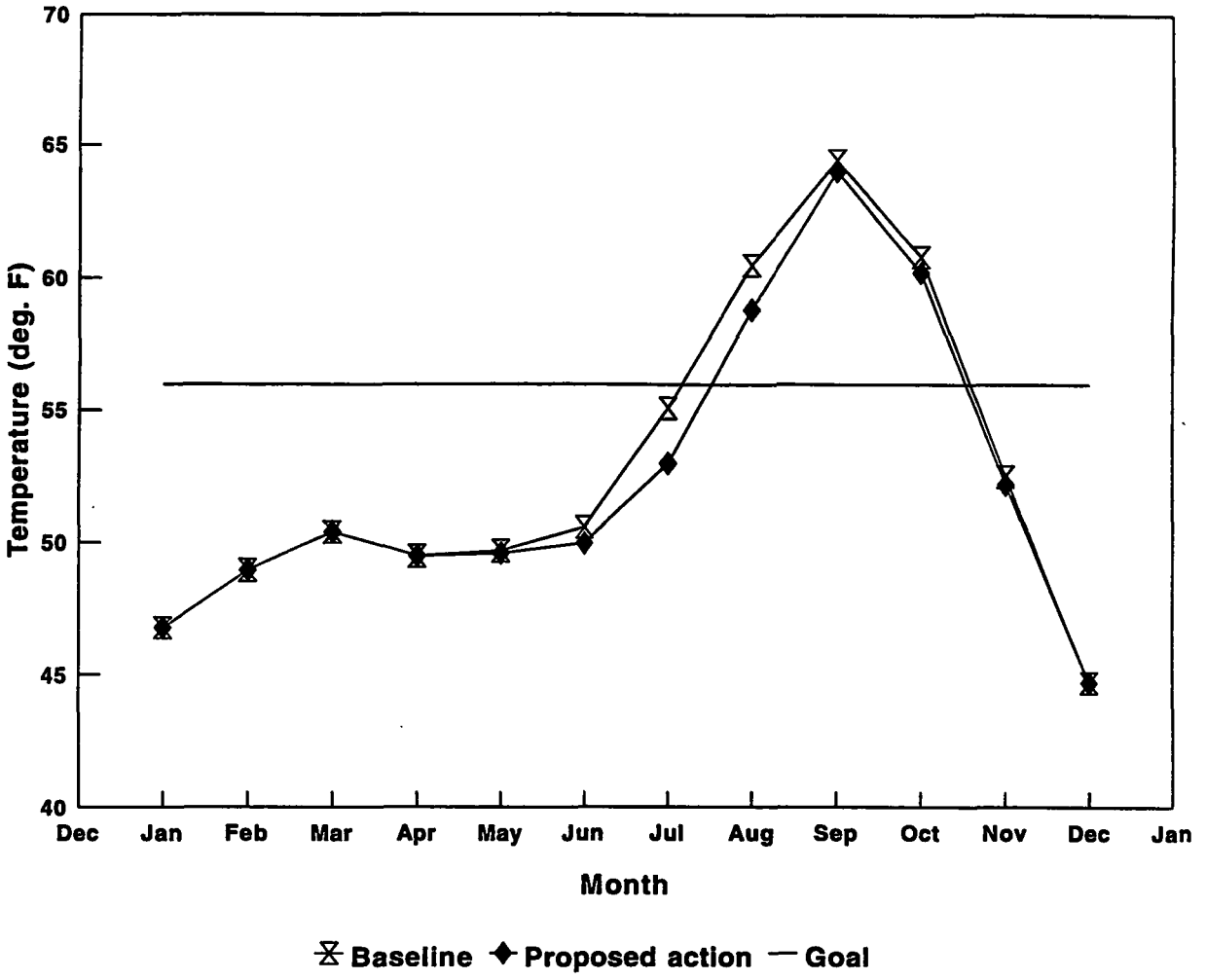

Figure III-7.–Comparison of alternatives at Keswick Dam (1931).

In summary, the curtains (Proposed Action) can reduce temperature relative to the baseline, based on temperature simulations using the period 1922-90. The operation of the Whiskeytown curtains reduces the 69-year average monthly temperature at Red Bluff in May and July to approximately the goal. The curtains also cause some temperature reduction in September and October and pull the August temperature well below the goal. However, in the very driest years, it may not be possible to meet the temperature goal at RBDD in all months of the year.

Whiskeytown Lake.–The temperature control curtains would have the effect of restricting the mixing of the colder inflow with overlying layers of water. These curtains are expected to further enhance and strengthen stratification.

DO declines during the period in which a reservoir is stratified, and replenishment is restricted because surface atmospheric oxygen is unable to affect the bottom water of a lake or reservoir. The installation of the temperature curtains should increase the

