MEMBER UNITS EXHIBIT NUMBER 15

15	03/11/98	Santa Ynez River Fisheries Management Alternatives

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SANTA YNEZ RIVER FISHERIES MANAGEMENT ALTERNATIVES

Prepared by:

SANTA YNEZ RIVER TECHNICAL ADVISORY COMMITTEE

Prepared for:

SANTA YNEZ RIVER CONSENSUS COMMITTEE

March 11, 1998

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1.1 BACKGROUND

Since 1993, several parties (Signatory Parties) with interests in the resources of Lake Cachuma and the lower river have signed a Memorandum of Understanding (MOU) for Cooperation in Research and Fish Maintenance on the Santa Ynez River downstream of Bradbury Dam (lower river):

- Bureau of Reclamation
- Fish and Wildlife Service
- California Department of Fish and Game
- Cachuma Conservation Release Board
- Santa Ynez River Water Conservation District, Improvement District #1
- Santa Ynez River Water Conservation District
- Santa Barbara County Water Agency
- City of Lompoc

The Signatory Parties anticipate the development of a fisheries management plan for the lower river in preparation for a State Water Resources Control Board (SWRCB) hearing to begin in the year 2000. The Signatory Parties maintain a Technical Advisory Committee (SYRTAC), which has conducted cooperative studies since 1993 to collect information in order to develop recommendations for long term fishery management, projects and operations in the lower river. In 1996, the "Proposed Investigations to Determine Fish-Habitat Management Alternatives for the Lower Santa Ynez River, Santa Barbara County" (Long Term Study Plan or LTP) was adopted in the MOU to provide a framework for continuing studies. The data collected on the lower Santa Ynez River between 1993 and 1996 was synthesized and evaluated in the 1996 Synthesis Report to assist in the overall planning process and management of the SYRTAC investigations.

In order for the SYRTAC to develop the management recommendations that will be presented to the Consensus Committee and later the SWRCB, it is necessary to assess whether the studies will provide sufficient information to develop and evaluate potential management options. This report used information from the Contract Renewal EIR/EIS, the 1996 Synthesis Report, other literature where appropriate, and technical discussions by the Biology Subcommittee and SYRTAC to identify potential management actions and opportunities to be evaluated in ongoing or future SYRTAC investigations.

1.2 OBJECTIVES

The ultimate goal of the cooperative SYRTAC studies is to identify and evaluate potential management actions that will benefit fishery resources in the lower Santa Ynez River. Improving conditions for native fishes in general and rainbow trout/steelhead in particular is a management priority in the lower Santa Ynez River, while avoiding adverse impacts to other species of special concern (federal and state listed species of birds, mammals, amphibians and reptiles) and vegetation and wildlife habitat values. Steelhead in the Southern California Evolutionarily Significant Unit (ESU) were listed as endangered in August 1997 under the Federal Endangered Species Act (ESA). In the Santa Ynez River only the anadromous life form of rainbow trout/steelhead residing below Bradbury Dam is listed. Efforts to improve the steelhead population may include measures to restore access to spawning and rearing habitat above Bradbury Dam.

As described in the LTP, alternative management recommendations for fishery resources will be developed and evaluated in context with other management objectives for the river. The comparative feasibility of various actions in achieving these management objectives will be evaluated according to (1) the probability of achieving the desired benefit, and (2) whether the action can be reasonably implemented considering the constraints imposed by natural conditions and existing beneficial uses of land and water resources.

The ability of the U.S. Bureau of Reclamation (USBR) and local water agencies to successfully implement a wide range of optimum actions may be limited due to requirements for access to private lands which are outside the control and authority of the USBR and supporting water users. Therefore, a phased program of implementation, based upon an adaptive management strategy, should be used. First priority should be given to implementing those elements of the management plan which are located on lands and involve facilities under the direct control of the USBR and/or participating local water agencies.

In this report the alternatives will be screened according to legal and institutional obstacles, technical infeasibility, cost infeasibility, other unacceptable environmental impacts, and compatibility with the Endangered Species Act. The potential alternatives will then be ranked in a three-stage process, first according to the biological benefits provided to fishery resources (focused on rainbow trout/steelhead and native fishes), then according to likelihood of success and costs, and finally according to other considerations such as institutional coordination, incidental environmental impacts and benefits, and operational and maintenance requirements.

The objectives of the Management Alternatives Report are:

1. To identify the potential biological benefits associated with potential management alternatives, with a focus on rainbow trout/steelhead and other native fishes;

2. To evaluate the management implications of the identified alternatives;

3. To identify data needs, data gaps, and additional studies that may be needed to evaluate the biological benefits and the feasibility of the management alternatives; and

4. To develop and recommend a prioritized list of management alternatives in order to help focus and prioritize future investigations.

1.3 Adaptive Management Strategy

The final management plan that will be developed will consist of a suite of various management actions. An adaptive management strategy is recommended to allow the management plan to adapt to changing conditions and new information developed through the ongoing SYRTAC studies to take advantage of opportunities that may arise for habitat protection and improvement that may arise.

This strategy will take into account the annual and interannual variation in hydrologic conditions and water supply availability in the Santa Ynez River basin. For example, in years when precipitation, runoff, and storage are high, acceptable habitat conditions can be extended further downstream in the mainstem Santa Ynez River. In years when available water supplies are low, acceptable mainstem habitat can be maintained in a reduced geographic area. Understanding this backdrop of variable water availability will be critical to selection and implementation of beneficial and feasible actions.

1.4 Organization of the Report

The report includes the following sections:

2.0 *Hydrology of the Santa Ynez River Basin*

Overview of the hydrology of the Santa Ynez River and its tributaries

3.0 *Potential Management Alternatives*

Description of each alternative and potential biological benefits, assessment of available data that can be used to evaluate the benefits and feasibility, identification of data gaps that hinder assessment of the alternative, and recommendations to address data gaps.

4.0 *Screening and Ranking of Management Alternatives*

Evaluation of each management alternative.

5.0 *Promising Alternatives for Further Development*

Overview of the most promising management alternatives, organized into suites of related actions.

2.1 PURPOSE

The purpose of this section is to provide hydrologic information for the Santa Ynez River watershed. This section focuses on information intended to assist in a better evaluation of the fish management alternatives. More detailed descriptions of the general hydrology of the Santa Ynez River may be found in other publications.

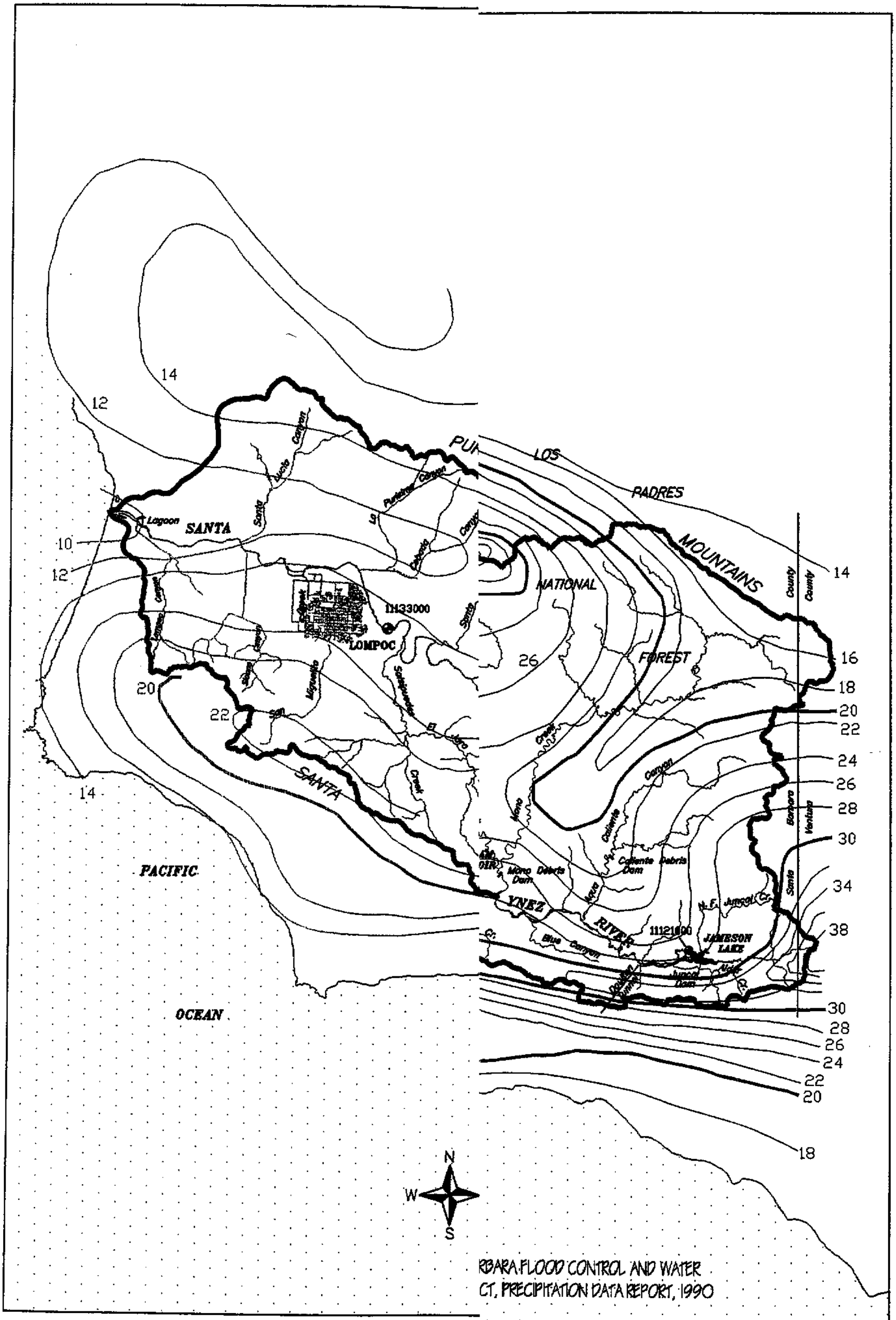
2.2 GENERAL DESCRIPTION OF SANTA YNEZ RIVER WATERSHED HYDROLOGY

The Santa Ynez River watershed, located in the central part of Santa Barbara County, California, is about 900 square miles in area. The Santa Ynez River, its tributaries and drainage boundary are shown in Figure 2.1 This figure also shows water development features in the Santa Ynez River basin.

The Santa Ynez River originates in the San Rafael Mountains in the Los Padres National Forest, at an elevation of about 4,000 ft. near the eastern border of Santa Barbara County. A small portion of the Santa Ynez River watershed lies within Ventura County. The river flows westerly about 90 miles to the ocean, passing through Jameson Lake, Gibraltar Reservoir and Lake Cachuma. The terrain on the south side of the river rises steeply to the crest of the Santa Ynez Mountains. These mountains range in elevation from about 2,000 to 4,000 ft. and separate the Santa Ynez River basin from Santa Barbara and the South Coast. The north side of the basin is formed by the Purisima Hills and San Rafael Mountains, which range in elevation from 4,000 to 6,000 ft. Immediately upstream from Lake Cachuma, the river passes through a narrow trough between the mountains. Below Lake Cachuma, the river passes along the southern edge of the Santa Ynez Upland and flows past the broad part of the valley near Buellton. West of Buellton it flows through a narrow meandering stretch to the Lompoc Narrows and emerges onto the broad, flat Lompoc Plain. The river flows through the Lompoc Plain for about 13 miles before it empties into the Pacific Ocean at Surf. The gradient of the Santa Ynez River ranges from 25 to 75 ft. per mile in the upper watershed to a gently sloping coastal plain in the lower watershed. As a result of these gradient changes, the Santa Ynez River is characterized by both narrow channel sections on bedrock and broad alluvial floodplains of more than 1,000 feet wide near Solvang and Lompoc. Near Bradbury Dam, the river is approximately 40 ft. wide. Farther downstream, near the confluence with Alamo Pintado Creek, the river is more than 400 ft. wide.

2.2.1 CLIMATE

The Santa Ynez River Basin has a Mediterranean climate characterized by hot, dry summers and cool, wet winters. Temperature varies from 23°F (-5°C) to 115°F (46°C), with an average of 60°F (15°C) (USBR). Almost all precipitation occurs between November and April, with



Lagoon
SANTA
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PACIFIC
OCEAN
SANTA
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NATIONAL
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Mono Debris Dam
Caliente Debris Dam
Blue Canyon
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JAMESON LAKE
Juncal Dam
N. F. Juncal Cr.
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large variations in annual amounts occurring between years. For example, near Lake Cachuma, precipitation has ranged from 11 inches (winter 1923 -1924) to 66 inches (winter 1940-1941). Average annual rainfall ranges from approximately 14 inches near the Pacific Ocean to approximately 30 inches at Juncal Dam, with higher amounts in the headwater areas resulting from orographic effects. Table 2.1 shows some of the regional locations of precipitation information with respective annual averages. Figure 2.2 shows isohyetal lines for precipitation within the watershed.

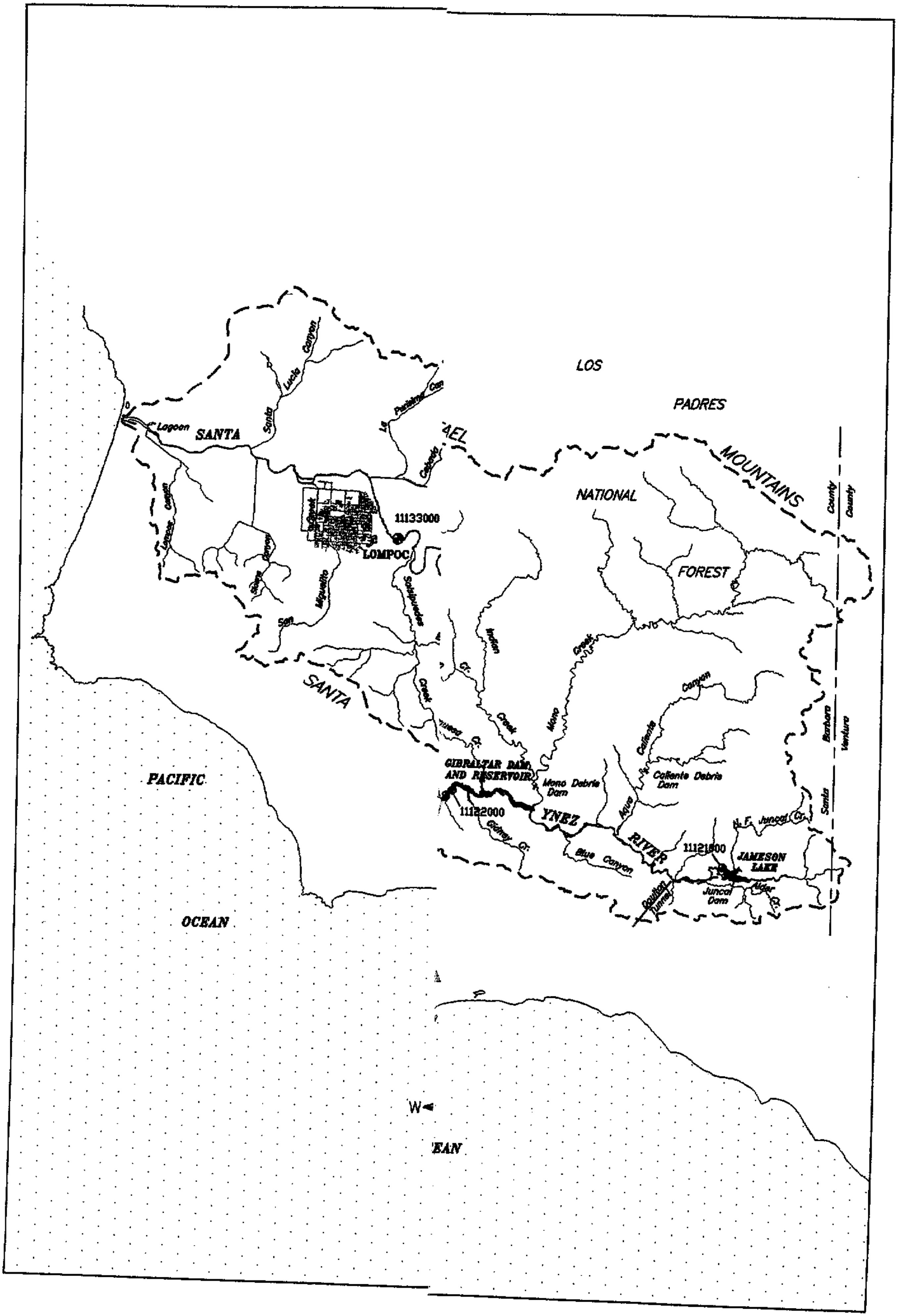
Table 2-1. Monthly Precipitation Data at Selected Stations in the Santa Ynez Valley.

Location	Period of Record	Annual Average (in)
Santa Barbara	1868-1993	17.99
Lompoc Water Treatment Plant	1951-1993	14.09
Salsipuedes Creek gaging station	1942-1993	16.76
Buellton Caltrans	1963-1993	15.63
Santa Ynez Fire Station	1949-1993	14.99
Los Alamos	1910-1993	15.25
Cachuma Dam (sic)	1951-1993	19.30
Los Prietos Ranger Station	1943-1993	21.98
Gibraltar Dam	1920-1993	25.94
Juncal Dam	1926-1993	29.02

(Santa Barbara County Flood Control and Water Conservation District 1993)

Weather modification, in the form of cloud seeding to augment natural precipitation within winter storms, has been applied intermittently in Santa Barbara County during the majority of the winter seasons since 1950. Since 1981, the cloud seeding program in the county was conducted on an ongoing basis. Prior to that time, Santa Barbara County Water Agency (Agency) retained North American Weather Consultants (NAWC) to conduct a study of cloud seeding potential. This study was focused on the watershed above Lake Cachuma. Statistical studies performed by NAWC allowed them to draw the conclusions that natural precipitation above Jameson Lake and Gibraltar Reservoir could be increased, through cloud seeding efforts, up to approximately 20 percent during the October through April period. Winter storms are presently being seeded in various parts of Santa Barbara County depending on hydrologic, watershed, and reservoir storage conditions. Because the watershed of the Santa Ynez River is one of the principal target areas of the program, cloudseeding directly benefits fish through augmentation of streamflow.

The longest period of record for Santa Barbara County is for the gage in the City of Santa Barbara which dates from 1868. This record has been compared to gage records in the Santa Ynez Valley and shows similar trends, although the average precipitation at Santa Barbara is somewhat higher than the average precipitation reported for similar elevations in the Santa Ynez Valley. The Santa Barbara gage is useful in providing a longer trend in precipitation for the region. Figure 2.3 shows the departure from the mean for the entire period of record.



LOS
PADRES
NATIONAL
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MOUNTAINS
SANTA
Lagoon
Santa Lucia Canyon
La Purisima Can
Cebada
11133000
LOMPOC
Salsipuedes
Miguelito
San
Indian
Cr.
Creek
Mono
Creek
SANTA
Creek
Cr.
GIBRALTAR DAM AND RESERVOIR
Mono Debris Dam
11122000
Gidney Cr.
YNEZ
RIVER
Blue Canyon
Agua
Caliente
Canyon
Caliente Debris Dam
N. F. Juncal Cr.
11121000
JAMESON LAKE
Juncal Dam
Alder Cr.
County
County
Santa
Barbara
Ventura
PACIFIC
OCEAN
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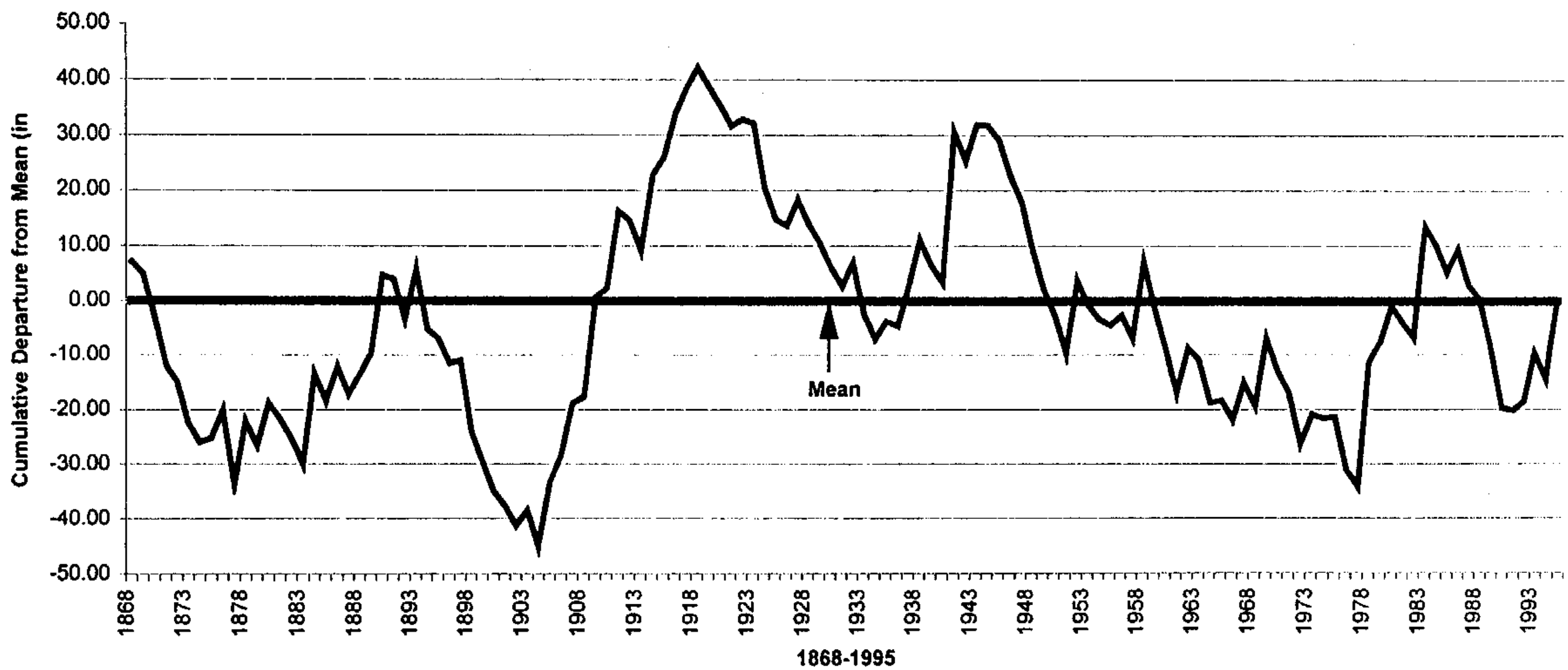


Figure 2-3. Precipitation Cumulative Departure from Mean City of Santa Barbara Precipitation, 1968-1995.

This is an update of an analysis done in the mid 1960's in an investigation of groundwater resources of the Santa Ynez Valley (LaFreniere and French, 1968). LaFreniere found that precipitation occurred in wet and dry periods that were not random, but the periods have no dependable cycle to them. At the time of this analysis in 1964, LaFreniere suggested that the Santa Ynez River watershed might be in the midst of a long dry period.

Looking at Figure 2.3, it appears that LaFreniere was correct. The dry period appears to have bottomed out in 1977. Depending on the interpretation of the following years, the Santa Ynez River watershed has experienced a short wet period followed by a short dry period and it may now be in a building wet period; or the area may be in a longer wet period that happened to have a severe drought. It is clear from Figure 2.3 that one can distinguish wet and dry periods that are clumped together in a nonrandom manner and that precipitation since the 1977 low has been above average even with the 1986-91 drought. Certainly, the period since the start of the fishery investigations has been wetter than average.

2.2.2 Streamflow

Streamflow in the Santa Ynez River watershed is derived primarily from surface runoff and shallow groundwater inflow following storm events, which vary greatly in frequency and intensity from year to year. The soils, geology, and topography of the watershed create relatively rapid runoff conditions, with streamflow hydrographs showing a rapid rise and fall in response to precipitation. As a result, the Santa Ynez River is characterized as a "flashy" system, with intermittent surface flow conditions.

Several major tributaries downstream of Bradbury Dam contribute significant flows to the lower Santa Ynez River, including Santa Agueda, Alamo Pintado, Zaca, Alisal, Salsipuedes, and San Miguelito Creeks (Santa Barbara County Flood Control and Water Conservation District 1992 and Jones and Stokes Associates, 1997). Figure 2.1 shows the locations of these tributaries.

When water rights releases are made in the summer months, there are mainstem flows downstream of Gibraltar and Cachuma Reservoirs. In addition, the treated effluent from the Lompoc Regional Wastewater Treatment Plant creates almost continuous flow conditions in the river year round from the facility to the ocean. This facility, constructed in 1974 to replace an older facility, discharges up to 3.5 million gallons per day (up to 5.4 cfs). The flow from the WWTP is about 3.5 cfs.

The Santa Ynez River watershed has a significant amount of streamflow data available; much of it, however, for limited periods. There are several gages active within the watershed and many more locations where streamflow data has been systematically collected over the years. Tables A-1 and A-2 in the appendix show compilations of the many gaging sites within the watershed. These tables have concentrated on data published by the U.S. Geological Survey but also show information collected by the City of Santa Barbara and the U.S. Bureau of Reclamation. Tables 2.2 and 2.3 show annual discharge at selected main stem sites and all tributaries below the dam with more than ten years of record. The data from these gages demonstrate the year to year variability in streamflow within the watershed.

Table 2-2. Annual Flow at Selected Locations in the Santa Ynez River, 1908-1996.

Values in acre feet

Water Year	SYR b. Gibraltar	SYR@ Los Laureles Cyn	SYR@ Santa Ynez	SYR@ Solvang	SYR@ Narrows	SYR nr Lompoc
1908	17,800					221,952
1909						881,378
1910						114,597
1911						533,010
1912	18,900					50,402
1913	17,000					47,413
1914	137,000					545,788
1915	43,900					395,857
1916						258,278
1917	44,500					137,387
1918	84,200					320,382
1919						60,300
1920						43,500
1921	907					16,800
1922	62,784					19,500
1923	5,815					13,000
1924	713					53,000
1925	308					73,000
1926	35,721					90,188
1927	23,726					151,749
1928	2,024					30,797
1929	448			7,698		9,770
1930	407		3,110	6,610		5,781
1931	298		0	3,183		2,384
1932	31,514		0	110,442		142,046
1933	4,186		11,600	17,217		17,629
1934	13,412		17,160	21,468		24,167
1935	26,877		42,230	55,043		56,837
1936	18,044		30,740	40,499		40,818
1937	68,561		156,830			209,037
1938	136,185		273,250			352,394
1939	8,360		18,700			32,858
1940	3,309		10,460			20,610
1941	217,370		475,120			652,340
1942	14,277		32,580			67,314
1943	86,462		183,820			231,881
1944	44,995		80,820			118,364
1945	16,578		39,450			50,695
1946	18,599		34,120			38,975
1947	6,262		10,670	14,922		13,952
1948	24	59	0	2,404		50
1949	23	385	420	2,804		2,037
1950	38	338	1,550	3,223		0
1951	41	12	0	1,492		
1952	85,486	123,884	198,260	238,117		261,811
1953	7,983	8,502	8,870	13,422	20,491	18,913
1954	9,240	11,683	3,560	8,401	5,832	5,580
1955	84	930	2,600	4,198	2,061	1,650
1956	3,483	9,778	1,900	12,137	28,754	28,866
1957	71	1,889	2,890	3,349	1,459	1,111
1958	123,611	164,827	44,000	91,635	139,990	140,173
1959	4,501	7,331	5,530	10,355	16,935	16,516
1960	2	55	3,180	3,153	1,568	1,261
1961	0	9	650	625	332	
1962	46,260	83,069	24,790	49,079	87,886	
1963	74	1,074	1,450	3,568	9,523	
1964	53	218	2,320	1,061		
1965	1,478	4,873	7,110	5,886	4,977	
1966	65,317	70,398	2,800	16,929	29,241	
1967	123,470	146,250	139,040	148,680	181,692	
1968	1,403	2,793	6,690	5,186	5,701	
1969	316,372	401,123	482,510	548,779	617,713	
1970	13,611	21,007	4,050	4,411	8,495	
1971	19,485	24,883	12,550	9,446	7,422	
1972	687	4,718	6,810	4,383	3,177	
1973	68,781	116,509	34,310	48,096	80,769	
1974	18,325	28,040	7,180	10,703	20,404	
1975	26,265	37,675	21,030	34,491	61,854	
1976	481	2,383	4,710	2,312	3,977	
1977	162	717		1,006		
1978	195,116	256,104		327,540	391,552	
1979	34,562	44,055		54,348	70,180	72,647
1980	86,840	114,028		196,284		189,105
1981	4,868	11,108		10,688	20,243	
1982	11,905	15,978		3,816	6,447	
1983	236,488	316,850		511,215	503,622	
1984	23,528	23,762		24,859	34,107	
1985	24	1,118		2,677	3,101	
1986	56,159	53,523		12,297	30,108	
1987	70	48		1,853	5,213	
1988	96	2,431		4,119		
1989	0	61		1,758	32	
1990	0	21		828	0	
1991	31,098	36,821		12,381	20,896	
1992	90,978	122,443		40,134	62,090	
1993	216,790	292,163		364,086	391,525	
1994	3,322	4,852		4,734	7,869	
1995	119,000	176,818		269,191	244,720	
1996	5,778	8,598		7,865	12,515	

Table 2-3. Annual Flow at Selected Santa Ynez River Tributaries and Alisal Reservoir Storage, 1929-1996.

Values in acre feet, except as noted
Alisal Reservoir storage is as of September 30 of each water year.

Water Year	Santa Aqueda Creek	Alamo Pintado Creek	Alisal Creek	Alisal Reservoir (AF)	Zaca* Creek	Salsipuedes Creek	Miguelito Creek
1929		140	1,241			1,956	
1930	87.1	170	421			845	
1931	78	175	0			420	
1932							
1933							
1934							
1935							
1936							
1937							
1938							
1939							
1940							
1941	18,176						
1942	1,548				97	10,652	
1943	6,632				922	10,701	
1944	4,150				462	8,874	
1945	1,980				26	2,267	
1946	1,140				20	1,787	
1947	558				3	870	
1948	134				0	402	
1949	141				47	1,707	
1950	161				23	1,281	
1951	116				1	326	
1952	6,376				1,093	16,871	
1953	515				17	4,633	
1954	375				3	2,406	
1955	150		653		7	1,319	
1956	1,206				76	15,610	
1957	172		906		3	1,247	
1958	10,687		15,751		2,321	23,567	
1959	317		1,727		29	2,620	
1960	30		295		7	1,416	
1961	92		85		2	686	
1962	3,902		10,892		2,078	22,199	
1963	45		1,586		25	5,329	
1964	0		101		1	931	
1965	191		1,314		5	2,720	
1966	864		8,352		11	9,476	
1967	4,405		6,506		755	6,708	
1968	34		132		1	777	
1969	18,602		20,779		6,683	20,520	
1970	444		198		19	1,814	
1971	337	4	95		6	1,182	172
1972		0	112	756	2	517	108
1973		173		2,270	611	15,656	1,737
1974		60		2,260	56	5,316	833
1975		107		2,300	122	13,775	1,641
1976		4		2,240	23	1,518	361
1977	6	6		2,180	11	597	124
1978		2,220		2,360	3,686	36,228	3,673
1979		89		2,230	185	8,414	1,097
1980		998		2,240	886	14,985	1,939
1981		166		2,180	349	5,065	916
1982		22		2,210		1,612	544
1983		4,507		2,350		36,853	5,766
1984		556		2,040		3,355	974
1985		390		2,090		1,165	687
1986				2,180		10,290	
1987				2,120		1,613	
1988				2,090		889	511
1989				1,690		207	142
1990		0		1,230	0	125	162
1991		1,079		2,080	588	4,424	855
1992		1,894		2,090	1,760	6,682	685
1993				2,210		17,026	1,706
1994				2,060		1,384	356
1995		3,859		2,180	2,821	29,421	5,019
1996		1,139		1,980	289	1,821	1,080

The data from these gages also demonstrate the ephemeral nature of streams within the watershed, with high flows available in the winter from winter storms and the likelihood of low or no flows in the summer. Figure 2.4, Santa Ynez River flows at Narrows and near Lompoc, 1908-1953 and Figure 2.5, Santa Ynez River at Narrows, 1954-1993 show the average and monthly flows in the Santa Ynez River flow at the Narrows (earlier data is from a gage a small distance downstream nearer to the City of Lompoc). These charts demonstrate the seasonal nature of streamflow in the river that exist now and prior to the construction of the Cachuma Project. Please notice that the scales for both charts are logarithmic and that the average and median values differ by approximately an order of magnitude. The very big years affect the average in all months and typical years are much lower in flow than average years.

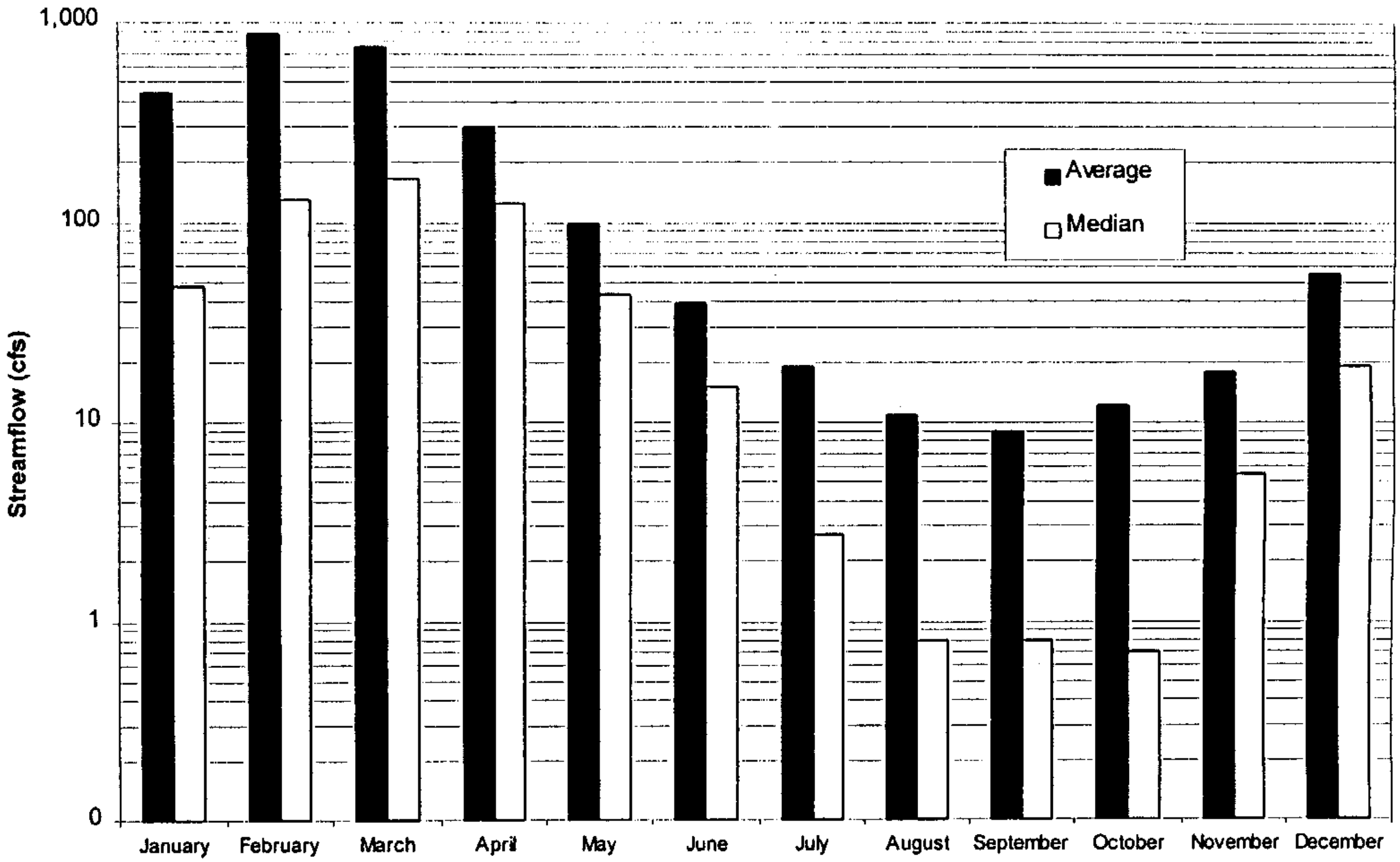
As can be seen from these figures, during summer and fall months, the flows are significantly reduced. The median flows for the period from August through November are generally reduced to zero. That is to say, the river flows are practically nonexistent for 50 percent of the time in months of August through November. Similar charts could be constructed for other locations on the mainstem and its tributaries. Generally average and median flows are less as one moves upstream along the mainstem of the Santa Ynez River. Flows in the tributaries are flashier as the watersheds become smaller. The upper reaches of these tributaries may maintain flow much longer than the lower reaches where the gages are located. Many of these upper reaches may maintain flow or pools perennially.

2.3 DAMS ON THE SANTA YNEZ RIVER

Three water supply reservoirs are located on the Santa Ynez River: Jameson, Gibraltar, and Cachuma (see Figure 2.1). All of the reservoirs are used for water supply and are not designed for flood control purposes. The characteristics of each reservoir are described briefly in the following sections.