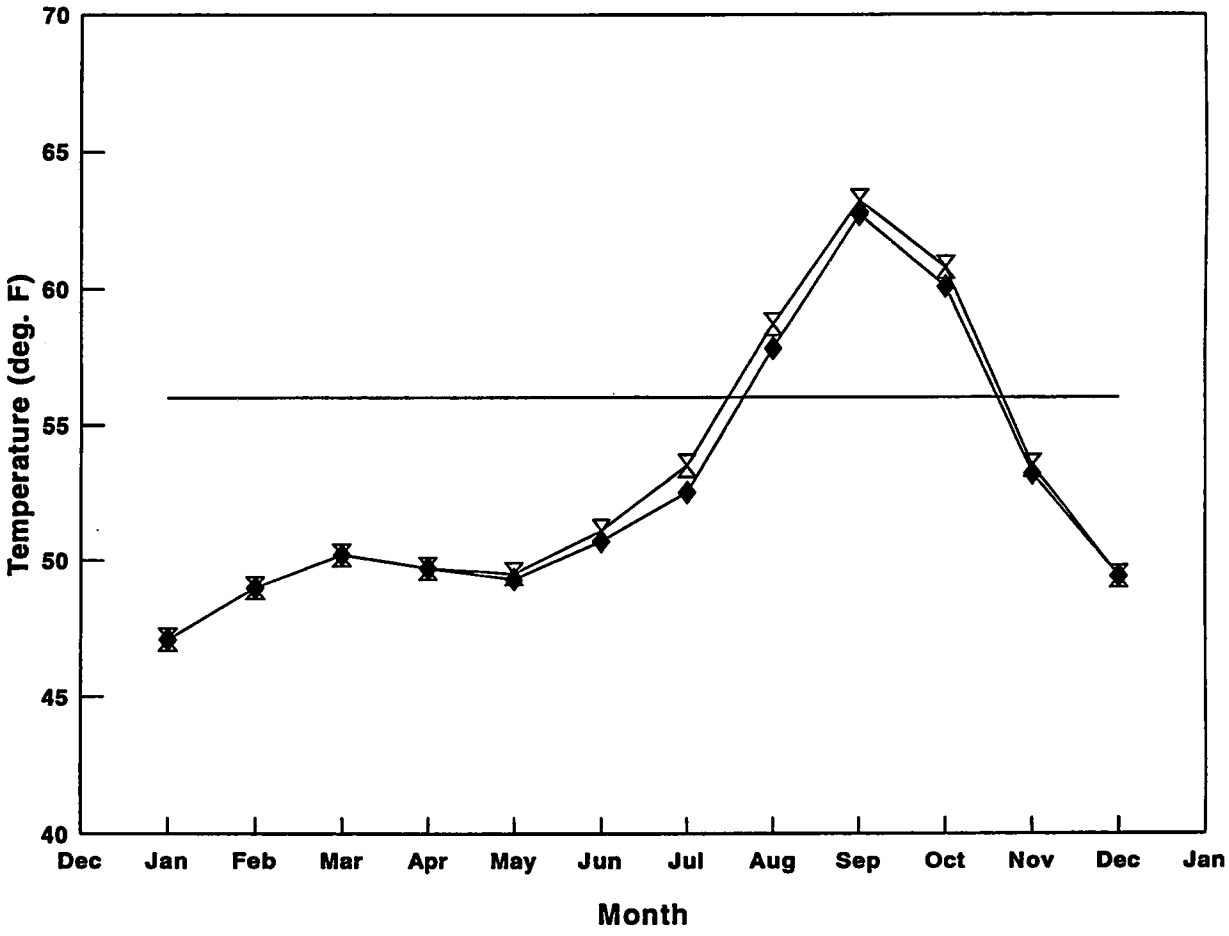

Figure III-8.–Comparison of alternatives at Keswick Dam (1977).

exchange of water in the isolated deeper, colder layer. The increased exchange would allow for greater re-aeration of the deeper water. No significant adverse effects on the reservoir DO are anticipated.

Forcing additional cold water to flow under the curtain will increase the velocity of the water flowing under the curtains. Increased velocity can increase scour along the reservoir bottom, particularly if there is fine, loosely consolidated material available. To date, the turbidity of the releases from the reservoir has been relatively low, averaging 1.25 formazin turbidity units, which are considered equivalent to Jackson turbidity units or nephelometric turbidity units (NTU's).

The maximum turbidity for drinking water is 0.5 to 1 NTU, depending on the quality of the source water. The existing untreated water from Whiskeytown Lake nearly

meets the standard applicable to treated water, indicating that there is little existing turbidity. Since the increase in velocity under the temperature control curtain is, by design, small, and potential sources of turbidity appear to be lacking, no large increase in turbidity is anticipated.

Clear Creek.—The construction activities associated with the installation of the curtains are not expected to have any discernible effects on the releases to Clear Creek below Whiskeytown Lake. The long-term operation of the curtains would affect the Clear Creek releases to a lesser degree than the way they would affect the releases at the Spring Creek Tunnel outlet, since the dam outlet is at a much lower elevation than the Spring Creek Tunnel inlet and the releases to Clear Creek are much less than Spring Creek. The effects on DO and turbidity would be similar to those at the Spring Creek Tunnel outlet.

FISH, WILDLIFE, AND VEGETATION

Affected Environment

Sacramento River

Anadromous Fish.—Chinook salmon and steelhead trout are the principal anadromous fish species in the Sacramento River between Keswick Dam and RBDD. This is the section of the river where most chinook salmon spawn. American shad and white sturgeon are also occasionally found in the Red Bluff area.

The Sacramento River, the largest producer of chinook in California, is unique in supporting four distinct runs of chinook salmon. The runs are named for the time period they first leave the ocean and enter the river system to spawn. These four runs—the winter, spring, fall, and late-fall—have been declining since the early 1970's.