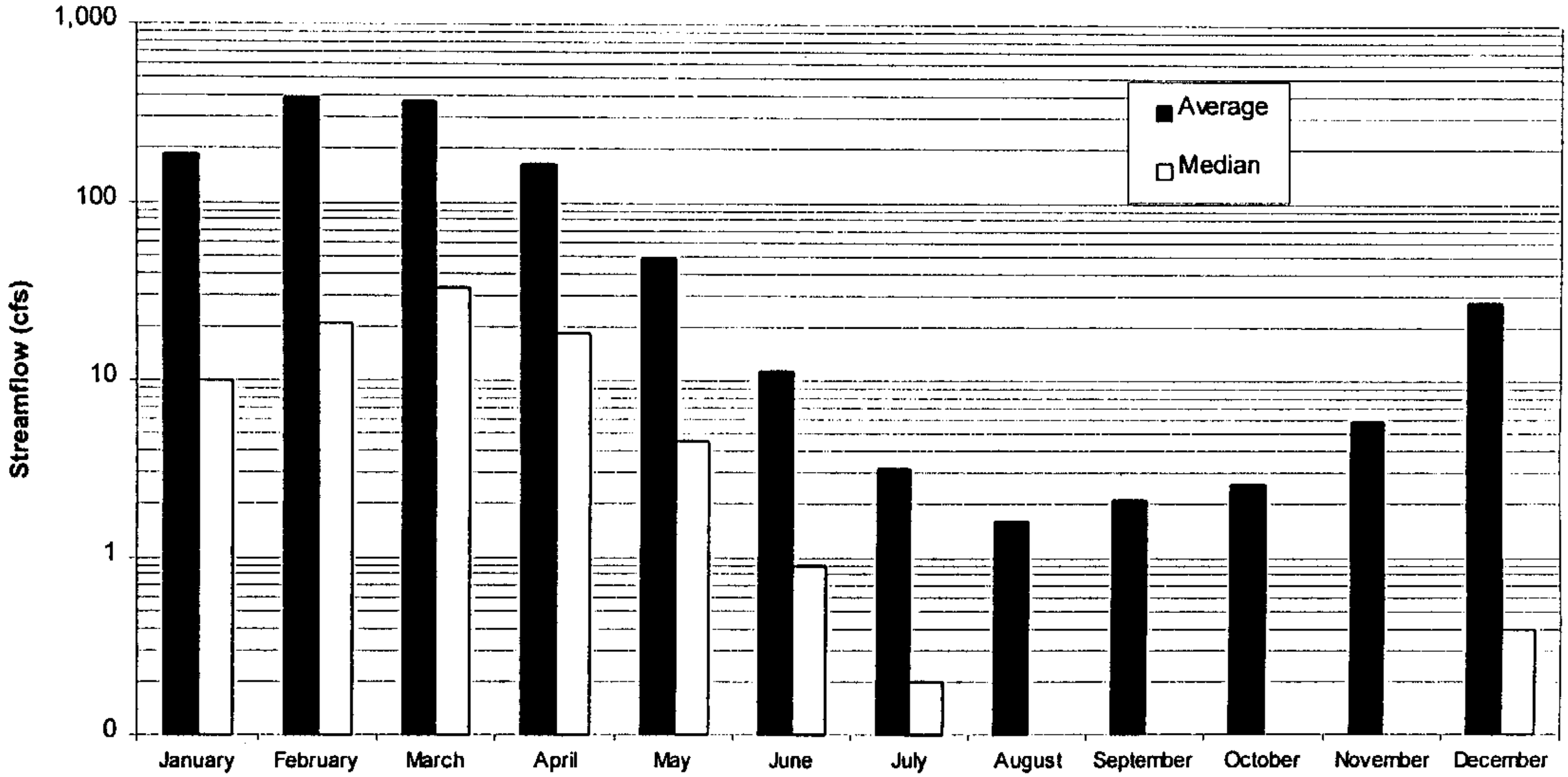
2.3.1 JAMESON RESERVOIR

Jameson Reservoir was formed by the construction of Juncal Dam in 1930. Juncal Dam is a 160 foot high concrete arch located about 88 river miles from the Pacific Ocean (see Figure 2.1). The dam has a crest length of 447 ft. at an elevation of 2,230 ft., MSL. The spillway is an overflow weir located mid-arch six feet below the dam crest which bridges the weir dividing it into twenty two 9.2 ft. bays, giving a total spillway width of 202 ft. The watershed area above Juncal Dam is approximately 14 square miles. Alder Creek is a tributary to the Santa Ynez River located south of Jameson Lake and flowing into the river at a point downstream from Juncal Dam. A portion of the runoff from Alder Creek is diverted via a flume to Jameson Reservoir. In 1994, the storage capacity of the reservoir was 5,235 acre feet, reduced from the original capacity of 7,228 acre feet by siltation. The water surface area of the full reservoir (elevation 2224 ft.) as surveyed in 1994 is 128 acres. The reservoir is owned and operated by Montecito Water District and diversions to the South Coast are made through the 2.14-mile long Doulton Tunnel. In addition, a portion of the water from Fox Creek, a downstream tributary to the Santa Ynez River, is diverted into the tunnel.



Average	443	872	756	301	99	39	19	11	9	12	18	56
Median	48	132	164	125	44	15	2.7	0.8	0.8	0.7	5.5	19

Figure 2-4. Average and Median Daily Flows for Each Month, 1908-1953 Santa Ynez River at Narrows or Near Lompoc.



Average	185	390	371	164	48.7	11.4	3.2	1.6	2.1	2.6	539	27.5
Median	10	21	33	18.5	1.5	0.9	0.2	0	0	0	0	0.4

Figure 2-5. Monthly and Median Daily Flow for Each Month, 1954-1993 Santa Ynez River at Narrows.

Currently, the long-term yield of the reservoir with a draft of 2,000 AFY is estimated to be about 1,800 AFY. Tunnel infiltration plus Fox Creek diversions provide an average supply of about 500 acre feet per year in addition to the reservoir yield. Table 2.4 shows a summary of Jameson Reservoir operations.

2.3.2 GIBRALTAR RESERVOIR

Gibraltar Dam and Reservoir was constructed by the City of Santa Barbara in (the City) 1920 73 river miles from the Pacific Ocean (see Figure 2.1). Gibraltar Dam is a 180 ft high concrete arch with a crest length of 600 ft. and a crest elevation, at the top of a continuous parapet, of 1405.3 ft, MSL. The crest walkway elevation is 1401.8 ft, MSL. The spillway is adjacent to the south abutment of the concrete arch, which is on a rock ridge, and has five gates for the release of water. An intake tower is located on the upstream face of the main concrete arch with openings at selectable elevations allowing diversion of lake water into a 48-inch conduit which conveys water into a 900-ft. tunnel through the south abutment.

From the tunnel outlet water is conveyed to a downstream release outlet and to a 36 inch pipeline into the north portal of Mission Tunnel about one half mile down river from Gibraltar Dam. The outlet works for downstream releases allows releases of up to 15 cfs into the Santa Ynez River through a weir box.

Watershed area above Gibraltar Dam is approximately 216 square miles; the southeast fourteen square miles of which are located above Juncal Dam. In 1995, the reservoir capacity was 7,634 acre feet with a corresponding surface area, when full, of 248 acres. Diversions from Gibraltar Reservoir to the City of Santa Barbara are made through the 3.7 mile long Mission Tunnel. In addition, some water from Devils Canyon Creek, a downstream tributary to the Santa Ynez River, is diverted into the tunnel. Currently, the long-term average yield of the reservoir with a draft of 5,000 AFY is estimated to be about 4,600 AFY. Tunnel infiltration produces an average additional supply of about 1,100 acre feet of water per year.

The City of Santa Barbara's diversions from Gibraltar Reservoir were defined by the 1930 *Gin Chow* California Supreme Court decision. This decision allowed the City to annually divert from Gibraltar Reservoir 4,189 AF of ordinary inflow and up to 14,000 AFY when including flood and freshet flow. It also requires the City to release up to 616 AF of summer inflow. The City and other Santa Ynez River water users entered into the 1989 Upper Santa Ynez River Operations Agreement (USYROA, also known as the "Pass Through Agreement") which resolves a number of issues regarding the interpretation of Gin Chow. The goals of the agreement were to allow the City to maintain yield from its Gibraltar water rights in the face of reservoir sedimentation while preventing impacts on the Cachuma Project and other downstream interests.

Two modes of operation ("mitigation" and "pass through") are defined in the agreement. "Mitigation" mode requires the City to declare a maximum annual Gibraltar diversion level of up to 8,000 AFY and to mitigate any reduction in the average long-term annual yield of the downstream Cachuma Project that is estimated to result from that level of diversion.

Table 2-4. Summary of Jameson Reservoir Operations, 1931-1996 (acre feet/year).

Water Year	End-of-Year Storage	Diversion to Doulton Tunnel	Spill	Reservoir Evaporation	Precipitation on Reservoir	Computed Inflow
1931	36	217	0	33	12	274
1932	4,791	258	0	449	122	5,330
1933	4,922	1,121	0	509	181	1,590
1934	5,626	1,156	0	548	254	2,160
1935	6,123	912	828	509	345	2,400
1936	5,594	1,360	441	555	286	1,540
1937	6,486	980	7,726	549	469	9,680
1938	6,748	696	15,164	527	584	16,200
1939	5,686	1,491	883	475	260	1,530
1940	4,790	1,400	0	437	192	760
1941	7,134	554	19,870	445	729	22,500
1942	6,130	1,032	2,131	442	245	2,350
1943	6,464	1,120	9,694	404	464	11,080
1944	6,049	1,231	3,992	460	358	5,180
1945	5,664	1,566	1,155	535	310	2,570
1946	6,103	1,149	1,814	497	362	3,550
1947	4,186	2,277	0	468	241	1,360
1948	2,645	1,472	0	353	102	277
1949	1,697	1,088	0	267	97	310
1950	1,545	505	0	244	99	498
1951	1,046	424	0	225	50	100
1952	6,265	548	5,771	448	401	11,585
1953	5,357	1,223	0	496	198	614
1954	5,265	1,201	0	447	256	1,300
1955	3,934	1,464	0	390	211	312
1956	3,031	1,553	0	301	199	752
1957	1,252	2,209	0	225	122	533
1958	6,168	909	7,622	381	386	13,442
1959	4,827	1,985	339	441	223	1,201
1960	2,607	2,117	0	336	134	99
1961	847	1,557	0	202	74	0
1962	5,531	1,096	521	380	256	6,425
1963	4,324	1,142	0	327	216	76
1964	2,768	1,796	0	303	166	377
1965	2,066	1,676	0	237	161	1,050
1966	5,071	2,004	2,946	388	252	8,091
1967	6,133	1,286	7,264	381	542	9,451
1968	4,658	2,259	0	364	143	1,005
1969	5,364	2,572	30,424	356	946	33,112
1970	4,343	2,583	119	415	193	1,903
1971	4,336	2,192	0	370	253	2,302
1972	3,509	1,577	0	321	156	915
1973	5,475	1,121	10,857	347	456	13,835
1974	5,390	1,080	2,050	365	324	3,086
1975	5,550	1,133	2,266	340	370	3,529
1976	5,500	866	637	340	267	1,526
1977	4,380	1,340	0	306	184	342
1978	6,010	881	21,984	572	749	24,318
1979	5,250	1,843	4,098	544	367	5,358
1980	4,970	1,892	9,345	425	411	11,321
1981	3,350	2,082	866	476	187	1,617
1982	3,120	1,589	0	398	198	1,559
1983	5,500	1,011	19,428	398	623	22,594
1984	4,160	1,929	2,124	533	182	3,064
1985	2,790	1,650	0	549	141	688
1986	4,970	1,160	5,621	433	304	9,090
1987	3,540	1,649	50	469	66	672
1988	4,140	1,493	0	483	241	2,335
1989	2,850	1,572	0	407	138	551
1990	1,570	1,310	0	281	101	212
1991	5,220	1,002	994	324	132	5,838
1992	5,290	1,060	11,060	512	479	12,223
1993	5,560	958	27,204	454	716	28,170
1994	3,840	1,619	725	393	232	1,542
1995	4,890	1,343	41,581	219	756	43,537
1996	4,060	1,821	1,456	361	287	2,541

Mitigation is by relinquishment of a portion of the City's Cachuma Project entitlement. Diversions must conform to a monthly schedule. The City is currently in the mitigation mode with a declared diversion level of 5,000 AFY requiring mitigation of 67 AFY.

The "pass through" mode allows the City to take a portion of its allowable Gibraltar diversions via the Cachuma Project, to the extent that spills at Gibraltar Dam exceed the amount of spills that would have occurred under the "base" operation. The "pass through" mode is intended to be useful as the capacity of Gibraltar is reduced by siltation. The reservoir lost approximately 1,000 AF of storage from siltation during the 1995 storms. Table 2.5 shows a summary of Gibraltar Reservoir operations.

2.3.3 CACHUMA RESERVOIR

Cachuma Reservoir is the largest of the three reservoirs on the Santa Ynez River. The reservoir is formed by Bradbury Dam 48.7 river miles from the Pacific Ocean. The dam is a 205 foot high (structural height is 275 feet) earth-fill structure with a 2,975 ft. crest length set at elevation 766 ft MSL. The spillway is a broad-crested weir in the south abutment of the dam consisting of 4 bays, each with a 50 ft. wide by 31 ft. high radial gate. The gates open from the bottom and are seated in the weir invert at elevation 720 ft., MSL. The normal full operating level of the reservoir is 750 ft., MSL (with the gates fully closed). The storage capacity of Cachuma Reservoir, when constructed, was 204,874 acre feet with a surface area of 3,090 acres. Based on the 1990 silt survey, the capacity of the reservoir has been reduced to 190,409 acre feet with a corresponding surface area of 3,043 acres. The watershed area above Bradbury Dam is approximately 417 square miles, 216 square miles of which are above Gibraltar Dam. Downstream releases to the Santa Ynez River and pipeline diversions to the Santa Ynez River Water Conservation District, Improvement District No. 1 (ID#l) service area have historically been accomplished through outlet works containing the following basic features: an inlet box at elevation 600 feet in the reservoir; a 1500 ft. long, 7 ft. diameter tunnel with a 38-inch pipe running from beneath the inlet box to the outlet building on the downstream toe of the dam adjacent to the north side of the spillway stilling basin; a 30-inch delivery pipeline to ID#l from the outlet building; two 30 inch hollow-jet valves, and a 10-inch butterfly valve set at elevation 563 ft., MSL, which, when opened, direct water into the stilling basin for a downstream release.

Minor lake diversions are made directly to the County park at the reservoir. Diversions to the South Coast are conveyed through the 6.4 mile long Tecolote Tunnel completed in 1956. The diverted lake water enters the tunnel via a pentagonal intake tower, with conduit from tower to tunnel, near the south bank of the reservoir, about 3.7 river miles upstream from Bradbury Dam. Tecolote Tunnel north portal elevation is about 660 ft., MSL (south portal elevation is 650 ft., MSL). When lake levels fall near this elevation, as they did during the 1986-1991 drought, diversions to the South Coast are continued by pumping from the lake through a floating conduit into the intake tower.

In 1997 the State Water Project (SWP) water deliveries were started to ID#1 and Lake Cachuma. As part of this project, the pipeline that formerly delivered Cachuma Project

Table 2-5. Summary of Gibraltar Reservoir Operations, 1920-1996 (acre feet/year).

Water Year	End-of-Year Storage	Diversion to Mission Tunnel	Spill and Release	Reservoir Evaporation	Precipitation on Reservoir	Computed Inflow
1920	10,237	908	205	566	0	112
1921	12,659	1,921	907	1,907	540	6,616
1922	12,732	2,210	62,764	2,300	1,189	65,716
1923	11,517	2,155	5,716	1,803	606	10,457
1924	7,783	4,189	713	1,228	232	2,156
1925	6,235	3,708	308	915	287	3,077
1926	11,531	3,333	35,721	1,260	820	44,990
1927	11,448	3,677	23,726	1,786	754	28,354
1928	10,267	4,069	2,024	1,695	491	6,076
1929	8,347	3,885	448	1,173	382	3,203
1930	5,586	4,354	407	859	290	2,568
1931	1,964	3,923	298	671	159	1,111
1932	10,379	2,774	31,514	1,008	475	44,041
1933	10,034	3,395	4,186	1,141	342	8,034
1934	7,425	3,579	9,753	1,087	402	13,258
1935	8,372	3,355	18,825	961	587	23,500
1936	7,140	3,806	11,732	1,044	419	15,297
1937	8,138	3,306	74,603	1,006	719	79,194
1938	8,995	2,776	120,023	970	888	123,946
1939	7,212	3,555	10,366	913	410	13,581
1940	6,314	4,242	4,200	938	324	8,158
1941	8,638	2,567	183,135	860	1,281	187,743
1942	6,512	3,199	19,138	843	356	21,210
1943	6,596	2,746	86,312	841	682	89,300
1944	6,618	3,278	46,938	848	516	50,563
1945	5,387	3,676	16,567	779	348	19,945
1946	5,391	4,192	18,598	775	406	23,171
1947	4,095	4,718	8,508	772	274	12,643
1948	1,712	1,986	24	569	138	58
1949	1,670	802	24	562	164	1,183
1950	3,174	550	38	653	164	2,561
1951	1,659	995	41	614	135	0
1952	14,876	2,203	85,502	1,601	1,249	101,274
1953	13,378	2,138	7,991	1,825	602	9,854
1954	12,734	3,220	9,240	1,803	718	12,901
1955	10,623	5,097	83	1,614	705	3,978
1956	11,662	6,655	3,481	1,569	668	12,654
1957	10,655	3,812	72	1,605	591	3,891
1958	12,464	5,169	123,615	1,516	1,436	130,673
1959	9,483	9,667	4,504	1,646	549	12,287
1960	4,364	6,858	17	820	274	2,302
1961	2,844	1,483	0	603	158	408
1962	10,582	6,100	46,267	1,241	897	60,449
1963	9,579	5,029	74	1,167	515	4,752
1964	7,216	3,708	53	973	321	2,050
1965	11,412	5,351	1,479	1,212	474	11,764
1966	10,879	6,488	65,316	1,637	990	71,918
1967	13,504	5,591	123,261	1,531	1,368	131,640
1968	10,578	7,226	1,403	1,563	471	6,795
1969	8,981	6,142	316,606	1,172	1,946	320,377
1970	4,393	6,978	13,615	826	442	16,389
1971	2,712	6,583	19,474	678	487	24,567
1972	3,843	7,043	687	747	257	9,351
1973	6,720	7,348	69,779	887	740	80,148
1974	5,970	7,597	18,330	1,045	513	25,709
1975	6,730	6,058	26,262	985	495	33,570
1976	5,040	6,281	481	982	350	5,704
1977	4,400	2,829	163	800	252	2,900
1978	8,330	3,508	195,120	1,002	1,297	202,263
1979	6,790	5,761	34,565	1,020	624	39,182
1980	6,720	5,661	86,846	972	758	92,991
1981	5,780	7,912	4,869	1,021	411	12,451
1982	6,750	4,997	11,905	842	433	18,281
1983	8,320	5,217	236,499	809	1,355	243,169
1984	4,620	6,942	23,528	1,010	407	27,373
1985	3,550	4,872	24	792	234	4,384
1986	6,940	4,387	56,224	958	560	64,399
1987	3,150	4,194	71	825	261	1,209
1988	4,370	5,829	96	773	346	7,572
1989	337	5,652	0	595	194	2,020
1990	0	255	0	86	4	0
1991	6,970	1,807	31,064	945	393	40,393
1992	6,940	4,657	91,015	981	835	95,788
1993	7,860	3,198	216,789	1,459	1,153	221,132
1994	6,580	4,180	6,588	1,006	330	10,164
1995	6,370	3,551	236,039	2,046	1,380	240,159
1996	6,310	3,990	11,468	1,336	408	16,327

entitlement to ID#1 was purchased and improved by the Central Coast Water Authority (CCWA) to convey SWP water into Cachuma Reservoir and through the Tecolote Tunnel to the South Coast recipients. ID#1 will no longer receive Cachuma Project water directly (except under emergency); it will receive treated SWP water in exchange for ID#1 Cachuma Project entitlement.

The SWP deliveries to Cachuma Reservoir will be pumped through the pipeline acquired from ID#1, as noted above. The CCWA pumping facility has a maximum capacity of 22 cfs. When a downstream release coincides with a SWP water delivery, CCWA expects to discharge SWP water to the river at the outlet works of Bradbury Dam. CCWA has agreed to guarantee a blend of at least 50% Cachuma water and a released water temperature of less than 18°C. These arrangements are subject to approvals by the USBR and fisheries resource agencies.

Yield and Diversions from the Cachuma Project

Under the Reclamation Act of 1939 and State water permits, the Cachuma Project is authorized to develop water for municipal, industrial, domestic, irrigation supply, with incidental recreation and salinity control purposes. The Cachuma Project provides about 65 percent of the total water supplies for the Member Units which provide water to greater than 200,000 people along the South Coast and in the Santa Ynez Valley. The Member Units include the City of Santa Barbara, Goleta, Montecito, and Carpinteria Valley Water Districts, and Santa Ynez River Water Conservation District, Improvement District #1. Approximately 38,000 acres of croplands are irrigated by water from the Cachuma Project (Woodward Clyde Consultants 1995).

The initial planning studies that supported the original Cachuma Project contract indicated that the project could deliver a safe yield of 32,000 acre-feet per year. However, these studies were performed using a hydrologic study period prior to the 1946-51 drought. Subsequent re-evaluations by Reclamation resulted in the lowering of the Project yield. Incorporating the 1946-1951 drought into the hydrologic study period resulted in lowering project yield to about 27,800 acre-feet per year. Silt surveys performed in the recent drought indicated that Lake Cachuma had lost about 15,000 acre-feet of active storage; hence, the Project safe yield was further reduced to about 24,800 acre-feet per year. Since 1992 the Member Units have been using an operational yield of 25,714 AFY that allows for some delivery shortages during periods when the reservoir storage drops below 100,000 AF.

Table 2.6 shows a summary of annual information on the Cachuma Project since its construction in 1953.

Spills and Lake Levels

There has been considerable discussion of the possibility of surcharging Cachuma Reservoir and using gravity to siphon water to Hilton Creek. These alternatives are contingent on

Table 2-6. Summary of Cachuma Reservoir Operations, 1953-1996 (acre-feet/year).

Water Year	End-of-Year Storage	Computed Inflow	Precipitation on Reservoir	Reservoir Evaporation	Estimated Spill	Diversion to Tunnel	Park Diversions	SYRWCD ID #1 Deliveries	Downstream Release*
1953	9,158	17,912	106	1,319	0	0	0	0	7,541
1954	21,749	18,955	598	2,327	0	0	0	0	4,635
1955	21,164	4,941	936	2,540	0	0	0	0	3,922
1956	38,209	24,330	1,482	4,200	0	2,118	0	0	2,449
1957	31,632	6,151	1,163	4,642	0	5,467	0	0	3,782
1958	196,889	219,129	4,459	11,210	35,738	4,850	0	0	5,060
1959	187,178	15,068	3,629	14,624	1,068	8,432	0	0	4,284
1960	163,149	2,643	2,669	13,613	0	11,410	169	0	4,149
1961	134,493	795	2,382	12,015	0	17,309	662	239	1,608
1962	190,475	100,134	4,963	12,446	21,622	11,921	402	890	1,633
1963	171,736	4,270	3,788	12,158	0	10,595	510	694	2,843
1964	141,506	2,439	2,378	11,786	0	17,352	447	1,504	3,898
1965	122,308	12,314	3,043	10,204	0	14,909	182	1,837	7,423
1966	168,926	79,352	3,707	12,524	0	17,522	345	2,129	3,862
1967	191,622	208,961	5,774	12,683	138,587	14,155	246	2,575	23,789
1968	160,871	10,404	2,414	13,524	0	18,199	357	3,669	7,820
1969	190,181	526,726	9,727	12,305	468,143	15,031	240	2,597	7,467
1970	176,407	27,967	1,793	13,525	0	20,689	335	4,115	4,888
1971	161,345	31,045	3,497	12,239	0	22,800	357	3,115	11,028
1972	121,314	8,754	2,231	11,454	0	28,162	167	4,471	6,769
1973	185,591	125,804	5,948	12,056	23,665	18,456	129	3,552	9,617
1974	182,039	34,023	4,112	12,677	1,405	17,805	138	3,469	5,840
1975	184,467	50,650	5,867	11,866	16,804	20,854	128	3,057	1,275
1976	145,187	5,474	3,189	11,804	0	26,020	148	4,655	5,152
1977	112,077	1,520	2,601	10,775	0	18,740	98	4,563	3,035
1978	193,424	329,219	9,573	13,535	209,494	20,701	114	3,011	10,591
1979	183,949	61,692	5,250	13,917	25,852	20,102	147	4,029	12,198
1980	187,382	153,603	6,003	13,353	105,763	22,057	139	2,483	13,189
1981	168,871	22,066	4,019	13,811	0	20,856	178	5,007	4,743
1982	159,528	26,848	3,868	11,479	0	20,956	187	2,963	4,474
1983	196,347	428,601	10,995	12,630	332,479	22,616	183	1,532	34,922
1984	171,599	39,087	3,340	14,534	12,184	25,601	193	5,054	9,679
1985	135,748	5,061	2,816	12,275	0	22,781	142	2,664	5,862
1986	171,873	76,564	4,830	12,783	0	21,689	108	2,686	8,010
1987	128,352	2,374	1,996	12,147	0	27,209	150	3,812	4,573
1988	99,150	8,732	4,092	9,794	0	23,917	102	2,803	4,911
1989	66,098	4,044	1,459	8,366	0	20,632	86	2,802	6,601
1990	34,188	2,627	909	6,019	0	16,384	66	863	4,792
1991	60,995	53,566	2,057	6,373	0	15,762	43	1,656	4,983
1992	157,066	135,828	4,022	11,239	0	18,170	52	891	13,427
1993	177,479	333,322	8,875	13,428	297,827	22,582	79	2,042	3,826
1994	151,048	16,350	4,298	12,390	0	22,772	74	1,819	10,021
1995	134,855	385,072	10,063	10,301	354,402	23,887	64	109	2,563
1996	120,503	33,240	2,653	11,614	0	24,721	76	2,119	11,715

* Downstream releases include: leakeage, miscellaneous releases, precautionary and flood control release, through outlet works, water right release and Fish Reserve Account releases.

Source: U.S. Bureau of Reclamation

appropriate reservoir water surface levels. Figure 2.6 shows the historical water surface levels at Cachuma Reservoir.

Cachuma has spilled 14 times since its completion. These spills have ranged in length from 27 days to 179 days and in magnitude from 5,300 to 467,000 AF. The 179 day spill happened during 1995 when there were operating restrictions on the reservoir; the next longest spill was 159 days. The median spill length has been 87 days. During spills it is presumed that the sand barrier at the ocean is open to fish migration. Figure 2.6 also shows the period of times that the Cachuma water surface elevation is below 720 feet (the prospective elevation of a siphon for releases to Hilton Creek). Historically that has not happened frequently, but it did occur for almost 4 years between 1988 and 1992 during the 1987 to 1992 drought.

2.4 GROUNDWATER RESOURCES DOWNSTREAM OF BRADBURY DAM

2.4.1 GROUNDWATER BASINS

Within the Santa Ynez River basin, groundwater occurs primarily in younger unconsolidated alluvial deposits or in older unconsolidated deposits. In most cases, the older and often deeper deposits are not in hydrologic continuity with the shallower alluvial deposits. Groundwater storage is generally recharged by precipitation and streamflow and provides water supply for irrigation, municipal and industrial uses through pumping. The principal sources of groundwater within the Santa Ynez River basin are (1) the Santa Ynez alluvial deposits; (2) the Santa Ynez Upland groundwater basin; (3) the Buellton Upland groundwater basin; (4) the Santa Rita Upland groundwater basin; and (5) the Lompoc area.

The Santa Ynez River traverses two groundwater basins downstream of Lake Cachuma: the Santa Ynez River alluvial deposits, located upstream of the Lompoc Narrows, and the Lompoc Plain, located downstream of the Narrows. The Santa Ynez River alluvial deposits have been divided into the Santa Ynez subarea, the Buellton subarea and the Santa Rita subarea. Along the river, groundwater occurs in the river-channel deposits and thin bodies of younger alluvium. In the Santa Ynez subarea, from Bradbury Dam to Solvang, these deposits are almost completely bordered and underlain by non-water-bearing consolidated rocks. In the Buellton subarea, from Solvang to a point about four miles downstream of Buellton, on the north side of the river channel, deposits and younger alluvium partially overlie and abut older unconsolidated deposits of the Paso Robles Formation and Careaga Sand that fill a northwest-trending structural basin. Because of extensive clay deposits in the upper portion of these older deposits, it is believed that the hydrologic continuity between the younger river channel alluvium and the older deposits is poor. The older deposits probably slowly yield water to the alluvial deposits.

The alluvial deposits along the Santa Ynez River in the Santa Rita subarea, downstream of the Buellton subarea to the Lompoc narrows, occur in very similar conditions to those in the Santa Ynez subarea, to the extent that they are essentially separated from older unconsolidated deposits by generally non-water-bearing consolidated rocks. The alluvial deposits in this subarea are generally unconfined with some local confinement.

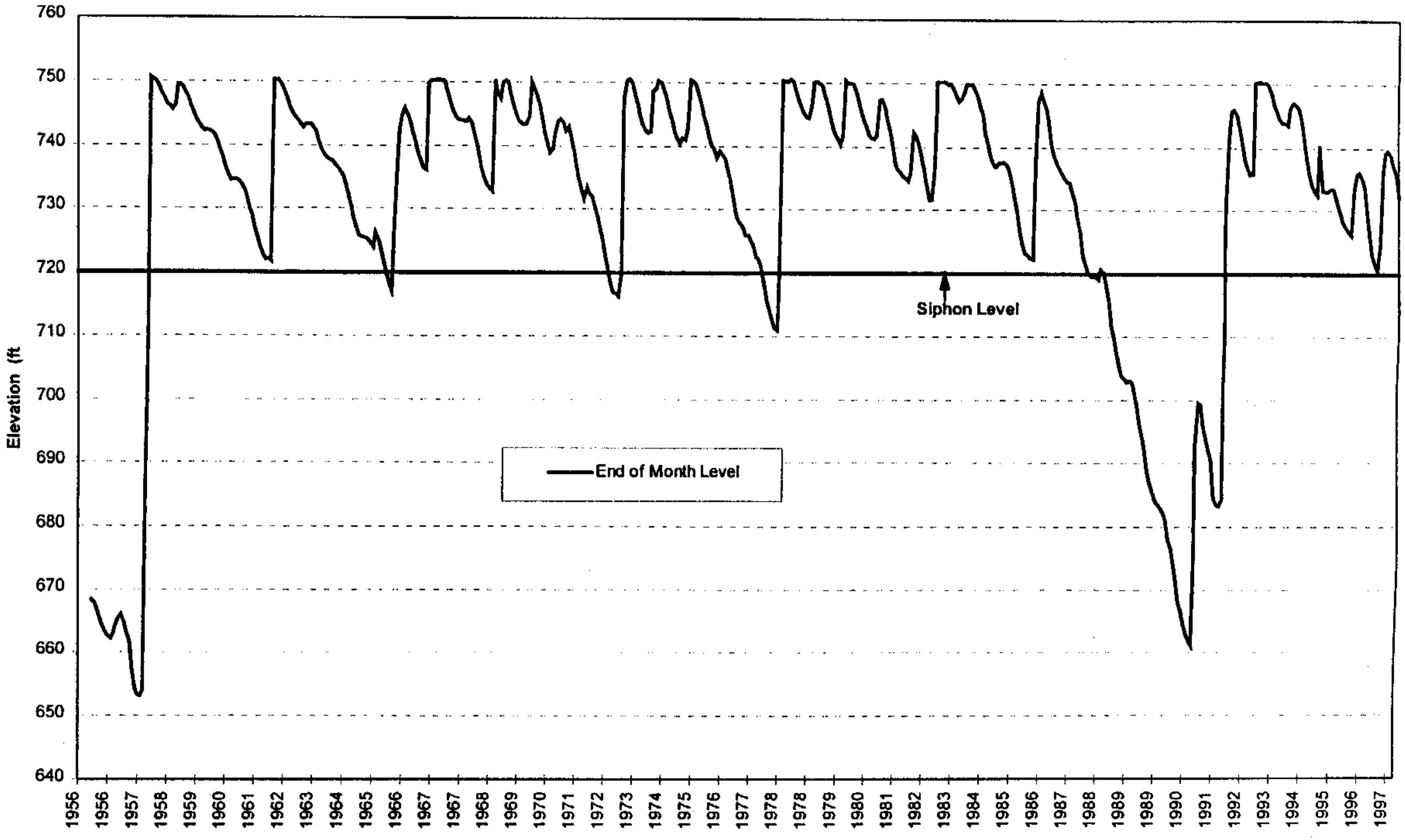


Figure 2-6. Historic Water Surface Elevation at Cachuma Reservoir.

The Santa Ynez River alluvial deposits are relatively thin, with a typical thickness of 30 to 80 feet, with local thicknesses of more than 100 feet. The storage capacity of the alluvial deposits under full water conditions is as follows:

	Acre-Feet
Santa Ynez Subarea	21,000
Buellton Subarea	27,500
Santa Rita Subarea	56,500
Total	105,000

The usable storage is significantly less than the above amounts. Replenishment to the alluvial basin is by natural seepage from the river, seepage from tributaries, return flows and releases from Lake Cachuma to satisfy downstream water rights.

The Lompoc area includes the Lompoc Plain, Lompoc Upland and Lompoc Terrace basins. Only the Lompoc Plain is directly linked to the Santa Ynez River. The Lompoc Plain basin is an alluvial filled trough cut into the south limb of the Santa Rita syncline. The principal water-bearing units beneath the Lompoc Plain are the river-channel deposits and younger alluvium that compose the upper aquifer and the Paso Robles Formation and Careaga Sand that comprise the lower aquifer.

Most of the percolation from the Santa Ynez River to the groundwater basin in the Lompoc Plain occurs between the Narrows and the Floradale Bridge. Groundwater provides 100 percent of the water supply in the Lompoc Basin (population over 50,000) and is used primarily for agricultural, municipal, industrial and military purposes.

The reported groundwater productions from the Santa Ynez River alluvium (above Lompoc Narrows) and the Lompoc groundwater basins (Plain, Upland and Terrace) for the last fifteen years are shown in Table 2.7.

2.4.2 CACHUMA PROJECT AND DOWNSTREAM WATER RIGHTS

On March 25, 1946, the USBR filed Applications 11331 and 11332 with the former State Division of Water Resources in support of the Cachuma Project. The Cachuma Project was authorized under the Reclamation Law on March 24, 1948, and was designed to conserve and place to beneficial use the floodwater runoff of the Santa Ynez River originating above the Cachuma Dam. The downstream water users viewed the proposed Cachuma Project as potentially affecting their water supply and reducing the amount of groundwater replenishment significantly.

In May 1949, the USBR and the Santa Ynez River Water Conservation District (SYRWCD) agreed on principles as a basis for releasing water from Cachuma Reservoir to protect the downstream prior rights. The principles included the following statement:

Table 2-7. Annual Reported Groundwater Production (Acre-feet).

Fiscal Year (July-June)	Santa Ynez River Alluvium	Lompoc Area
1981-82	9,729	25,163
1982-83	9,113	20,170
1983-84	10,955	21,171
1984-85	9,721	23,086
1985-86	9,923	24,551
1986-87	10,182	29,129
1987-88	8,178	28,484
1988-89	10,257	26,624
1989-90	10,014	25,930
1990-91	10,313	25,603
1991-92	11,118	25,941
1992-93	8,923	26,493
1993-94	8,429	24,408
1994-95	8,677	21,726
1995-96	8,848	21,701

The Cachuma Reservoir will be operated in such a manner as not to interfere with the flow of the Santa Ynez River whenever such flow, under natural conditions would replenish the underground water basins.

On October 7, 1949, the SYRWCD entered into the "livestream agreement" with the USBR as a method of releasing water from the Cachuma Project for the benefit of downstream prior rights. The agreement required data collection to learn about the method of release and downstream water supply for a period of ten years. The temporary agreement expired on November 16, 1962. In 1958, the State Water Rights Board extended the "livestream" operation (Decision No. D886) for another 15 years with the requirement of collecting extensive data on the Project operation and the downstream basins.

The SWRB approved Applications 11331 and 11332 in its Decision No. D886 on February 28, 1958, and ordered the issuance of permits. Permits 11308 and 11310 were issued on the applications on March 19, 1958. The permits were issued subject to vested rights and to certain terms and conditions. Included among the special conditions was a requirement for a surveillance program to extend to 1973 and for further hearings. This reserved jurisdiction was continued through a series of subsequent water rights orders.

In 1973, the SYWRCD expressed its concerns to the USBR that the "livestream" operation did not provide adequate releases to meet the water right requirements of the downstream water users. The specific concerns were that the "livestream" operation did not directly take into account the groundwater storage in the basins downstream of Bradbury Dam and it did not provide adequate flows to the reach between Bradbury Dam and the Narrows, and the Lompoc area. There was an extended period of negotiations between the SYRWCD and the USBR with the participation of South Coast Project water users. The permittee (USBR), with the concurrence of representatives of downstream water users (SYRWCD) and South Coast Project water users (Cachuma Conservation Release Board (CCRB)), submitted a new plan for the operation of Cachuma Reservoir to the SWRCB in the hearing on January 26, 1973. Subsequent to this hearing, the SWRCB issued Order WR 73-37 on July 5, 1973, amending the permit conditions. The SWRCB also extended the initial 15-year trial period for development of Cachuma Reservoir operating criteria for an additional 15 years, thus extending the reservation of jurisdiction to July 5, 1988.

The new Order (WR 73-37) was principally structured by creating two accounts, accruing credits for the Above and Below Narrows areas, in the Cachuma Reservoir. Scheduled releases from the Above Narrows Account (ANA) are made at Bradbury Dam for the benefit of downstream water users between the dam and the Lompoc Narrows. Releases from the Below Narrows Account (BNA) are delivered to the Narrows for the benefit of water users in the Lompoc basin. Depletions in conveying the BNA water from the Bradbury Dam to the Narrows are deducted from the ANA. The credits are determined based on the impairment caused by the operation of Cachuma Reservoir in the amount of natural replenishment from the Santa Ynez River downstream of the Bradbury Dam. The Above Narrows credits are calculated based on the livestream observation and groundwater depletion in the above Narrows basins. The Below Narrows credits are calculated based on constructive flows at

Narrows and constructive percolation from the Santa Ynez River in the Lompoc basin. The percolation calculations took into account the groundwater level in the groundwater forebay of Lompoc basin (the area downstream of the Highway 246 Bridge). Calculations utilized two percolation curves depending on the elevation of water level in the indicator well.

The releases under WR 73-37 enhanced the replenishment of the groundwater basins downstream of Bradbury Dam. However, the enhanced replenishment to the Lompoc groundwater basin was not fully realized. Experience during the 15-year period (1974-1988) indicated that the designated indicator well in the Lompoc forebay area did not accurately reflect the groundwater level, affecting percolation calculations for the benefit of below Narrows credits. Furthermore, the percolation potential of the Santa Ynez River in the Lompoc basin was not fully reflected by the percolation curves used under WR 73-37. In 1988, negotiations between the USBR, SYRWCD, CCRB and the City of Lompoc dealt primarily with the above issues and construction of three new monitoring wells in the Lompoc forebay. It also included the modification of constructive flow at the Narrows under certain flow conditions.

In petitioning to the SWRCB in 1989, the permittee and the parties were in agreement on amendments to Order WR 73-37. The SWRCB Order WR 89-18 issued on September 21, 1989, incorporated the amendments to Order WR 73-37, including amended Condition 6(m) for the vegetation monitoring study along the lower Santa Ynez River. The SWRCB granted a five-year continuance for the parties to analyze the data from the three monitoring wells and negotiate an agreement on the method of using the second percolation curve.

The amendments to WR 73-37, as ordered under WR 89-18, have significantly increased the below Narrows releases for the Lompoc area, thus resulting in an operation benefiting both the above and below Narrows areas. Therefore, historical releases under WR 73-37 do not represent the present release regime under WR 89-18. Tables 2.8 and 2.9 show the historic releases at Bradbury Dam for the above and below Narrows areas under WR 73-37 and WR 89-18, respectively.

2.4.3 Releases Since 1993

Since 1993 releases for fish maintenance and studies have been made from the Fish Reserve Account which was established by the 1993 Fish Maintenance and Study MOU. These releases are made outside of the downstream water right releases. No deductions are made from the Fish Reserve Account when the downstream water rights releases coincide with the scheduled fish releases. Figures 2.7 and 2.8 show the relationship in 1994 (dry year) and 1995 (wet year) among releases from Bradbury Dam, and flow near Solvang and at the Lompoc Narrows. These years are selected for comparison because water year 1994 was a dry year with no spill from Cachuma Reservoir and downstream water rights releases were made starting in July 1994. Water year 1995 was a wet year with a spill (and restricted storage in the reservoir) and no downstream water rights releases occurred.