The winter-run chinook salmon population in the Sacramento River is the only winter run remaining in California. Although conservation measures have been implemented since 1987, specifically to improve habitat conditions for the winter run, the population has continued to decline precipitously. In 1989, the run size was estimated at only 547 fish; in 1990, the run estimate was 441 fish; and in 1991, the run estimate was 191 fish. The NMFS listed the winter-run chinook salmon as threatened in November 1990 and endangered in 1994. The State of California listed winter-run chinook as endangered in 1989.

Spring-run chinook salmon were historically the most abundant run in the Central Valley. Run sizes have varied greatly since the early 1970's, averaging around 13,000 fish annually since 1981 but decreasing to 3,922 fish in 1990, 773 fish in 1991, and 431 fish in 1992.

The fall run is the largest run of chinook salmon in the Sacramento River with an average spawning population since 1980 of 108,000 fish. This exceeds the combined total of the other three runs and is the mainstay for the ocean commercial and recreational troll fishery. The fall run comprised an average of 83 percent of all chinook salmon spawning stocks in California Central Valley from 1986-1990. However, the fall run's spawning population dropped to 44,937 fish in 1991 and 41,376 fish in 1992.

- above RBDD only. (does not incl. Yuba, Feather, + Amer. R's.)

The late-fall run has averaged 11,000 fish annually since 1981, but the spawning fish population decreased to 7,305 in 1990 and 7,089 in 1991.

Recent prolonged drought conditions in the Sacramento River have adversely impacted chinook salmon, particularly the winter-run chinook. Excessive water temperature is one of the most critical factors limiting chinook salmon populations. Eggs and newly hatched sac-fry are the two life stages of chinook salmon that are most sensitive to warm water temperatures. Eggs and sac-fry require water temperatures not exceeding 56 °F for normal development. The temperature range between successful spawning and complete mortality of the resulting eggs and newly hatched sac-fry is only 6 °F (from 56 to 62 °F).

Infectious bacterial and fungal fish diseases also respond to temperature. High temperatures cause significant fish losses. The triggering level for various diseases generally are temperatures outside the ranges tolerated by fish. Warm water temperatures may also increase fish predation and cause algae proliferation.

The winter-run chinook has been severely impacted by the warm summer and fall temperatures in the Sacramento River. They spawn from mid-April to early August, which results in the presence of incubating eggs and sac-fry during the warmest water temperatures of the year. Incubation occurs from mid-April through mid-September.

Spring-run chinook have also been negatively impacted by warm river temperatures during the summer and fall. They spawn from mid-August through early October. Incubation occurs from mid-August through January.

The fall run overlaps the spawning period of the spring run. Fall-run chinook spawn from October through December, and incubation occurs from October through March. Mortality due to warm water temperatures occurs during October, when about 30 percent of the fall-run spawning has been completed.

The late-fall run has experienced little mortality resulting from warm temperatures because spawning and temperature-sensitive life stages are completed before temperatures warm during summer and fall. Spawning occurs from January through mid-April, and incubation occurs from January through June.

The steelhead trout is an anadromous strain of rainbow trout, with a life history similar to chinook salmon. Spawning in the Sacramento River and its tributaries usually occurs from January through March. Thus, the temperature-sensitive egg and sac-fry life stages of steelhead are not present in the river during the warmest period of the year.

Resident Fish.—The rainbow trout is the principal nonmigratory or resident fish species being managed for in the Keswick Dam to RBDD section of the Sacramento River. Brown trout also occur in the upper Sacramento River but are relatively rare. Brown trout are fall spawners, while rainbow trout spawn in early spring through mid-May, usually in the tributaries. Baseline population data for quantitative assessment of the effects of temperature control alternatives are not available for either species.

Other fish, primarily warmwater species, occur in the lower reaches of the upper Sacramento River, particularly in the sidestream channels, oxbows, and backwaters. Baseline population data are not available for comparison of temperature control alternative impacts for these species.

Other than the winter-run chinook salmon, there are no other federally listed threatened or endangered fish species in this section of the Sacramento River.

Wildlife and Vegetation.—The riparian corridor along the Sacramento River below Shasta Dam to RBDD is characterized by box elder, cottonwood, willow, and black walnut. Sycamore, valley oak, and ash occur less frequently. Groundcover species consist primarily of blackberry, mugwort, and white alder.

Riparian lands provide a highly suitable and often critical habitat for a wide array of raptors, migratory birds, waterfowl, mammals, and a variety of reptiles and amphibians. State and/or Federal threatened or endangered species present along this section of the Sacramento River include the bald eagle, western yellow-billed cuckoo, Swainson's hawk, and the valley elderberry longhorn beetle which is endemic to the Central Valley of California.

Whiskeytown Lake

Fish.—Efforts to manage the lake for self-sustaining populations of trout, bass, and other species to provide a sport fishery have been disappointing due mostly to the inability to establish a forage base for gamefish. The lake is currently managed by stocking yearling trout for immediate harvest. Whiskeytown Lake does, however, support one of the largest populations of bluegill in northern California. Additionally, the lake also supports a good kokanee fishery. Kokanee are stocked annually. Some natural reproduction also occurs in Whiskey Creek (a tributary of Whiskeytown Lake). In November 1992, nearly 1,000 kokanee were observed in or near Whiskey Creek.

Spotted bass, introduced in 1980, are well established in the lake but are too small to be attractive to anglers. The lake also supports a sizeable population of crayfish in the small bays and shallow areas.

Creel surveys conducted by the CDFG indicated that planted yearling rainbow trout comprised the bulk of the catch, while kokanee originating from annual plants of fry and some natural production accounted for most of the remainder of the catch. CDFG studies showed that planted trout migrate to the vicinity of the Carr Powerplant and that most of the trout are caught in this area.

Fish species found in Whiskeytown Lake are shown in table III-8.

Table III-8.—Fish species in Whiskeytown Lake

Alabama spotted bass	California roach	Rainbow trout
Black crappie	Green sunfish	Sacramento squawfish
Bluegill	Hardhead	Sacramento sucker
Brown bullhead	Kokanee salmon	Sculpin
Brown trout	Largemouth bass	Smallmouth bass

There are no threatened or endangered fish species known to inhabit Whiskeytown Lake.

Wildlife.—Wildlife found at Whiskeytown Reservoir includes those species typically occurring in the foothills of the Sierra Nevada Mountains. Species directly dependent on the lake include waterfowl and shorebirds, as well as species dependent on fish, such as belted kingfishers and great blue herons. The bald eagle, listed as both a Federal and State endangered species, winters and nests near Whiskeytown Lake, feeding primarily on fish.

Environmental Consequences

No Action Alternative

Implementation of the No Action Alternative would have no effect on anadromous fish over and above that which has occurred prior to the emergency action taken to install temporary temperature curtains in Whiskeytown Lake. Temperatures in the Sacramento River would periodically exceed the 56-°F maximum temperature depending on the water year, leading to anadromous fish mortalities.

It is not anticipated that any aspects concerning fish, wildlife, and vegetation would change appreciably under the No Action Alternative for either the Sacramento River or Whiskeytown Lake.

Proposed Action

Sacramento River

Anadromous Fish.—Models for monthly river and reservoir temperature and chinook salmon temperature-related mortality were used to compare the Proposed Action, as well as two other alternatives that proved infeasible, against the No Action Alternative. Details of that analysis can be found in the *Sacramento Basin Fish Habitat Improvement Study Special Report* and Fisheries Technical Appendix to that report (Reclamation, 1993).

Data on water-year conditions for the 69-year period of record (from 1922 to 1990) were used in the models to calculate temperature-related mortality for each run of chinook salmon. Table III-9 shows the average annual percent of each of the four runs of salmon that would be spared from temperature-related mortality for the Proposed Action. These percentages were derived by comparing the mortality of the No Action Alternative with the mortality that would occur for the Proposed Action.

Table III-9.—Average percent of run saved annually compared to No Action Alternative (averaged over 69-year period of record)

	Fall	Late-fall	Winter	Spring
Proposed Action	0.89	0.05	1.10	1.34

From these percentages, projected populations for each run were calculated for 50 years and appear in table III-10.

Table III-10.—50-year annual population projections for each alternative

	Fall	Late-fall	Winter	Spring
Proposed Action	44,638	9,843	856	4,106
No Action	38,762	9,757	718	3,317

Assuming a 3-year average life cycle and that all other influencing factors remain constant, these runs would increase in size over the life of the project at a rate proportional to the reduction in mortality provided by the proposed alternative. This procedure does not account for any other form of mortality in the adult forecasts, as no adequate models presently exist. However, results are applied evenly to the alternatives and are therefore considered adequate for comparison purposes.

The 50-year population projection (table III-10) indicates that an additional 1.1 percent annually, or a total of 138 additional adult winter-run chinook, would be produced with the Proposed Action when compared to the No Action Alternative. Implementation of the Proposed Action would also benefit the fall run with the production of an additional 5,876 adults, an annual increase of 0.89 percent. Similarly, the spring run would increase annually by 789 adults, or 1.34 percent. Further analysis of the model results indicates savings to winter-run chinook are significantly increased during periods of drought. Drought conditions as characterized by the 1931 water year resulted in a 17.5-percent annual savings to the winter run. This has particular relevance to the most recent 6-year drought that has severely impacted this threatened species.

Late-fall-run chinook are not benefitted significantly by the proposed alternative. This is because none of the late-fall-run chinook's temperature-sensitive life stages (eggs and sac-fry) are present in the river during the warm part of the year. Winter-run chinook, however, have eggs and sac-fry in the gravel in July and August and are very vulnerable to warm water temperatures. The fall run has eggs and sac-fry in the gravel during the warm months of September and October. Spring-run chinook overlap with the fall run, also having eggs and sac-fry in the gravel during September and October.

Impacts to steelhead would likely be minimal, as their egg and sac-fry life stages are present in the Sacramento River primarily during January through March and most of the spawning that does occur is in the tributary streams. However, steelhead could benefit from cooler summer and fall temperatures by reduction of bacterial and fungal disease outbreaks.

The bulk of the American shad and white sturgeon are in the Red Bluff area and below. Changes in river water temperatures are not expected to impact these species.

Resident Fish.—Since the temperature-sensitive egg and sac-fry life stages for rainbow trout are present in the river only during the cool spring months, cooler summer and fall temperatures will have little benefit. The early life stages of brown trout, present in small numbers in the river in the fall, may benefit slightly due to reduced river temperatures.

Both species would likely benefit slightly from reduced disease outbreaks as well as reductions in predation rates and the growth of nuisance algae. No negative impacts to other resident fish species are anticipated.