In 1994 no spill occurred. Fish releases were made in the early summer but no flow was recorded at the Solvang gage. When the downstream water rights releases started in late July,

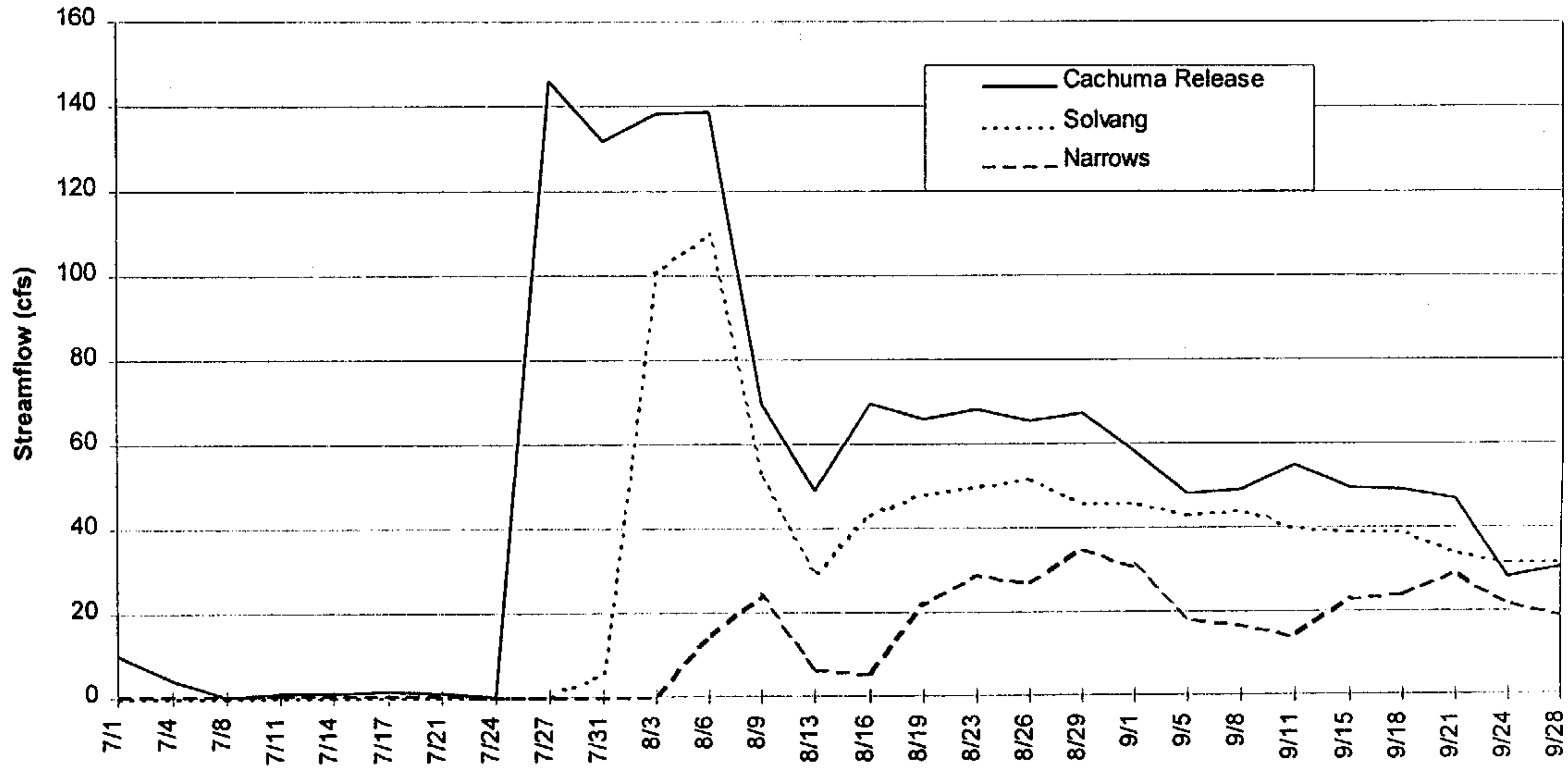
Table 2-8. Downstream Water Right Releases Under WR 73-37 by Calendar Year [1] (Acre-Feet).

Calendar Year	ANA Release	BNA Release	Total Release
1974	1,353	0	1,353
1975	1,152	0	1,152
1976	4,237	0	4,237
1977	2,299	0	2,299
1978	56	0	56
1979	1,200	0	1,200
1980	0	0	0
1981	4,175	0	4,175
1982	6,655	755	7,410
1983	0	0	0
1984	3,162	0	3,162
1985	5,686	0	5,686
1986	5,317	1,780	7,097
1987	3,887	0	3,887
1988	5,050	1,283	6,333

Table 2-9. Downstream Water Right Releases Under WR 89-18 by Calendar Year [1] (Acre-Feet).

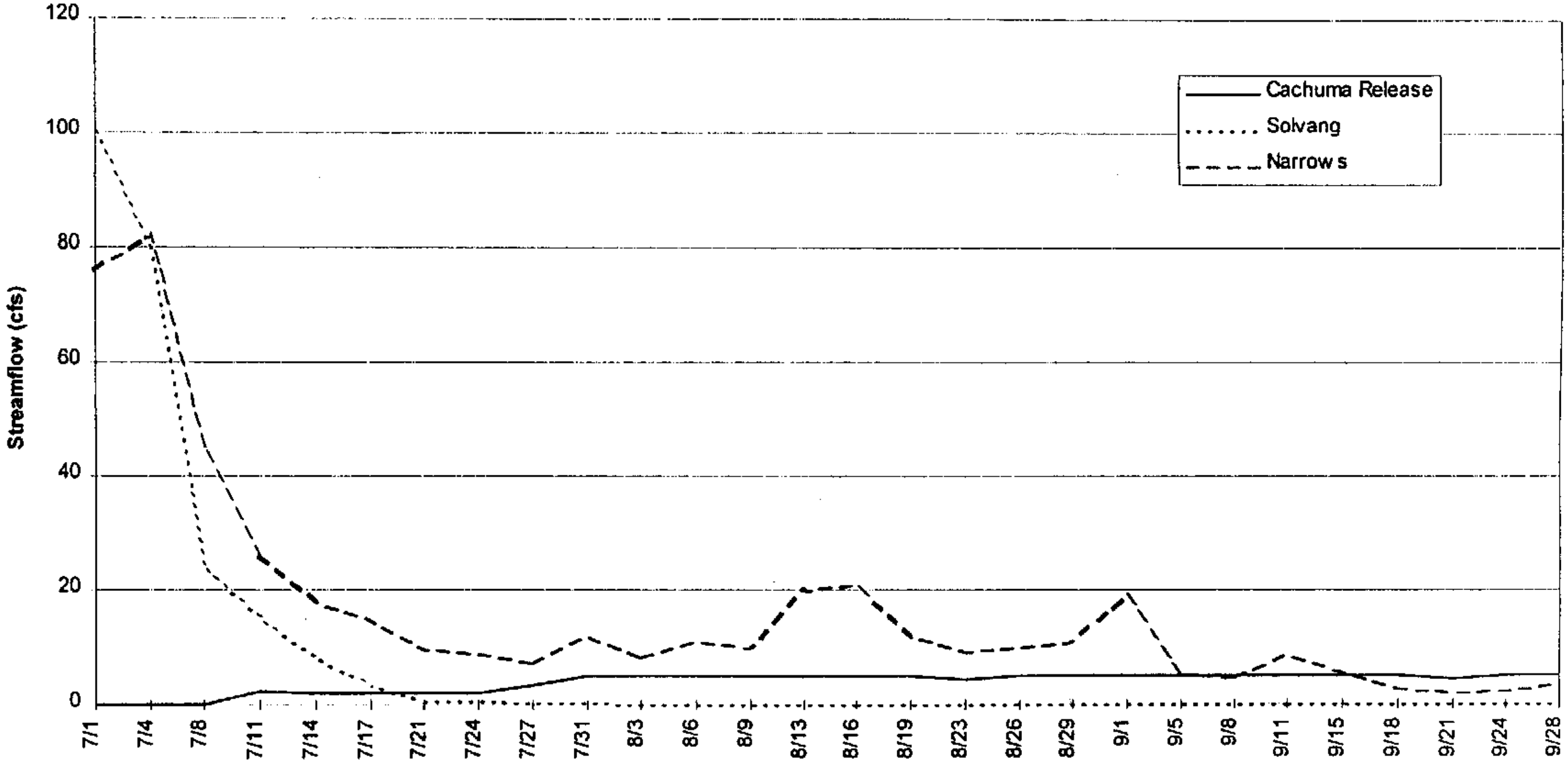
Calendar Year	ANA Release	BNA Release	Total Release
1989	5,192	0	5,192
1990	4,792	0	4,792
1991	7,745	3,638	11,383
1992	4,930	3,287	8,217
1993	0	0	0
1994	6,727	4,012	10,739
1995	0	0	0
1996	7,319	3,459	10,778

[1] Preliminary subject to revision.



	1-Jul	4-Jul	8-Jul	11-Jul	14-Jul	17-Jul	21-Jul	24-Jul	27-Jul	31-Jul	3-Aug	6-Aug	9-Aug	13-Aug	16-Aug	19-Aug	23-Aug	26-Aug	29-Aug	1-Sep	5-Sep	8-Sep	11-Sep	15-Sep	18-Sep	21-Sep	24-Sep	28-Sep
Cachuma Release	10.1	4	0	1	1	1.5	1	0	145.7	131.6	138.2	138.7	69.6	48.9	69.6	66.1	68.1	65.5	67.1	58	48.4	48.9	55	49.4	48.9	46.9	28.2	30.3
Solvang	0	0	0	0	0	0	0	0	0	5.4	101	110	52	29	43	48	50	52	46	46	43	44	40	39	39	34	32	32
Narrows	0.53	0.67	0.31	0.26	0.28	0.3	0.23	0.07	0.05	0	0	14	24	6.4	5.5	22	29	27	35	31	18	17	14	23	24	29	22	19

Figure 2-7. Comparison of Cachuma Release and Summer Flows at Solvang and at the Narrows, 1994.



	1-Jul	4-Jul	8-Jul	11-Jul	14-Jul	17-Jul	21-Jul	24-Jul	27-Jul	31-Jul	3-Aug	6-Aug	9-Aug	13-Aug
Cachuma Release	0	0	0	2.6	2	2	2	2	3.5	5	5	5	5	5
Solvang	100	80	24	15	8.2	3.5	0.69	0.73	0.49	0.33	0.12	0.06	0	0
Narrows	76	82	45	26	18	15	9.8	8.9	7.4	12	8.3	11	10	20

	16-Aug	19-Aug	23-Aug	26-Aug	29-Aug	1-Sep	5-Sep	8-Sep	11-Sep	15-Sep	18-Sep	21-Sep	24-Sep	28-Sep
Cachuma Release	5	5	4.5	5	5	5	5	5	5	5	5	4.5	5	5
Solvang	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Narrows	21	12	9.3	10	11	19	5.4	4.7	8.8	5.7	2.7	2.1	2.4	3.4

Figure 2-8. Comparison of Cachuma Release and Summer Flows at Solvang and at the Narrows, 1995.

the initial rate of downstream releases were in the range of 100-150 cfs. After the flow was established downstream, releases ranged from 40 to 80 cfs. Figure 2.7 shows that at these release levels approximately 20-40 cfs recharged into the groundwater basin between Bradbury Dam and Solvang. Similar recharge happened between Solvang and the Narrows.

The 1995 hydrograph shows that, early in the summer, flows at Solvang were higher than the releases from Bradbury Dam. This was because the Santa Ynez River tributaries contributed significant flows to the mainstem. By mid July these contributions had lessened or ceased and losses in the mainstem were greater than any residual contributions from the tributaries. By mid August, the gage at Solvang recorded no flow at that site although fish releases from Cachuma continued. The flow at the Narrows stayed higher than the fish releases into September, most likely because of contributions from Salsipuedes Creek which had constant flow recorded through September.

2.5 DIVERSIONS FROM TRIBUTARIES

2.5.1 ALISAL RESERVOIR

Alisal Reservoir, constructed by the Petan Company at the southerly boundary of the SYRWCD, about three miles south of Solvang, is under a 1969 permit from the State Water Resources Control Board for the diversion and storage of 2,342 acre-feet per year of Alisal Creek water. The permit allows uses for irrigation, domestic, stock watering and recreational purposes. Actual water use from Alisal Reservoir has not been quantified. End of year reservoir storage and available information on Alisal Creek streamflow are in Table 2.3 above.

Alder and Fox Creeks are tributaries to the Santa Ynez River joining the river immediately downstream of the Juncal Dam. Water from Alder Creek is diverted by the Montecito Water District via a flume to Jameson Lake for delivery to the Doulton Tunnel. Water from Fox Creek is diverted by a pipeline directly to the Doulton Tunnel.

Devil's Canyon Creek is a tributary to the Santa Ynez River joining the river at a point immediately downstream of Gibraltar Dam. The City of Santa Barbara diverts water from Devils Canyon Creek directly via a pipeline to the Mission Tunnel. Available data on historical diversions from Fox, Alder, and Devil's Canyon Creek are shown in Table 2.10.

2.6 SANTA YNEZ RIVER HYDROLOGY MODEL

The Santa Ynez River Hydrology Model (SYRHM) was developed to evaluate water management alternatives, conjunctive use of surface and groundwater, Cachuma enlargement and the State Water Project. The SYRHM was developed by the Santa Barbara County Water Agency utilizing earlier models of the Santa Ynez River developed by consulting firms and the U.S. Bureau of Reclamation (USBR). The SYRHM has been expanded and modified in consultation with the Santa Ynez River Hydrology Committee.

Table 2-10. Annual Diversions from Fox, Alder, and Devils Canyon Creeks (acre-feet).

Water Year	Fox Creek	Alder Creek	Devils Canyon Creek
1935		169	
1936		118	
1937		142	
1938		98	
1939	41	102	63
1940	121	97	71
1941	71	14	481
1942	139	66	96
1943		110	221
1944		102	161
1945		16	142
1946		45	120
1947		44	40
1948		10	0
1949		0	72
1950		0	11
1951		0	0
1952		0	133
1953		42	0
1954		59	1
1955		10	10
1956			20
1957			26
1958			77
1959			[3]
1960			[3]
1961			[3]
1962			[3]
1963			[3]
1964			[3]
1965			[3]
1966		15	[3]
1967	197	119	[3]
1968	197	98	262
1969	197	36	65
1970	197	183	203
1971	197	216	0
1972	197	99	0
1973	197	354	16
1974	197	319	0
1975	197	345	0
1976	197	153	31
1977	197	115	26
1978	197	160	102
1979	197	654	18
1980	197	344	0
1981	197	231	56
1982	197	50	233
1983	197	629	138
1984	197	321	63
1985	197	199	100
1986	197	242	317
1987	197	126	91
1988	197	197	236
1989	197	209	51
1990	197	110	24
1991	197	51	236
1992	197	631	499
1993	197	478	752
1994	197	196	140
1995	197	25	278

Data Sources:

1. Fox Creek diversion provided by Montecito Water District and Santa Brabara County Water Agency

2. Alder Creek diversion provided Montecito Water District

3. Data source: City of Santa Barbara; data from 1959 to 1967 missing

The SYRHM includes operations of Juncal, Gibraltar, and Bradbury Dams, and the Santa Ynez River alluvial groundwater basin. The model is based on historic records of rainfall, runoff, evaporation, percolation, and tunnel infiltration. The model utilizes monthly records for the period 1918 through 1993 and is capable of simulating the effect of cloud seeding in flow augmentation. Reservoir releases, diversions, groundwater pumping, and depletions are based on monthly time steps. The model includes monthly phreatophyte consumptive use, bank inflow, and percolation along the Santa Ynez River. It also includes the operations under the Upper Santa Ynez River Operations Agreement and the State Water Resources Control Board Decision No. D886 and Order WR 73-37 as amended by WR 89-18. Recently the model was tested for a limited verification. Presently, it is scheduled for an expanded verification and a possible recalibration. Because of its monthly time step, the model may be limited in its utility to assess certain fisheries management alternatives.

2.7 LAGOON

The Santa Ynez River Lagoon is the zone of interaction between the river and coastal front. The river lagoon includes the shifting channels and depositional environments at the mouth of the river. Lagoons form in many California streams when a sandbar closes the river mouth. Sandbar formation and breaching depends on wave action to deposit or remove sand, freshwater streamflow in the river, and tidal action. The Santa Ynez River Lagoon generally opens during periods of high river flows and storm-generated waves in the winter storm season. Low streamflows during drought years can prevent sandbar breaching. Artificial breaching has been practiced to reduce rising water levels in the lagoon and upstream.

The Santa Ynez River Lagoon is two to three km long and gradually widens seaward to the railroad trestle where it abruptly narrows; a small, equally narrow variable portion lies seaward of the railroad trestle to the ocean or barrier sand bar. Typically in the fall (with the sandbar barrier established) the river is one to ten meters wide at the entrance to the lagoon and about 300 meters wide just above the railroad trestle. The lagoon opens in winter after the first one or two major storms and usually remains open to early spring. When this happens, the surface area of the lagoon decreases substantially. With the sandbar open, the deepest point in the lagoon is approximately 3.5 meters. This is the deepest water in the Santa Ynez River system below Bradbury Dam during normal flows. Ponding with the sandbar barrier in place may add two to three meters (Swift et al 1997).

Recorded historical information on when the sandbar barrier has been breached or existed, or for how long the lagoon has been open to the ocean during each year, is not available. Runoff from large storms breach the lagoon and that in the summer as flow decreases buildup of sand at the mouth will block the river mouth. No records of when this has historically happened in any particular year are available. Therefore, estimates of the amount of time the lagoon is open or closed in relation to various levels of runoff cannot be provided.

2.8 TEMPERATURE DATA

As reviewed in the SYRTAC Synthesis Report (SYRTAC 1997a), water temperature has been monitored since 1993 at various locations below Bradbury Dam in the mainstem and selected tributaries. Both temperature and temperature variability were lowest near Bradbury Dam, particularly during the summer, with a longitudinal gradient of increasing temperature moving downstream. Water temperatures within the lagoon are typically cooler than conditions further upstream, except for locations immediately downstream of Bradbury Dam.

Thermal tolerance guidelines that have been suggested to provide suitable conditions for rainbow trout/steelhead are 20°C for the average daily temperature and 25°C for the maximum daily temperature, although tolerances for southern stocks may be different (SYRTAC 1997a). Water temperatures at a number of mainstem locations exceeded these criteria during the summer, and the frequency and magnitude of exceedances increased as a function of distance downstream from the Dam (except for the lagoon). Monitoring during the 1996 WR 89-18 releases showed that temperatures increased rapidly (at locations 3.4 miles below the dam and further downstream), despite releases of 50 cfs and 135 cfs. In the tributaries, summer temperatures sometimes exceeded these guidelines in Hilton, El Jaro, lower Salsipuedes, and Nojoqui Creeks. Water temperatures in the well-shaded reach of Salsipuedes upstream of the El Jaro Creek confluence did not exceed these guidelines in the two monitoring years.

Models have been used to predict the effects of various instream flow releases on seasonal water temperature downstream of the dam, and thus predict the geographic region where suitable habitat conditions would exist for various life stages of rainbow trout/steelhead. The Contract Renewal EIS/EIR used the U.S. Fish and Wildlife Service SSTEMP model (Woodward Clyde Consultants 1995, SYRTAC 1997a). The results of modeling are consistent with the measurements of the longitudinal gradient in water temperatures at mainstem locations downstream of Bradbury Dam.

2.9 Conclusions

The Fish MOU studies have occurred in a wetter than average period

The Fish MOU studies started in 1993, a year when Cachuma Reservoir spilled, and included 1995, a year that brought damaging floods to the area. In addition, storage restrictions in Cachuma Reservoir resulted in extended downstream flows in 1995.

Seasonal nature of rainfall and runoff

The majority of rainfall and runoff occurs in the winter and spring months. There is often no flow or very low flow in the mainstem of the Santa Ynez River above and below Cachuma Reservoir and in the tributaries from August until the onset of the rainy season. Downstream water rights releases provide some flow in the mainstem of the Santa Ynez River in the years that releases are made.

Downstream water rights releases and Bradbury Dam spills occur in different seasons and in different years

Downstream water rights releases are generally made in June through the fall depending on hydrologic conditions and during average and dryer than average years. Spills occur in wet years (14 out of 42 years) and usually end in the spring or early summer.

Spills are a possible source of surcharging Cachuma Reservoir

Cachuma Reservoir has spilled in 14 out of the 42 years of its existence. Surcharging to add water to a fish account would appear to have little effect on the downstream spill in most years. Surcharging may not be a dependable supply of water – between 1984 and 1993, there was no spill and, thus, no opportunity to surcharge the reservoir. Another way to look at this is that during wet periods surcharging appears to be a fairly dependable source for a fish reserve account. During dry periods it is not.

Released water

Water right releases are made for the sole purpose of recharging the groundwater basins below Bradbury Dam. The water right releases are intended to percolate into the groundwater basin and provide water supply to the areas between Bradbury Dam and the Narrows, and the Lompoc Valley.

Water released for fish purposes has significant losses as it moves downstream. During wet periods, contributions from the tributaries maintain the flow level as one moves downstream. During typical summers and falls, the fish maintenance flow released at the dam or through Hilton Creek may reach the Highway 154 Bridge. It will not reach the Solvang gage.

Mainstem temperatures increase rapidly downstream

Water temperatures at a number of mainstem locations exceeded suggested thermal criteria for rainbow trout/steelhead during the summer, and the frequency and magnitude of exceedances increased as a function of distance downstream from the Dam. Monitoring during the 1996 WR 89-18 releases showed that temperatures increased rapidly (at locations 3.4 miles below the dam and further downstream), despite releases of 50 cfs and 135 cfs. In the tributaries, summer temperatures sometimes exceeded these guidelines in Hilton, El Jaro, lower Salsipuedes, and Nojoqui Creeks.

The Fish Management Plan should take into consideration wet and dry conditions

Figure 2.1 shows the nonrandom nature of rainfall (runoff corresponds to this) in the Santa Ynez River watershed. Any management plan for fish maintenance and recovery needs to consider the wet and dry periods that will occur in the watershed. During wet periods there appears to be adequate water for all uses because the reservoir is full, tributary flows are high and the riparian groundwater basins are relatively full. Extended dry periods, such as the period between 1985 to 1993, will not allow any opportunity for surcharging and use of the fish reserve account will draw the reservoir supplies down further. Natural flow in the mainstem and tributaries will cease in summer and fall. Releases will be lower, meaning groundwater replenishment in the riparian zone will be less, and any releases will have greater percolation, resulting in surface flow moving less far downstream. The Hilton Creek Siphon also may not be available for long periods during a dry period.

3.1 INTRODUCTION

This chapter introduces the potential management alternatives to improve habitat conditions for fishery resources, population levels, and/or reproduction of fishes (particularly rainbow trout/steelhead) in the Santa Ynez River system. Potential alternatives have been identified from the Contract Renewal EIR/EIS and through discussions in the SYRTAC and Biology Subcommittee. Alternatives are grouped geographically in this chapter:

1. Mainstem Santa Ynez River below Bradbury Dam
2. Tributaries below Bradbury Dam
3. Mainstem Santa Ynez River above Bradbury Dam
4. Tributaries above Bradbury Dam

Within each geographic region, the potential management alternatives have been divided into different categories:

1. Flow-related measures to improve habitat
2. Habitat improvements (non-flow related)
3. Fish passage measures to facilitate upstream and downstream migration
4. Predator removal
5. Population augmentation through supplementation of fish

A description of each alternative is provided below, including:

- Explanation of the management alternative
- Potential biological benefits provided and constraints on implementation
- Identification of data that should be used to evaluate benefits and feasibility

As described in the hydrology chapter (Chapter 2), the Santa Ynez River basin experiences annual and interannual variation in hydrologic conditions and water supply availability. Management strategies should therefore respond to this variability. For example, in years when precipitation, runoff, and storage are high, acceptable habitat conditions can be extended further downstream in the mainstem Santa Ynez River. In years when available water supplies are low, acceptable mainstem habitat will be maintained in a reduced geographic area.

The ability of the USBR and local water agencies to successfully implement a wide range of optimum actions may be limited due to requirements for access to private lands which are outside the control and authority of the USBR and supporting water users. Therefore, a phased program of implementation, based upon an adaptive management strategy, should be used. First priority should be given to implementing those elements of the management plan which are located on lands and involve facilities under the direct control of the USBR and/or participating local water agencies.

3.2 MAINSTEM SANTA YNEZ RIVER BELOW BRADBURY DAM

The range of potential management alternatives for the mainstem below Bradbury Dam is presented in Table 3-1.

3.2.1 FLOW-RELATED MEASURES FOR THE MAINSTEM BELOW BRADBURY DAM

1. Conjunctive use of water rights releases

Releases are currently made from Bradbury Dam to meet downstream water right requirements (Water Rights Order 89-18 releases). In wet years, WR 89-18 releases are generally not made because the aquifers have been sufficiently recharged by the heavy winter rains. These managed releases are typically made during the late spring and/or summer and early fall, using flow patterns designed to recharge the groundwater basin between Bradbury Dam and Lompoc Narrows and the Lompoc groundwater basin.

Operation of water right releases in conjunction with releases from the Fish Reserve Account (Alternative 4) can provide instream flows for the mainstem from Bradbury Dam to Highway 154 or Bradbury Dam to Solvang, depending on the time of year and hydrologic conditions. This conjunctive operation would occur through coordination by the USBR with the Santa Ynez River Water Conservation District (SYRWCD) in the course of the SYRWCD's management of the downstream releases required by WR 89-18.

The objective of conjunctive operation of the WR 89-18 releases in combination with releases from the Fish Reserve Account (Alternative 4) would be to extend the period of time each year when instream flows improve fisheries habitat for oversummering and juvenile rearing within the mainstem river. The primary priority reach is from Bradbury Dam to Highway 154, with particular focus on USBR land (including the stilling basin and long pool). This priority reach has been identified based upon the quality of existing

Table 3-1. Potential management alternatives for the mainstem Santa Ynez River below Bradbury Dam.

Type	Alt. #	Description
Flow-related measures	1.	Conjunctive use of water rights releases
	2.	Alternate release points along mainstem
	3.	Manage flood-control spills
	4.	Additional mainstem flow releases (Fish Account)
	5.	Surcharge reservoir for additional mainstem flow releases
	6.	Purchase water and/or water rights for flows
	7.	Recirculate/recycle flows in mainstem
Habitat Improvements	8.	Riparian enhancement along mainstem
	9.	Mainstem stream channel modifications (e.g. erosion control, deepen channel)
	10.	Instream structures in mainstem (e.g. woody debris, boulders)
	11.	Place gravel in mainstem
	12.	Conservation easements or mitigation banking along mainstem
Fish Passage	13.	Passage barrier removal in mainstem
	14.	Passage channel at lagoon beach barrier
	15.	Fish ladder at Bradbury Dam
	16.	Hilton Creek as a fish ladder
	17.	Trap & truck adults from mainstem below Bradbury Dam to Lake Cachuma above dam, and outmigrants back below dam
	18.	Trap & truck SYR adults to outside SYR drainage
Predator Removal	19.	Remove warmwater fish below Bradbury Dam
Fishing Regulations	20.	Fishing moratorium downstream of Bradbury Dam
Fish Supplementation	21.	Wild steelhead hatchery
	22.	Use upstream broodstock for supplementation
	23.	Streamside incubators in mainstem
	24.	Spawning channels along mainstem

habitat and results of extensive water temperature monitoring and modeling (ENTRIX 1995, SYRTAC 1997a), and the likelihood for successful protection and improvement. A secondary area for possible enhancement in certain years and under certain hydrologic conditions would extend downstream from Highway 154 to the Solvang area.

Water temperature conditions would be closely monitored to establish geographic and seasonal zones for determining priority habitat. Operation of water right releases, in conjunction with releases from the Fish Reserve Account, would be managed to avoid stranding of rainbow trout/steelhead and other fish species. Since 1994, water rights releases have been ramped down voluntarily at the termination of the releases in accordance with recommendations of the Biological Subcommittee of the SYRTAC. This practice will be continued under this alternative.

The ability to manage the combined releases from Bradbury Dam to the mainstem varies substantially among years in response to variation in factors such as precipitation and runoff, reservoir storage, and downstream need. Releases are adaptively managed based on variation in conditions, constraints, and need.

The benefits achieved will depend on the time of year and hydrologic conditions. These can include increased amount of aquatic habitat, improved dissolved oxygen conditions from flushing of accumulated algae, and generally reduced water temperatures in reaches close to the Dam). Temperature monitoring suggests, however, that improved temperature conditions do not extend beyond the Highway 154 bridge, which is 3.4 miles downstream of Bradbury Dam (SYRTAC 1997a). Furthermore, the increased flows may reduce the value of refuge pools farther downstream for rainbow trout/steelhead by reducing thermal stratification and allowing free movement of predators in the lower river. Additional discussion of benefits and constraints is provided under Alternative 4.

In general, managed releases provide opportunities for improved maintenance of fisheries habitat over longer periods of time than have occurred in the past several decades. These releases can be made from the Bradbury Dam outlet and/or via the planned Hilton Creek permanent siphon (Alternative 26). Using an adaptive management strategy, conjunctive operation of water releases will be made to improve habitat conditions and build the rainbow trout/steelhead population during wet years, while using limited water supplies to maintain the rainbow trout/steelhead population and other fishery resources in dry years.

2. Alternate release points along mainstem

Currently, all water released to the mainstem Santa Ynez River comes from Bradbury Dam. At times, releases are made for both the above and below Narrows areas. The water right releases recharging the Santa Ynez River alluvium between Bradbury Dam and the Narrows are deducted from the Above Narrows Account (ANA). The water released for the Lompoc area is measured at the Lompoc Narrows and deducted from the Below Narrows Account (BNA). Delivering water directly to the below Narrows area can separate such joint ANA and BNA releases to some extent.

The Central Coast Water Authority (CCWA) pipeline that carries State Water Project (SWP) water would be the source of such releases. Two alternate release sites have been proposed for delivery of SWP water in lieu of the BNA releases (B. Burnworth, CCWA pers. comm.). One would be near the Robinson Bridge (Highway 246 crossing) and the other further downstream near Rucker Road. Both sites are downstream of Salsipuedes Creek. Water would be directly released into a dry, sandy recharge area. Under this alternative, a portion of the BNA releases would be met by the SWP releases. The releases of the SWP water would be deducted from the BNA under an appropriate exchange agreement between the SYRWCD and the CCWA.

The CCWA pipeline also crosses the Santa Ynez River approximately 2.5 miles downstream of Buellton. The SWP water can be released directly into the river at this location to replenish the alluvial groundwater basin in the Santa Rita subarea (between Buellton and the Narrows). Such pre-arranged releases would be deducted from the ANA under an appropriate exchange agreement between the SYRWCD and the CCWA.

Percolation of SWP water in the recharge zone during late summer and fall could raise the water table below the Narrows. This could benefit migrating fish later in the year by enhancing flows in the mainstream or reducing the delay between the start of winter rains and commencement of surface flows. Use of this alternative could also somewhat reduce blending SWP water in releases at Bradbury Dam that may affect oversummering fish in the stilling basin and long pool. As noted in the hydrology chapter, when a downstream release coincides with a SWP water delivery into Lake Cachuma, SWP water will also be discharged to the river at the outlet works of Bradbury Dam. The Department of Fish and Game has expressed concerns that anadromous steelhead may obtain false cues for imprinting if they were exposed to SWP water from the Sacramento-San Joaquin Delta. Another concern has been that warm water from the pipeline could elevate stream temperatures. CCWA has agreed to guarantee a blend at least 50% Cachuma water and a released water temperature of less than 18°C. Releasing SWP water directly to the recharge areas may reduce the need to deliver SWP water into Cachuma during WR 89-18 releases, thus minimizing water mixing.

To further evaluate this alternative, information is needed on groundwater basin relationships near Salsipuedes Creek and passage flow requirements for reaches near Lompoc and below Buellton.

3. Manage flood-control releases

This alternative examines the possibility of conducting "prereleases" of flood-control releases from Lake Cachuma to increase or improve the pattern of streamflows downstream of Bradbury Dam for fisheries. The Cachuma Project is not actively managed for flood control purposes because it was not authorized, designed, or built to provide flood protection (R Almy, pers. comm.). Except to meet the requirements of SWRCB orders and pursuant to the fish study MOU, no water is released downstream until the reservoir level exceeds elevation 750 feet (the top of the conservation pool) and the inflow to Lake Cachuma exceeds evaporation and diversions. (Combined diversions and other losses generally are in the range of 40-150 acre-feet per day and are weather dependent).

Theoretically, water could be released from Lake Cachuma in advance of an expected storm event ("prerelease") in order to provide a longer period of elevated stream flow below Bradbury Dam, which could improve upstream passage conditions. By spreading the release out over a longer period at a lower flow level, the habitat benefits of flow supplementation to the mainstem can be extended over time.

However, the opportunity to realize any significant biological benefit may be limited. The extended period of flows might only last hours, and therefore not provide much benefit. Another factor limiting the benefits is the pattern both of runoff in the watersheds above and below Bradbury Dam and of reservoir filling and bypass. By the time the reservoir approaches elevation 750 feet, runoff from the watershed below Bradbury Dam may already provide sufficient streamflow in the mainstem for passage.

Release of inflow is achieved either through the "release works" (currently with an upper limit of 150 cfs) or through the spillway gates which have a combined design capacity of 160,000 cfs. Each of the four gates opens from the gate's bottom, to a maximum opening of 32 feet. Due to their design, precise control is difficult for lower release rates, in the range of 400 cfs or less. During normal operation, the gates and/or release works are used to pass storm flows directly downstream when the lake is at or above the top of the conservation pool. The USBR can slightly manipulate the gates' opening to alter the release. Releases below 150 cfs can be made through the valve on Bradbury Dam.

However, there is a substantial risk that an expected storm will not materialize, and thus the prerelease would have been made at the expense of water supply for the reservoir. The uncertainty of the 36-48 hour predictions and range of error in predicting rainfall for small to moderate storms make it difficult to accurately forecast inflow. The reservoir is operated with the expectation of a 5-6 year drought (no inflow and no spill) and a mistimed prerelease can have large consequences later in the year. Releases in excess of those stipulated by the rule curve (normal operating procedures) to lower the reservoir below the top of the conservation pool have only occurred in response to Safely of Dams Program restriction, the reasons for which have been corrected. In that case the reservoir was lowered to elevation 733 after storms as rapidly as possible, consistent with avoiding flood control problems.

The opportunities for manipulating storm-related releases to benefit downstream fishes are thus limited by the flashy hydrology of the upper Santa Ynez watershed and the lack of a flood control pool in the Cachuma Project that can be actively managed. Natural inflow to Lake Cachuma drops off quickly after a storm over a matter of weeks, leaving little opportunity to refill the reservoir should too much water be prereleased. Furthermore, our ability to predict storms with sufficient advance warning to achieve a prerelease of significant duration is probably limited.

To further evaluate this alternative, it would be necessary to compare the pattern and magnitude of downstream flows (USGS gages), inflow to Cachuma, and spillage from Bradbury Dam in different years. The Santa Ynez River Model could be used to test the timing and frequency of conditions conducive for prerelease, although this monthly model may not provide sufficient resolution for the hourly or daily decisions involved in flood control. This upcoming year, with the forecast El Nino conditions, would be a good year for observation. Information on the timing, duration, and flow requirements for the spawning migration in the Santa Ynez would be required. Migrant trapping studies have been conducted in the mainstem in 1996 and 1997, and in tributaries from 1994 through 1997. Passage models were developed during the Contract Renewal EIR/EIS from IFIM transects to describe the minimum amount of flow for upstream migration on the mainstem (ENTRIX 1995) (These transects, however, were not specifically sited to support passage analysis). The SYRTAC is currently developing and evaluating a directed passage model.

4. Additional mainstem flow releases at Bradbury Dam

The Santa Ynez River below Bradbury Dam is typically dry through much of the summer and fall, unless WR 89-18 releases are being made from the dam. Prior to the construction of Bradbury Dam, this reach was also typically dry or had very low flows. Most of the historical steelhead rearing habitat occurred in tributary streams, particularly in tributaries upstream of the current location of Bradbury Dam. Historically, the mainstem of the Santa Ynez below the Buellton provided poor quality rainbow trout/steelhead spawning habitat and instead functioned primarily as a passage corridor.

Alternative 4 evaluates the feasibility of making additional releases of water at Bradbury Dam to the mainstem Santa Ynez River. The Cachuma Fish Reserve Account is the basis for this alternative. A dedicated volume of water would be made available within Cachuma Reservoir for purposes of environmental protection and enhancement. The Fish Reserve Account would be allocated and administered under the direction of the SYRTAC. These releases would improve habitat for some distance below the dam over a period of time, depending on the magnitude and timing of these releases.

The Fish Reserve Account would be adaptively managed to reflect annual and interannual variations in hydrologic conditions. In those years when precipitation and runoff results in spill from Bradbury Dam, the Fish Reserve Account would be allocated 3,000 AF of water. In those years when Bradbury Dam does not spill, but storage is greater than 100,000 AF within the reservoir, the Fish Reserve Account would be allocated 2,000 AF. During years when reservoir storage within Lake Cachuma is less than 100,000 AF, the Fish Reserve Account, as with other water deliveries, would experience shortages and would be allocated less than 2,000 AF, based upon the storage level within the reservoir. Fish Reserve Account water would carry over each year to a maximum amount of 4,000 AF; however, in the event of a spill, the Fish Reserve Account will reset to 3,000 AF. The annual allocation for the Fish Reserve Account will be determined no later than April 30th of each calendar year.

The water dedicated to the Fish Reserve Account may be provided from existing storage within Lake Cachuma and/or through modifications to Bradbury Dam to enhance reservoir storage (Alternative 5). Allocations from the Fish Reserve Account may be used to provide instream flow to the lower Santa Ynez River to:

- Complement naturally-occurring flow conditions to increase instream flows or extend the duration of instream flows to improve habitat conditions for fish
- Provide a "bridge" between naturally-occurring seasonal streamflow and water right releases (conjunctive use of WR 89-18 releases, Alternative 1);
- Provide periodic pulsed flows to reduce algal accumulations within the pools and mainstem channel;
- Provide periodic increases in pool depth; and
- Maintain and improve habitat conditions in both Hilton Creek (via the Hilton Creek siphon, Alternative 26) and the stilling basin and long pool regions (via release from the Bradbury Dam outlet works).

The primary priority reach is from Bradbury Dam to Highway 154, with particular focus on USBR land including the stilling basin and long pool. This priority reach has been identified based upon the quality of existing habitat and results of extensive water temperature monitoring and modeling (ENTRIX 1995, SYRTAC 1997a), and the likelihood for successful protection and improvement. A secondary area for possible enhancement in certain years and under certain hydrologic conditions would extend downstream from Highway 154 to the Solvang area.