Whiskeytown Lake

Fish.—Operation of the temperature curtains under the Proposed Action may impact nutrient cycling and primary productivity in Whiskeytown Lake and, ultimately, the lake's ability to produce fish. Prior to installation of the curtains, the cold Trinity

River water diverted through the Carr Powerplant mixed with the warmer surface layers of the lake. Additionally, the inlet at the Spring Creek Tunnel has not accessed the coldest, deepest layers of the lake that were near the dam.

Results from modeling the temperature curtains in Reclamation's Engineering Laboratory, as well as information provided from operation of temperature curtains at Lewiston Lake, indicate that flow through the deepest layers of Whiskeytown Lake (hypolimnion) would be accentuated. The temperature curtains would immediately force the cold Trinity River water into the coldest, deepest layers of the lake at the Oak Bottom Campground area and reduce the amount of mixing with the warm surface layers. This would result in colder water at the bottom of the lake. The curtains near the Spring Creek Tunnel inlet would also reduce the amount of mixing with warm surface layers, resulting in the coldest water possible passing into the tunnel inlet.

Reducing the amount of mixing of incoming cold water with the warmer surface layers of the lake and releasing the bottom layers of water could have a number of impacts on the productivity of Whiskeytown Lake. It is possible that the nutrients from the Trinity River might be lost to the system by being forced into the deepest lake layers and then discharged into the Sacramento River. Normally, nutrients and plankton that settle to the bottom are seasonally mixed back into the surface layers during the fall. With implementation of this alternative, these nutrients and plankton would be swept out of the lake with the Spring Creek Tunnel releases. Those nutrients that exist in the warmer surface layers would be quickly consumed by the plankton. No new nutrients would become available except for the small amount coming into the lake from tributaries such as Clear Creek, and overall productivity would decline.

Based on available evidence, however, it is thought that the temperature curtains would reduce the rapid flushing that occurred in the reservoir prior to installation of the curtains. Plankton would grow and remain in the lake instead of being rapidly flushed into the Sacramento River, as is currently thought to occur. This would provide a greater food source for juvenile fish and improve the lake's ability to produce self-reproducing sport-fish populations.

Studies conducted under contract with the University of California at Davis during 1993 and 1994 will provide a better understanding of the impacts of the temperature curtains on the limnology of Whiskeytown Lake.

Wildlife and Vegetation.—Cooler river water temperature in the summer and fall, particularly during drought periods, is not anticipated to affect any riparian vegetation species. Wildlife species that prey upon fish, such as great blue herons, belted kingfishers, mergansers, river otters, and bald eagles, may benefit due to increasing production and survival of coldwater fish species.

CULTURAL RESOURCES

Affected Environment

Sacramento River

No impacts would occur to any cultural resources existing along the Sacramento River corridor by any of the proposed alternatives since only water temperature would be altered. Thus, no information on cultural resources is included in this section.

Whiskeytown Lake

The ground affected by the installation of the temporary temperature curtain had previously been heavily disturbed by the construction of the dam; therefore, any archeological sites would likely have been damaged or destroyed. No historic resources were known to exist in the area. The National Park Service (NPS) archeologist met onsite with Reclamation engineers to determine the area of potential effects of the project. A class III survey of that area was then conducted by the NPS on April 15, 1993. As anticipated, no cultural resources were identified. A categorical exclusion for cultural resources was then completed for the project by the Mid-Pacific Regional Archeologist based on the findings of the NPS.

Environmental Consequences

Sacramento River

The minor temperature alterations that would occur to the Sacramento River between Keswick and RBDD would not affect cultural resources in any way.

Whiskeytown Lake

No Action.—No impacts to cultural resources would occur to cultural resources with this No Action Alternative.

Proposed Action.—As the Proposed Action would simply make the temporary curtains permanent, no impacts would occur for any cultural resources.

FLOOD PLAINS AND WETLANDS

Affected Environment and Environmental Consequences

Executive Order 11988 requires that Federal agencies prepare flood plain assessments for proposals located within or affecting flood plains. Since the Proposed Action will have no effect on either the Sacramento River or Whiskeytown Lake, no flood plain assessment will be prepared.

Executive Order 11990 requires that Federal agencies prepare wetland assessments for proposals located within or affecting wetlands. The Proposed Action is not located in, nor will it affect wetlands in either the Sacramento River or Whiskeytown Lake.

POWER GENERATION

Affected Environment

Reclamation operates three powerplants within the study area: Keswick Powerplant, located at Keswick Dam, which is capable of a total output of more than 90,000 kilowatts; Spring Creek Powerplant which has a total output of 192,000 kilowatts; and Carr Powerplant, located just above Whiskeytown Lake, which has a total output of 154,000 kilowatts.

Environmental Consequences

No Action Alternative

There would be no change in power generation under this alternative.

Proposed Action

Implementation of the Proposed Action would likely have no significant effect on total annual power generation. However, the monthly distribution of power generation might change, particularly during the construction period. It is expected that these temperature control facilities would allow water to be brought through the system during times of high temperatures.

RECREATION

Major recreation destinations within Shasta and Trinity Counties include Shasta Lake, located 11 miles from downtown Redding; Clair Engle Lake and the Trinity

River, located about an hour's drive to the west of Redding; Whiskeytown Lake, located 8 miles west of Redding in the Whiskeytown Unit of the Whiskeytown-Shasta-Trinity National Recreation Area; and the Sacramento River.