Pulse flows may flush excessive algal buildup from the pools in the mainstem. The amount of water released would depend on groundwater and instream flow conditions. Diurnal dissolved oxygen studies conducted in summer 1997 prior to WR 89-18 releases indicated that a release of 15 cfs did not extend downstream of Highway 154 and thus was inadequate to remove algae from the pools downstream.

Release of additional water has been proposed to improve water temperature conditions. Rainbow trout/steelhead require cool, well-oxygenated water to survive and grow. Releases from the hypolimnion in Lake Cachuma would provide water that is cool but low in oxygen. The maximum water temperature at the release point should be 15.5°C (60°F). This will ensure acceptable water temperatures for juvenile rainbow trout/steelhead should some warming occur as water moves downstream. Temperature criteria for rainbow trout/steelhead were recommended in the Fisheries Technical Report (ENTRIX 1995), based on the scientific literature (Hokanson et al. 1977) and CDFG standards in central and southern California. Average daily temperatures should be less than 20°C and daily maximum temperatures should be less than 24°C to allow acceptable trout growth.

The degree and extent of water temperature improvement that could result from the proposed flows, however, may be limited. Based on the results of temperature models developed during the Contract Renewal EIR/EIS, creating summer rearing habitat (mean daily water temperature <20°C) downstream of Buellton appears infeasible, even at release flows of 25 cfs (ENTRIX 1995). Temperature monitoring studies conducted during the 1996 WR 89-18 releases indicate that water temperatures exceeded 20°C within 3.4 - 9.7 miles of Bradbury Dam, depending on the release (SYRTAC 1997a) (Table 3.2).

Table 3-2. Water Temperatures in the Mainstem Santa Ynez River During the 1996 WR 89-18 Releases.

Release at Bradbury Dam (cfs)	Flows @ 24 m. downstream (cfs)	Distance where temperatures >20°C	Date
135	70	3.8 miles 9.7miles	July 25 July 28
70	35	3.4 miles 7.8 miles	Aug. 4 Aug. 9
50		3.4 miles	Aug. 28

Water temperatures could exceed 20°C even closer to Bradbury Dam than these data indicate, since there are no monitoring stations between mile 0.5 (Long pool) and mile 3.4 (Refugio X site). Thus it may be impractical to maintain water temperatures adequate to support rainbow trout/steelhead during the summer months downstream of Highway 154 (2.9 miles downstream of the dam), even at quite high (and unsustainable) releases. Temperature monitoring will be continued to further assess the effects of variable flows.

The major constraint to this alternative is the reduction of available water supply to the member units. Some of this water might be reclaimed through reduced need for 89-18 releases, since earlier releases would contribute to recharge of downstream groundwater. Presumably the remainder of the water to be released would be provided by order of the SWRCB rather than through purchase from entities with existing water rights, as the purchase of water or water rights is covered in Alternative 6. Another consideration is the effect this alternative would have on meeting needs of the downstream accounts (i.e. Above Narrows and Below Narrows accounts). Another constraint is the degree to which maintaining a live stream downstream of Bradbury Dam adversely impacts current land use by private landowners. Concerns for increased flood risk have also been raised if riparian growth in the low flow channel should increase due to the increased streamflow.

Data available for the evaluation of this alternative include USGS flow records for two extant and several discontinued stations, the Santa Ynez River Model, and water storage and delivery records of the USBR. Habitat-versus-flow relationships were developed for rainbow trout/steelhead during the Cachuma Enlargement studies (DWR 1988) and updated during the Contract Renewal EIR/EIS (ENTRIX 1995). (In 1997, further refinement of the IFIM analyses was recommended by CDFG and others, and this study element was incorporated into the updated LTP [SYRTAC 1997b]). These relationships are valid for the portion of the river between Buellton and the dam, and have currently been developed only for steelhead. Similar models could be readily developed for other species, if necessary. The existing models use the Bovee (1978) winter steelhead criteria, which may be inappropriate for use on the Santa Ynez River. Additional information will be collected as part of the Long Term Study Plan. According to the LTP, these PHABSIM models will be run again using criteria more appropriate for southern steelhead. The southern steelhead criteria will be developed in a workshop sponsored by the SYRTAC.

As recommended in the updated LTP, additional habitat monitoring was conducted during the 1997 WR 89-18 releases to examine changes in habitat conditions at various release levels (50, 35, 20 and 10 cfs). Aerial photos were also taken during this release to examine habitat conditions (wetted area only) in regions without ground access. From these data, recommendations will be developed about the amount of release required to achieve certain instream conditions.

The temperature model developed for the Contract Renewal EIR/EIS is also available. As discussed above, the SYRTAC has collected additional temperature data in the years since 1994 which could be used to update the model.

Providing flows for passage may not be feasible, due to the large amount of water that would be required. Information on the flows needed for upstream passage was developed during the Contract Renewal EIR/EIS process. This analysis, however, was based on transects not selected specifically to evaluate passage. A focused evaluation of passage flows is currently being developed by the California Department of Fish and Game (CDFG) and the SYRTAC. Preliminary analysis indicates that instream flows of 25 cfs throughout the mainstem would be required to provide passage for migrating adult steelhead. Furthermore, years when supplemental flows for passage are required may be dry years when it would be difficult to maintain flows for rearing.

Information on conveyance loss of water in the river would be necessary to determine the actual release needed to obtain a desired flow level at some point along the river. This hydrological data could be derived from observations of different WR 89-18 releases, as well as other controlled releases.

5. Surcharge reservoir for additional mainstem flow releases

This alternative calls for surcharging (storing water in excess of the usual storage capacity) Cachuma Lake during the wet season and releasing this water during other times of the year. Benefits of releasing surcharged water would be similar to those described for Alternative 4, and would depend on the release schedule for the water.

To further evaluate this alternative, information is needed on the amount of additional water which can be stored by surcharging without compromising dam safety or safety from floods. In addition, information is needed on how and when the reservoir would be surcharged. The USBR is currently reviewing the feasibility of raising the radial gates at Bradbury Dam to provide additional water for fishery purposes. The information described under Alternative 4 would also be needed to fully evaluate the benefits associated with mainstem releases.

6. Purchase water and/or water rights for flows

Alternative 7 calls for purchasing water or water rights to provide flows for aquatic resources below Cachuma Dam. If possible, this alternative could provide benefits similar to those described under Alternative 4.

The water rights situation in the Santa Ynez River watershed and current land use policies make this alternative unattractive and likely infeasible. Water rights between Bradbury Dam and the Narrows (including tributaries) are riparian rights. These rights are attached to the land and are not transferable. These rights are not licensed. The only appropriators with permits (partly licensed) are the Cities of Solvang and Buellton and ID#1. The permitted groundwater diversions are used for M&I purposes. Current land use policies encourage the preservation of agriculture within the water shed. Purchasing riparian land to retire water rights and consequently the supported agriculture would not be consistent with the Santa Barbara County General Plan.

If this alternative were to be considered for implementation, information would be needed on stream reaches that could most benefit, potential sellers, and the amount of historically diverted water that may be available from willing sellers. The SYRTAC studies will provide data on habitat suitability and occurrence of rainbow trout/steelhead that will facilitate selection of target reaches.

7. Recirculate/recycle flows in the mainstem

Recirculation of base-level stream flows with a pumping system could be used to improve aquatic habitat within a small portion of the river. In the Contract Renewal EIR/EIS, the reach between Bradbury Dam and Refugio Road is identified as having the best potential rainbow trout/steelhead habitat. Recirculation may allow for higher flow conditions to occur for a longer part of the dry season. This alternative would require construction of a pumping plant at the lower end of the wetted reach, screens to prevent entrainment of fish in the pump, a pipeline to the upstream release point, and a means to elevate dissolved oxygen, lower water temperature, and minimize the erosion potential of the release water.

This alternative, however, faces serious technological challenges, would be expensive to operate and maintain, and would improve only limited lengths of stream. Maintaining suitable water temperature and water quality in the recirculated reach would be a major problem during the warmer summer months. This would require some sort of refrigeration or cooling system in addition to a pump. The length of stream selected for recirculation will be critical in determining the costs and potential problems. Augmenting flows in a longer reach may enhance more habitat, but would be more expensive and face more problems with maintaining cool water temperatures and suitable dissolved oxygen levels. A longer stream reach will also increase the loss of water in the recirculating system through percolation and evapotranspiration. Landowner agreement would be necessary for the pipeline easement and construction of the pumping facility. Implementation of this alternative would likely require purchasing water rights and/or finding alternative sources of water.

A recirculation system would be an expensive alternative to improve a limited amount of habitat. In addition, unacceptable environmental impacts may include degradation of water quality and adverse effects on existing hydrology. Finally, the technical problems make this alternative infeasible for implementation.

3.2.2 Habitat Improvement for the Mainstem below Bradbury Dam

If streamflow of acceptable temperature and quality is present throughout most years, habitat enhancement measures can improve the quantity and/or quality of aquatic habitats and increase fish populations. Without adequate streamflow, alternatives in this section will contribute little to increased fish populations. Because rainbow trout/steelhead require cool water of good quality throughout the year, providing good quality habitat for rainbow trout/steelhead will be more difficult than providing suitable habitat for warmwater fishes (e.g. arroyo chubs and largemouth bass).

8. *Riparian enhancement along mainstem*

Riparian zones perform a number of vital functions that affect the quality of salmonid habitats as well as providing habitat for a variety of terrestrial plants and animals (reviewed in Spence et al. 1996). Propagation of native riparian vegetation can improve stream habitat by reducing streambank erosion, providing cover and shade, developing undercut banks, and contributing woody debris, leaves, and insect food to the channel.

The vegetation monitoring study conducted in 1996 concluded that the riparian forest along the mainstem is well developed for an intermittent stream (Jones & Stokes Associates 1997). The quality of mainstem riparian vegetation appears to be good, with multiple age classes of vegetation present, a diversity of woody and herbaceous native plant species occupying major portions of the active channel and floodplain, and complex canopy structure at most sites.

According to the study, Cachuma Project operations have affected riparian vegetation primarily through modification of surface hydrology (e.g. reduced the magnitude, frequency, and duration of mean and median stream flows) (Jones & Stokes Associates 1997). Vegetation expansion, vigor, and canopy closure are closely correlated with the relative depth to underlying groundwater. However, groundwater conditions did not appear to be clearly affected by project operations. The primary effect of project operation appears to be reduced potential recruitment in dry years (reduced dispersal and germination of seeds and reduced survival of seedlings and saplings) although the project may also contribute to increased survival due to reduced magnitude and duration of winter peak flows. Dam releases during the dry season that have only a minor effect on stream stage or groundwater elevation do not appear to influence the distribution of vegetation, although these releases can affect the vigor of shallow-rooted trees and shrubs close to the low-flow channel.

Planting or enhancement of riparian vegetation may be useful at sites where the canopy cover is low and the stream channel is not too wide. Enhancement could be implemented if the cause of the current lack of riparian vegetation is clearly understood, and its direct contributions to aquatic habitat enhancement can be assessed for the area of interest. Low ground water levels, scouring stream flows, and land use are among the many factors that may contribute to the low density of riparian vegetation. Where these factors can be controlled or mitigated, riparian enhancement may be worth pursuing. If the primary causal factor cannot be mitigated, then riparian enhancement efforts will likely fail.

If vegetation enhancement is pursued, deep-rooted vegetation such as sycamore or cottonwood would be preferable to shallow-rooted vegetation such as willow. The species of vegetation selected for propagation can have a measurable effect on streamflow. The enhancement or expansion of streamside vegetation will likely increase water loss due to transpiration within the stream corridor.

Access problems will limit the feasibility of this alternative. Implementation would require cooperation from landowners to obtain access, plant vegetation or conduct other enhancement activities in the riparian zone, and protect new plants.

Additional information related to riparian vegetation includes the Contract Renewal EIR/EIS (Woodward Clyde Consultants and CH2M Hill 1995), the Cachuma Enlargement Studies (DWR 1988), ground water monitoring well data (USBR, CPA), historic aerial photography (1928, 1938, 1965, 1978, 1982, 1986, 1988, 1994, and 1996), and the Santa Ynez River model. Habitat mapping data collected in 1997 can be used to identify stream reaches that have suitable instream habitat but could benefit from additional riparian cover. For example, canopy cover may be sufficient in the reaches closest to Bradbury Dam.

9. Mainstem stream channel modifications

The lack of pools, which serve as refuge habitat when mainstem flows decline or cease during the summer, has been suggested as a factor limiting fish rearing in the mainstem (SYRTAC 1997a). Construction of pools in the mainstem could be used to improve and increase rearing habitat by providing deeper and cooler areas that serve as refuges. In dry reaches, these may be the only habitat available. Design and implementation of this alternative would need to address issues of channel stability, potential infilling of the pool, and water quality as stream flows decline (e.g. low dissolved oxygen due to algal growth). The recurrent high flows and mobile nature of the channel could make it difficult to retain constructed pools.

Available information for evaluation and design of channel modifications includes habitat mapping conducted in 1996 and 1997 (distribution of pools in the mainstem), water temperature monitoring (water quality conditions in pools and other habitat units), snorkeling surveys (seasonal and spatial distribution of fish along mainstem), and habitat-flow studies in summer-fall 1997.

10. Instream structures in mainstem

Properly designed and constructed instream structures can improve spawning, foraging and rearing habitat in a number of ways. Placement of instream structures can trigger gravel deposition, forming bars and riffles. Pool depth and frequency can be established and maintained by placing root wads, logs, or boulders in locations that will cause local streambed scouring. These structures can also provide cover and feeding lanes for fish.

The decision to use structures must be made within the context of site-specific habitat limitations, channel conditions, and watershed processes. Although much of the mainstem would probably benefit from the increased complexity that habitat structures could provide, the recurrent high streamflows and mobile nature of the channel would make it very difficult to retain long-term benefits of the structures. Instream structures require streamflow throughout the year and would likely require frequent maintenance and periodic replacement. For these reasons, habitat improvement structures are more appropriate for small perennial tributary streams than for the mainstem Santa Ynez River.

11. Place gravel in mainstem

The addition of gravel is often cited as a means of improving fish populations, but it is only effective when the lack of good quality spawning gravel is the principal factor limiting the rainbow trout/steelhead population. Alternatives to improve physical habitat should be designed in the context of the factors limiting the population and the stream's geomorphic processes (Kondolf et al. 1996). The availability of spawning-sized gravel was very limited between Bradbury Dam and Refugio Road in 1994 (ENTRIX 1995), probably because the dam interrupts the stream's normal bedload transport. Addition of gravel may therefore increase the amount of available spawning habitat for rainbow trout/steelhead. However, lack of fry habitat, not spawning habitat, was identified as the overall primary limiting factor in the lower Santa Ynez River, according to the analysis in the Contract Renewal EIR/EIS (ENTRIX 1995). For gravel placement in this reach to benefit the rainbow trout/steelhead population, adequate streamflows and habitat for spawning, incubation and fry rearing must also be provided, as well as upstream and downstream passage to this reach.

Geomorphic processes in the channel must also be considered in the project design (Kondolf et al. 1996). The potential stability of a gravel supplementation program will depend on erosion and sediment transport at the site. The current lack of gravels in this reach indicates that gravels do not tend to accumulate there in the long term. This could also have consequences for downstream habitat (e.g. filling of pools). Therefore, spawning gravel would likely need to be replaced after high flow years in order to maintain a reasonable amount of good quality gravel. Increasing water releases from the Dam would increase erosion in this reach, while also helping flush accumulated fine sediment. Sedimentation could be a problem if gravel supplementation is applied to reaches with significant sand bed load, although sediment traps could be used to reduce this problem (e.g. Avery 1996). Fine sediment inputs to the stream could also be a problem, depending on erosion in the surrounding watershed.

River gravel would be inexpensive to obtain in the Santa Ynez. The major cost would be transportation and placement, which might be as high as $100-$200 per cubic yard for small amounts of gravel (less than 100 cubic yards).

Information required for implementation would include habitat surveys (particularly of substrate conditions) to identify potential locations for enhancing spawning habitat (regions with suitable flow and temperature during the incubation period in spring, but insufficient gravel), reach-specific estimates of monthly streamflow, site-specific channel geometry measurements, and evaluation of sedimentation and erosion. It would also be necessary to assess landowners' willingness to support gravel placement.

12. Conservation easements along river channel

The acquisition of conservation easements can be very effective at fostering habitat improvement, both where land use is negatively affecting riparian and aquatic habitat (e.g. removal of riparian vegetation, increased sedimentation from stream crossings), or where frequent access to the stream is required for the maintenance of stream improvements. Conservation easements can foster natural recovery of habitat over time, provided that the land use prohibited by the easement was a contributing factor to the habitat degradation being addressed. Conservation easements can also enhance the success of active intervention through other management alternatives, such as planting riparian vegetation. Voluntary participation by private landowners is critical and can be encouraged by providing incentives such as resolution of regulatory compliance issues, tax incentives, or direct payments. For example, conservation easements might be exchanged for the development and maintenance of livestock watering areas away from the stream.

Priority areas for seeking conservation easements should be identified according to their direct contribution to improving habitat conditions, as well as their potential for facilitating implementation of other management alternatives. The persistence of flows, suitability of habitat (or potential for enhancement), and presence of downstream passage barriers need to be thoughtfully considered before easements are openly pursued.

Evaluation of this alternative will also require examination of economic viability, the potential for landowner participation, and grant funding sources.

3.2.3 FISH PASSAGE MEASURES FOR THE MAINSTEM BELOW BRADBURY DAM

13. Passage barrier removal in the mainstem

Physical barriers to passage can include natural barriers, such as low flow conditions, beaver dams, and cattail and willow thickets, as well as man-made barriers, such as road crossings, pipeline crossings, and check dams. Removal of such barriers can improve opportunities for fish such as rainbow trout/steelhead to migrate upstream and downstream during periods of moderate and low streamflow.

Passage barriers such as beaver dams, check dams, and cattail/willow thickets vary temporally and spatially. Check dams are generally reconstructed each year, but not always in the same locations. Beaver dams are constantly being built and abandoned in response to high streamflow events. All these barriers can be located annually by aerial surveillance and removed, with the cooperation of the landowner. When considering removal of natural barriers, however, impacts to other riparian and aquatic species should also be evaluated, since these features may provide habitat for other species.

Habitat mapping studies by DWR and T. Payne in 1991, ENTRIX in 1994 (ENTRIX 1995) (1988), and the SYRTAC (1996-present) have identified potential passage barriers along the course of the mainstem Santa Ynez River. These passage barriers are mostly related to low flow conditions, although a few are related to man-made structures such as pipeline crossings. Numerous beaver dams were observed in the Lompoc region in 1994, although it has been suggested that these may not prove to be serious barriers to adult rainbow trout/steelhead passage (ENTRIX 1995).

Passage models by ENTRIX (1995) and the SYRTAC through the CDFG (in prep.) have been developed to evaluate the amount of water needed to allow adult rainbow trout/steelhead to move upstream. To the extent that these models are representative of typical impediments to passage within the mainstem, the flow recommendations provided by these models will be adequate to provide for adult rainbow trout/steelhead migration. The types of barrier (critical riffles) addressed by these models tend to move from year to year, changing both their location and their cross-sectional profile. The ENTRIX analysis for sites between Buellton and the Alisal reach during 1994 recommended a minimum flow criteria of 25 cfs for passage over these riffles (ENTRIX 1995). A recently completed passage model analysis of data collected in 1995 (including sites in Lompoc and Alisal) also indicates a minimum flow criteria of 25 cfs for upstream passage.

To further evaluate passage problems in the mainstem Santa Ynez River, CDFG has conducted a survey of passage barriers as part of the SYRTAC studies. Additional evaluation was done by DWR for the Cachuma enlargement EIS. The SYRTAC has also conducted habitat surveys in the lower Santa Ynez River.