Affected Environment

Sacramento River

Recreation on the Sacramento River consists primarily of fishing and boating. Operation of the temperature curtains in Whiskeytown Lake are not expected to affect recreation since the temperature decreases predicted to result in the Sacramento River are minor from a recreation standpoint.

Whiskeytown Lake

Whiskeytown Lake is managed by the NPS. The lake encompasses 3,250 acres and at maximum lake elevation (1209 feet) has a shoreline of 36 miles and a maximum depth of 235 feet.

From 1987 to 1992, visitation at the Whiskeytown Unit has averaged 1.55 million visitors per year. Water-based sports are popular from April through October, although most visitations occur between Memorial Day and Labor Day. Whiskeytown Lake is heavily used by the local population as a day-use area. Visitors participate in a variety of activities including swimming and sunbathing, picnicking, fishing, motorboating and waterskiing, sailing, camping, hiking, and sightseeing. Fishing is the popular year-round activity on the lake; both cold and warmwater fish species are stocked.

Recreation facilities include a visitor center on the east end of the lake, three campgrounds, four picnic areas, two swimming beaches, two full-service marinas, launch ramps, courtesy docks, and parking areas. Dispersed recreation occurs in undeveloped areas along the shore of the lake. Numerous informal trails provide access to the lakeshore.

The Oak Bottom temporary temperature curtain is located adjacent to the Oak Bottom Marina and campground, an area that experiences intense recreational pressure. The channel upstream from the temperature curtain and below Carr Powerplant receives heavy fishing pressure during 8 months of the year.

The temporary Spring Creek Tunnel inlet curtain is located in an embayment below the visitor center on the northeast shore of the lake. Recreation use is concentrated at this site due to ease of access from Highway 299 and a combination of physical features.

Environmental Consequences

No Action Alternative

Under the No Action Alternative, no changes in recreation would be anticipated. The NPS would continue to manage the lake for recreation. Reclamation operations, including seasonal flood control drawdowns, would probably continue unchanged. If required during drought periods, Whiskeytown Lake could be drawn down to provide water to the Sacramento River.

Proposed Action

Both temperature curtains, if made permanent, would continue to disrupt views from the visitor center, the lake surface, and the Oak Bottom campground. Additionally, the curtains would continue to pose safety concerns.

Boat passage through the Oak Bottom curtain has been provided by a slot 16 feet wide and 6 feet deep. This curtain is in a 5-mile-per-hour zone, so high speeds would probably not be a problem. Some congestion could occur during high use periods, such as on holidays and summer weekends; however, courtesy rules of navigation would apply to these situations. The boat passage would be illuminated with regulation United States Coast Guard (Coast Guard) navigation lights and colored buoys.

Boat access through the Spring Creek curtain would allow only NPS personnel emergency access to the area behind the curtain. Passage to the general public would not be allowed.

The curtains interfering with the view cannot be completely mitigated because, for safety reasons, boaters must be able to see the curtains. However, the problem could be somewhat alleviated by increasing the public's awareness of the purpose of the curtains. To this end, Reclamation and NPS have developed site bulletins and a permanent site exhibit at the visitor center.

SOCIAL WELL-BEING

Affected Environment

The significant impacts resulting from implementation of the preferred alternative or any of the viable alternatives considered in this study would be felt most around Whiskeytown Lake and in the immediate vicinity of the city of Redding. Other direct and indirect beneficial impacts of the project that are associated with recreational and commercial salmon fishing will occur downstream from Keswick Reservoir in the Sacramento River and in the Pacific Ocean. The recreational fishing area that will be

affected by this project consists of 22 counties,[2] 15 border the Sacramento River and [3]7 border the Pacific Ocean. The seven coastal counties would also experience the impact to commercial fishing.

In 1991, the total employment in the commercial fishing impact area was slightly over 1 million, or approximately 7.7 percent of the total number of employees in the State. The unemployment rate for this area was 6.2 percent in 1991. The largest sector of employment in this impact area is services, with 26 percent, followed by retail trade, with 20 percent. The sectors of commercial finfish harvest, fish cooking and canning, and fish processing account for 1,400 jobs, or less than 2 percent of the total employment in this impact area.

Environmental Consequences

No Action Alternative

Lawsuits and opposition to Reclamation will continue until the river temperature problem is resolved. The same individuals, groups, agencies, and organizations that are now concerned with the decline of salmon populations will continue to apply pressure and voice their concerns.

For many of the groups and individuals whose incomes are directly or indirectly derived from salmon, the continued decline in the number of salmon would result in fewer jobs and smaller incomes. This decline in the number of salmon would have trickle down impacts spread over the previously identified 22-county area.

Proposed Action

The dominant safety issues concern boating and swimming, the major recreation activities on the lake. Standard Coast Guard navigation lights and buoys will mark curtain locations, entrance and exit lanes through the Oak Bottom curtain boat passage, and speed zones. Courtesy rules of navigation would apply to congested situations occurring during high use periods. The curtains could become an attractive nuisance, especially to young adults, teenagers, and children. Safety information (hazard signs at curtain sites) and normal law enforcement efforts by NPS rangers should help to inform the public about the dangers of swimming out to or climbing onto the curtain floats.

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[2] Shasta, Trinity, Tehama, Glenn, Butte, Colusa, Sutter, Yolo, Sacramento, Solano, Napa, Sonoma, Marin, San Joaquin, Contra Costa, Alameda, Santa Clara, San Mateo, Mendocino, Santa Cruz, Monterey, and San Luis Obispo.

[3] Mendocino, Sonoma, Marin, San Mateo, Santa Cruz, Monterey, and San Luis Obispo.

Curiosity would draw scuba divers, swimmers, and boaters to the curtains. It is anticipated that some people would walk on the booms and others would dive to explore the curtains at lower depths. This activity could result in a potential for accidents and the need for increased emergency response capabilities from NPS and first aid units from Redding and other nearby communities. The number of incidences occurring would be carefully monitored to determine the need for corrective measures. Most emergency responses would occur during the months of May through October. Emergency boat access to the area inside the Spring Creek curtain will be designed and constructed to provide adequate and timely response to any injury accidents that may occur during this season.

It is expected that each NPS response would require a boat with two employees; and during the prime recreation season, a third person would probably be needed. NPS currently does not have an adequate number of personnel for such purposes, and the increased need would place additional stress on the existing personnel.

The curtains also could be a hazard to boaters. Bumping the curtains would be a problem during windy periods. Boats traveling at high speeds might hit the curtains. This could result in property damage and injury to the occupants of the boats.

Groups interested in this action include commercial fishermen, environmental protection groups, State and Federal resource management agencies, and civic and local groups interested in sport fishing. All have a similar interest in reducing the decline of the salmon populations, particularly the winter- and spring-run chinook salmon. The basic concern is the near extinction of these runs of salmon. A related concern is that the economy will suffer as the number of salmon declines. All of these concerns would be alleviated by benefit to the winter run and other chinook salmon runs from operation of the temperature control curtains.

The continuing employment and income of commercial fishermen, fishing outfitters, and guides depend directly on the number of fish harvested. Communities that provide services and support to the fishing industry are threatened by the declining number of salmon. Sport fishermen and the service groups that cater to their needs are also concerned for the future vitality of the Sacramento River salmon. All of these groups would benefit from the potential population increases of chinook salmon in the Sacramento River from the temperature curtains.

This alternative would have no impact on Indian trust assets.

Economic Impacts

Regional economic impacts measured by sales, income, and employment were evaluated for construction and operating costs, Whiskeytown Lake recreation, and commercial and recreational salmon fishing. The regional economic impacts appear in table III-11.

Table III-11.—Regional economic impacts

Impact categories	Sales ($1,000)	Income ($1,000)	Employment (FTE's)
Construction costs	3,916	1,227	37
Operating costs	382	148	5
Lake recreation	0	0	0
Recreational salmon fishing	95	30	2
Commercial salmon fishing	461	119	4

The geographic area absorbing these impacts consists of the two northern California counties of Shasta and Trinity for all impact categories except salmon fishing. For salmon fishing, the impact region follows the salmon migratory path which includes the Sacramento River and a portion of the California coast.

The construction cost impacts have already been incurred since the curtains are currently in place. Converting the curtains to permanent status will involve no additional construction cost.

The operating cost, lake recreation, and salmon fishing impacts occur on an annual basis for the life of the project. The combined effect of these categories of annual impact represent an increase of only 11 jobs in regional employment. Overall, the temperature curtains do not present a significant impact to the regional economy.

Cumulative Impacts

Long-term operation of the temperature curtains in Whiskeytown Lake will likely have beneficial cumulative impacts to three of the four runs of chinook salmon in the Sacramento River from Keswick to RBDD. Detailed temperature and mortality model analyses indicate that the temperature curtains will provide small benefits (Reclamation, 1993) to winter-run salmon (an additional 1.1 percent of the run saved compared to the No Action Alternative); fall-run chinook (an additional 0.89 percent of the run saved); and spring run (an additional 1.34 percent) of the run saved compared to the No Action Alternative. While these are small percentages, they nevertheless will be beneficial in overall restoration efforts. Temperature control measures for water entering the Sacramento River from Whiskeytown Lake, in combination with the TCD scheduled for installation in Shasta Dam, habitat and passage improvement measures, diversion screening measures, and flow improvement measures will each contribute small benefits to the chinook salmon.

Chapter IV

CONSULTATION AND COORDINATION

This chapter presents information on consultation and coordination activities that have occurred to date and activities that will occur during the development and construction phase.

PUBLIC INVOLVEMENT

Public involvement is a process by which interested and affected individuals, organizations, agencies, and governmental entities are consulted and included in Reclamation's decisionmaking process.

Reclamation began public involvement and coordination in 1978, when it initiated the Central Valley Fish and Wildlife Management Study. Many individuals and organizations, including Federal and State agencies, have expressed interest in this project. In 1991, work started on a draft plan of study and a public involvement plan; a final plan was produced in June 1992. The public involvement program included producing a video of the construction of the curtains at Whiskeytown Lake that will be shown at the Whiskeytown Lake visitor's center, a short slide show on the construction of temperature control curtains at Lewiston Lake, briefings for various interest groups, open houses, newsletters and brochures, workshops, small group meetings, and field trips.

A letter introducing the study, stating its objectives and purpose, and describing the study organization was sent in September 1992 to the full mailing list of approximately 600 people. A second letter and an information brochure invited primary stakeholders to a public meeting and open house on November 4, 1992, in Redding, California. Six Reclamation employees attended the open house to answer questions and discuss aspects of the project relating to his or her area of expertise.

Many of the primary stakeholders wanted an immediate solution to the declining fish population, even if the solution was to be only temporary, rather than continuing studies while more fish were lost. It was the consensus of those attending the public meeting that Reclamation should investigate the potential for funding the design and construction of temporary temperature curtains in Whiskeytown Lake by June 30, 1993, without altering the schedule of the planning study.

Soon after meetings were held in Weaverville on November 23, 1992, and Redding on November 24, 1992, funds were acquired to design and install temporary temperature control curtains in Whiskeytown Lake.

Public meetings were scheduled for December 16, 1992, in Redding, on February 9, 1992, in Weaverville, and February 10 in Redding, California, to present information on draft conceptual alternatives for the curtains and to receive feedback.

Another set of public meetings was held on August 24, 1993, in Weaverville and on August 25, 1993, in Redding to discuss the impacts of the alternatives and to address any new issues before the draft document was published for review.

Before each public meeting, press releases were mailed out, and 100 known interested stakeholders were telephoned. Local television and radio stations covered most of the meetings.

An audio newsletter was made available so that the public could call a toll-free number to get a recorded update as the study progressed and to leave messages or questions on the recording.

The following were the most significant issues identified in the initial scoping process:

- Urgency of preserving the endangered fish populations.
- Availability of information about Reclamation's planning and decisionmaking process.
- Potential for adverse impacts to recreation on CVP reservoirs.
- Potential for adverse impacts to the Trinity River basin.
- Potential for adverse impacts to water users on the Sacramento River.
- Relationship of this planning process to more general water policy decisionmaking throughout the entire basin.
- Loss of tourism revenues.
- Repayment issues.
- Power losses.

COORDINATION WITH OTHER AGENCIES

An interagency team was formed in February 1992 to facilitate communication with the other resource agencies participating in the study. The participating agencies include the CDFG, NMFS, FWS, the California SWRCB, the Regional Water Quality Control Board, the Western Area Power Administration (Western), NPS, the U.S. Forest Service (USFS), and Reclamation. Each of these groups has been highly supportive of the study and has actively responded to questions at public meetings.

In addition to general coordination activities, Reclamation will coordinate development and implementation of the selected plan with the FWS under the requirements of the Fish and Wildlife Coordination Act (FWCA). Coordination under the FWCA provides FWS an opportunity to formally present their views on the effects of the proposed activity on fish and wildlife and to recommend any mitigation measures or project modifications that they feel are necessary to protect fish and wildlife. This activity will be concurrent with the NEPA process, and any FWCA report prepared by FWS will be included in the final environmental documentation.

Any alternative implemented as a result of this study must comply with section 7 of the Endangered Species Act (ESA) because its implementation will affect the winter-run chinook salmon, a federally listed species. All coordination and documentation procedures required by ESA will be accomplished concurrently with the NEPA process associated with this study.

ENVIRONMENTAL COMMITMENTS FOR PROPOSED ACTION

Because the temperature curtains have already been installed as an emergency measure to help protect the threatened Sacramento River winter-run chinook salmon, no further environmental commitments are required for construction.

However, long-term operation will require monitoring of the temperature changes in both the Sacramento River below the Spring Creek tunnel outlet and in Whiskeytown Lake. At present, there are 12 monitored sites at Whiskeytown Lake. Some monitoring sites are long term, and others are there to study the temperature curtains. The temperature monitoring techniques include:

- Monthly manual measurement of the water vertical profile at three permanent sites--near Clair A. Hill Whiskeytown Dam outlets, near Spring Creek power conduit intake, and 2 miles upstream of the dam in the old Clear Creek channel.

- Hourly monitoring of temperature, DO, and turbidity at the Spring Creek Powerplant release.

- Four curtain stations instrumented with multichannel temperature monitors with probes to monitor different depths. The hourly data is verified by measurements at depth once a month. Each curtain has an upstream and downstream site to determine the benefit of the curtain.

- Three stations with singular probe temperature recorders at Whiskeytown Dam outlet, Clear Creek Tunnel intake in Lewiston Reservoir, and Carr Powerplant discharge.

- A singular probe temperature recorder located at the National Park Service headquarters weather station to record hourly air temperatures.

Additionally, the effects of the deployment of the temperature curtains in Whiskeytown Lake are currently being studied by the University of California at Davis under contract with Reclamation. Baseline data were collected in 1993. Additional data will be collected through 1994 to detect and analyze any changes to the limnology of the lake caused by operation of the temperature curtains. Adjustments will be made if found to be necessary.

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ABBREVIATIONS AND ACRONYMS

Carr Powerplant	Judge Francis Carr Powerplant
CDFG	California Department of Fish and Game
cfs	cubic feet per second
Coast Guard	U.S. Coast Guard
CVP	Central Valley Project
DO	dissolved oxygen
ESA	Endangered Species Act
°F	degrees Fahrenheit
FWCA	Fish and Wildlife Coordination Act
FWS	U.S. Fish and Wildlife Service
JTU	Jackson turbidity unit
mg/L	milligrams per liter
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPS	National Park Service
NTU	nephelometric turbidity unit
OM&R	operation, maintenance, and replacement
RBDD	Red Bluff Diversion Dam
Reclamation	U.S. Bureau of Reclamation
SWRCB	(California) State Water Resources Control Board
TCD	temperature control device
TDS	total dissolved solids
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
Western	Western Area Power Administration