14. Passage channel at the lagoon barrier

Steelhead cannot enter or exit the Santa Ynez River when the sandbar at the mouth of the river separates the lagoon from the ocean. In many California coastal streams, a sandbar forms during low flow periods (usually late spring or summer) and isolates the stream until winter, when high streamflows and strong wave action breach the sandbar. During winters when the sandbar has not been naturally breached by late January or February, mechanically breaching the sandbar and maintaining an open connection to the ocean would improve access to the lagoon for adult steelhead. Breaching the sandbar is not sufficient, however, if winter rains have been too low to provide mainstem flows adequate for passage to upstream spawning habitat. Furthermore, wave action and sediment transport would tend to close a channel containing still water. It is unclear how significant a problem lagoon closure is during years when passage flows in other mainstem reaches are adequate.

Delaying the closure of the sandbar in spring may prolong the opportunity for outmigration by spawned-out adults and smolts, although mainstem flows must remain high enough to provide downstream passage to the lagoon. Mechanically breaching the lagoon during the summer or fall would provide little benefit to steelhead because they are not migrating then.

Breaching the lagoon during summer may also have adverse biological impacts on juvenile steelhead, which may rear in the lagoon, and on other species, particularly the tidewater goby. This small fish inhabits the lagoon and the tidally-influenced region of the river. The tidewater goby prefers low salinity conditions, which occur when the lagoon is closed. Artificial breaching of sandbars, particularly during the summer, has been identified as a potential problem for this endangered species (Capelli 1997). ESA consultation with the USFWS would be required to implement this action.

If this option is pursued, additional information would be needed on recent patterns of lagoon breaching and closure in order to evaluate the biological benefits of this alternative. Correlating the timing and duration of the opening and closure with typical monthly streamflow levels and passage requirements will be necessary to determine how much benefit this alternative may provide to steelhead populations. Little data has been collected, and no systematic monitoring program is in place except for quarterly water quality measurements.

15. Fish ladder at Bradbury Dam

Fish ladders are often constructed to allow upstream migrating fish to travel over a dam and gain access to spawning and rearing habitat in the upper portion of a watershed. In the case of Bradbury Dam, however, this alternative presents serious technological challenges, according to fish passage experts (G. Heise (CDFG) and J. Visamente pers. comm. to C. Fusaro; W. Trihey, ENTRIX pers. comm.). Bradbury Dam is a 279-foot tall earthen dam. A fish ladder at Bradbury Dam would be more than twice as high as the highest locations where successful ladders have been constructed.

According to guidelines suggested by Bates (1997), an Alaska Steeppass ladder (a style of Denil fishway) can achieve a slope of about 25 percent, and they have been tested up to a slope of 33 percent. The standard length of ladder sections is 30 feet, and a resting pool of approximately 10 feet is recommended between sections (R. Cullen, ENTRIX, pers. comm.) Thus, for every 40 feet of ladder and pool, one can achieve 7.5-10 feet in rise. Bradbury Dam (279 feet tall) would require a total ladder length of 1,116-1,488 feet. Such a ladder would need to be self-supporting structure that is connected to, but not supported by, Bradbury Dam and capable of withstanding seismic activity. To accommodate passage at different lake levels, several different outlets would need to be constructed at the ladder's upper end. Such outlet structures would require flow control gate structures and would represent a major engineering modification to the dam. This would increase its complexity and cost. Furthermore, operation of a fish ladder would require a substantial commitment of water releases from the reservoir over an extended period.

In addition to the engineering challenges, there are biological challenges as well. The distance that migrating adults can successfully travel in a steeppass ladder is limited because fish will tire climbing a long, steep ladder. Also, ladder would not be effective in providing downstream passage, due to the lack of migratory cues once migrating smolts enter Lake Cachuma.

Finally, allowing the federally listed steelhead to enter Lake Cachuma would have serious consequences for the recreational fishery in the lake. This would raise institutional conflicts with the Fish and Game Commission. All alternatives that transport upstream-migrating adult steelhead above Bradbury Dam (Alternatives 17, 18, 39, and 45) and thus place an endangered species into "new" habitat will need to consider the potential impacts on existing land and recreational uses and possible institutional conflicts.

16. Hilton Creek as a partial fish ladder over Bradbury Dam

Some of the technological problems of constructing a fish ladder at Bradbury Dam could be reduced by using Hilton Creek as a natural ladder for part of the elevation gain. This small tributary is located just downstream of Bradbury Dam. During winter flows, rainbow trout/steelhead swim up Hilton Creek to spawn (SYRTAC 1997a). Currently, the fish can reach 625 feet elevation before reaching a natural rock barrier. Removal or modification of this barrier would allow fish to reach 680 feet elevation (USBR property boundary). The crest of Bradbury Dam is at 766 feet elevation. A constructed fish ladder would be required to pass fish from Hilton Creek over the dam to Cachuma Lake. To accommodate passage at different lake levels, several different outlets would need to be constructed at the ladder's upper end. A ladder placed at the natural barrier would need to raise fish 141 feet, which is technologically infeasible. A ladder placed at the property boundary would need to raise fish 86 feet, which could be possible but would require an engineering feasibility analysis. However, the total climb up Hilton and the ladder may still be too difficult for rainbow trout/steelhead to negotiate.

In addition to constructing a ladder, flow sufficient to provide upstream passage of adults will need to be provided from Lake Cachuma through the ladder and down Hilton Creek. In 1995, a year with high numbers of upstream migrants in Hilton Creek (64 adult rainbow trout/steelhead were captured), measured flows ranged from 2-40 cfs (SYRTAC 1997a) and visual estimates of March storm flows exceeded 300 cfs (S. Engblom, pers. comm.)

As discussed above in Alternative 16, however, this alternative does not address the problem of downstream migrating juveniles navigating through Lake Cachuma. The lack of directional flow in the lake eliminates key migratory cues for the smolts migrating downstream to the fish ladder. This alternative would need to be coupled with a trap-and-truck operation for downstream migrants, as described in Alternative 18. Furthermore, allowing the federally listed steelhead to enter Lake Cachuma would have serious consequences for the recreational fishery in the lake. This would raise institutional conflicts with the Fish and Game Commission. All alternatives that transport upstream-migrating adult steelhead above Bradbury Dam (Alternatives 16, 18, 39, and 45) will need to consider the potential impacts on existing land and recreational uses and possible institutional conflicts.

In order to evaluate this alternative further, information would be needed on the technological feasibility of placing a ladder in Hilton Creek. An engineering study would be necessary to design the upper fish ladder between Hilton and Lake Cachuma. Passage flow requirements would also need to be assessed within Hilton Creek up to the ladder and within the ladder. Some information exists in the Synthesis Report, although flashy storm events were usually not recorded. Flows in the ladder could be augmented by the planned Hilton Creek pump/siphon (Alternative 26), depending on the system's discharge capacity.

17. Trap and truck adults from below Bradbury Dam to Lake Cachuma, and outmigrants back downstream

An alternative to the construction and operation of a fish ladder would be to trap-and-truck steelhead around Bradbury Dam. Trap-and-truck operations have been used in other river systems to transport migrating fish around passage barriers. In a trap-and-truck operation, upstream migrants would be trapped somewhere below Bradbury Dam and transported to Lake Cachuma via tanker truck.

Downstream migrants would be trapped above Lake Cachuma and transported downstream to be released in the river just downstream of Bradbury Dam or the estuary. If adopted for implementation, the trapping operation would need to be conducted every year during the spawning and outmigration season (about January-June). In dry years when spawning adults may not enter the Santa Ynez River, juveniles born in previous years may still attempt outmigration, so outmigrant trapping would still have to be conducted.

During periods of low streamflow, trapping and trucking can be an effective and relatively inexpensive method of moving adult fish upstream, but can cause stress and mortality because of high water temperatures during transport and/or low flows in the receiving stream. During high streamflows traps can be difficult to operate successfully because of the large amount of water to be "trapped", high velocities, and large amounts of floating debris and sediment. Even during low-flow years when trapping has the greatest potential to be effective, runoff events will occur which are capable of damaging trapping facilities not removed from the channel. Above Lake Cachuma, a single trapping site could be established on the mainstem, or trapping sites could be established on individual tributaries.

Prior to implementing trap-and-truck operations, surveys would be necessary to identify likely trapping sites above and below Lake Cachuma where flow rates and debris loads are manageable. Hilton Creek is one possible site that could be used collect upstream migrants. On-site reconnaissance and landowner cooperation would be the principal determinants of site selection. Information would also be required on the location and quality of spawning and rearing areas above Lake Cachuma in order to develop a viable plan for releasing adult fish into waters where they could successfully spawn and their progeny would survive through the low-flow season. USFS has collected some information on habitat quality in tributaries above Bradbury Dam. These data need to be evaluated.

As noted earlier, all alternatives that transport upstream-migrating adult steelhead above Bradbury Dam (Alternatives 16, 17, 39, and 45) and thus place an endangered species into "new" habitat will need to consider the potential impacts on existing land and recreational uses and possible institutional conflicts.

18. Trap and truck adults to streams outside the Santa Ynez drainage

If sufficient spawning and rearing habitat is unavailable in the Santa Ynez drainage, the trap-and-truck operations described in Alternative 18 could be used to transport spawning adults to suitable spawning habitat in another system. This alternative would address issues of fish passage and habitat availability in the lower Santa Ynez River system. However, it would not contribute to improving rainbow trout/steelhead populations in the Santa Ynez. Furthermore, it may have adverse effects on fish population dynamics in the receiving streams. Stock transfers such as this would be unacceptable according to the CDFG's stock management policy.

Therefore, this alternative is not a promising candidate for further development. If a stock transfer were to be considered further, additional information would be needed on potential release sites, the availability and condition of suitable habitat, and distance from the capture point in the Santa Ynez River. Problems of potential habitat limitations in other drainages cannot be overlooked. The effects of this action on the species in the receiving streams must also be considered.

3.2.4 PREDATOR CONTROL FOR THE MAINSTEM BELOW BRADBURY DAM

19. Remove warmwater fish below Bradbury Dam

Non-native warmwater fish, such as largemouth bass, bluegill sunfish, and catfish, feed on small fish, such as juvenile rainbow trout/steelhead and arroyo chub. Removal of predatory species could benefit rainbow trout/steelhead and arroyo chub, but the benefits would be temporary because of recolonization from other areas (the mainstem, Lake Cachuma, and/or the tributaries). Methods can vary, but physical capture methods (e.g. nets, traps, electrofishing) that selectively remove predators are preferable to chemical methods (e.g. rotenone) that can kill all fish in a region. However, such capture methods usually do not capture all fish, especially over large areas.

In general, fish control projects have had limited success. A review of 250 fish control projects for a variety of species and environments found that less than 50 percent were considered successful (Meronek et al. 1996). A fish removal project can be ineffective for several reasons. In many systems environmental conditions are more critical in determining fish community structure than predation and competition (Moyle et al. 1983). Thus, efforts to eliminate one species in order to restore another can be ineffective or short-lived because it treats a symptom rather than the cause of the problem (Meronek et al. 1996).

In spring 1997, hundreds of non-native warmwater fish were removed from the Long Pool and the drained stilling basin using box traps and seine nets, as part of the Bradbury Dam seismic retrofit work. It remains to be seen whether this effort will have significant or long-lasting effects. The SYRTAC snorkel surveys can be modified to monitor population recovery by predatory fish.

There are two questions to be asked when evaluating predator control as a management alternative. First, is predation a serious problem for native fish? Susceptibility of juvenile rainbow trout/steelhead to predation has been identified as a serious concern for juveniles that move from Hilton Creek into the long pool and stilling basin. However, if habitat availability and quality are the primary limitations, then removing predators is unlikely to have a significant effect on the populations of native fish. To evaluate this more thoroughly, information is needed on the distribution and abundance of undesirable warmwater fish in the lower Santa Ynez River, which would be used to determine the relative importance of predation as a serious limiting factor for native fish. SYRTAC snorkel surveys of the mainstem (1993, 1995, 1996, and 1997) indicated that largemouth bass are frequently observed in all surveyed river reaches and occasionally in Nojoqui Creek (SYRTAC 1997a). Smallmouth bass have been seen only occasionally in the river immediately downstream of Bradbury Dam, and black bullhead are present in low numbers in the long pool.

The second question is, how effective would a predator removal program be? Complete eradication of nonnative predatory fish would be impossible to achieve. However, some benefits could be achieved from periodically reducing the predator population, most likely through trapping.

3.2.5 FISHING REGULATIONS

20. Fishing moratorium downstream of Bradbury Dam

Under the current regulations, angling in waters of the Southern California Steelhead ESU is prohibited from late November to late May, the weekend before Memorial Day. This includes the waters below impassable dams, such as Bradbury Dam on the mainstem. However, from late May to November, angling is still allowed on a catch-and-release basis with barbless hook. A year-round moratorium on angling in the mainstem and tributaries downstream of Bradbury Dam will reduce disturbance of rainbow trout/steelhead and will complement habitat enhancement efforts to improve population numbers.

3.2.6 POPULATION AUGMENTATION IN THE SANTA YNEZ RIVER BASIN

21. Wild steelhead hatchery

Populations of rainbow trout/steelhead in the Santa Ynez River may be low because there are too few adults to effectively restart the population when good conditions occur. The rainbow trout/steelhead population of the Santa Ynez River could be directly supplemented by producing fish at a hatchery. The progeny would be outplanted into the river as button-up fry (less than 50 mm). Hatchery production would be used to supplement natural production to achieve a self-sustaining population. A hatchery would also provide some element of stability for the population, and serve as a genetic reservoir in the event of poor recruitment within a given year. Filmore Hatchery is one possibility, although there are no plans currently to increase production at this facility (M Cardenas, CDFG, pers. comm.).

The brood stock ideally would come from the Santa Ynez River, likely the residualized rainbow trout in the upper basin (e.g. Fox or Alder Creeks) with genetic characteristics of southern steelhead. Genetic analysis by Nielsen et al. (1994) indicates that fish in the upper basin near Jameson Lake are likely to be derived from southern stocks. If these potential sources are unavailable, the next most preferable stock would be southern steelhead from other nearby streams. Broodstock fish should be genetically screened before selection. Northern steelhead stocks should not be considered because their habitat requirements and life history patterns are thought to be different from those of southern steelhead, which have adapted to warmer conditions.

This type of hatchery would be used only temporarily to improve production. According to policies of the CDFG and Fish and Game Commission, artificial supplementation and rearing would only be allowed if current factors that are limiting the population (e.g.

passage obstacles, habitat disturbances) are alleviated (D. McEwan, CDFG, pers. comm.). Population supplementation should be halted once the number of returning adults is above critical levels. Using the established rearing facilities at Filmore hatchery would be much less expensive than developing a new streamside rearing facility.

22. Transfer broodstock from the upper basin to the mainstem below Bradbury Dam

Even after actions have been taken to improve instream conditions, recovery of the rainbow trout/steelhead population in the mainstem Santa Ynez River may be difficult to accomplish because few adults are returning to spawn. Supplementation of the lower river with adults or eggs from the residualized population of rainbow trout/steelhead upstream of Bradbury Dam could boost production in the lower river. Genetic analysis by Nielsen et al. (1994) indicates that fish in the upper basin near Jameson Lake are likely to be derived from southern stocks (SYRTAC 1997a). Broodstock fish should be genetically screened before selection.

In order to determine the number of fish to be used downstream, information will be required on the location and abundance of suitable spawning habitat and the abundance of rainbow trout/steelhead already present in that location, both resident and returning anadromous fish. The USFS has also collected some information of the genetic status of these upstream populations, as has the SYRTAC. Broodstock should not be collected from stream reaches that have been commonly stocked with hatchery fish, based on data from CDFG and USFS stocking records as well as genetic studies. Additional genetic analyses may be needed for potential source reaches or tributaries in order to ensure the genetic integrity of the broodstock used.

23. Streamside incubators in mainstem

Even if there were enough adults to theoretically recover the population, rainbow trout/steelhead populations may be unable to recover because of poor incubation success in redds. Egg survival might be improved through the use of streamside incubators to maintain ideal conditions for egg growth and survival. Streamside incubators have been used with different species of salmonids, including steelhead. Adult fish (probably residualized rainbow trout/steelhead from the upper watershed of appropriate stocks) are captured and artificially spawned. The eggs are placed in the incubator boxes, which are then placed either within deep clean gravel or on top of a riffle. The newly hatched alevins remain in the incubator until they are ready to emerge from the gravel. When the alevins reach the swim-up stage they typically emerge from the incubator and are carried into the stream through the drainage system. Once in the stream, the fry rear as they naturally would.

Instream incubation techniques have had varying degrees of success (e.g. Harshbarger and Porter 1982, Bams 1985). For example, Harshbarger and Porter (1982) had better survival when brown trout eggs were planted directly into clean gravel compared to twocompartment Whitlock Vibert boxes. Bams (1985) tested three methods on coho salmon and obtained best results with methods that place small groups of eggs in baskets that were put in cleaned-out pockets of gravel. Sedimentation and, to a lesser degree, fungal disease are two challenges in the use of instream incubators (Harshbarger and Porter 1982, Bams 1985).

The incubators would require regular monitoring to clear debris and sediment, depending on the incubator design. The potential risk of establishing a "feeding station", where predators lie in wait for young fish leaving from the incubator, should also be evaluated and addressed in the design of the facility. The use of such devices would require cooperation from landowners where the incubators were placed. Care should be taken during the installation of the incubator to minimize the potential for vandalism (by both humans and animals). Locating the incubators immediately below Bradbury Dam on USBR property would avoid problems of property access and reduce opportunities for vandalism.

To better evaluate the utility of this alternative, information will be needed on the location of springs or other quality water sources in the vicinity of good rearing habitat. Since some methods involve burying containers in gravel, this alternative might be implemented in concert with Alternative 11 (placing gravel in mainstem). Further review of the literature on incubator design and success would be necessary. Cooperative landowners will also need to be identified.

24. Spawning channel in mainstem

An alternative to streamside incubators or gravel placement would be constructing a spawning channel along the mainstem of the Santa Ynez River. This channel would be designed to promote redd construction by adult rainbow trout/steelhead in a location where incubation and rearing had a higher potential for success than elsewhere in the system. If a spawning channel were constructed, rainbow trout/steelhead could enter on their own volition or be released into the channel following trapping. This may provide benefits in reduced natural mortalities and predation.

The cost to design and construct a spawning channel would depend upon its size and configuration. Spawning channels for salmonids in other systems have been constructed beside the river with water control devices to allow the channel to be shut down for maintenance and to prevent damage during high water (Shelton and Pollock 1966, Pollock 1969), or through gravel-rubble islands in the river channel (Mullner & Hubert 1995). The high flows and flashy nature of the Santa Ynez would make maintenance of the channel difficult. Water would have to be made available according to the design specifications to provide adequate depths and velocities for spawning and incubation. Because the channel will only be used during the late winter and spring, problems with water temperature are unlikely. The channel would require periodic maintenance to remove fine sediments and other debris and to replace gravels or cover elements which are washed out of the channel.

Near Bradbury Dam, a spawning channel could be achieved beside the mainstem by extending the channel of Hilton Creek, which is discussed further below (Alternative 33). This offers the opportunity to increase the availability of spawning and rearing habitat for rainbow trout/steelhead with no substantial increase in the volume of water to be allocated to the Hilton Creek Siphon (Alternative 26).

3.3 TRIBUTARIES BELOW BRADBURY DAM

The range of potential management alternatives for the tributaries below Bradbury Dam are outlined in Table 3-3.

3.3.1 FLOW-RELATED MEASURES FOR TRIBUTARIES BELOW BRADBURY DAM

25. Purchase water/water rights for instream flows

As described earlier under Alternative 6, purchasing water from existing water rights holders or the outright purchase of their water rights are two means of increasing streamflow. Both methods would be most advantageous in situations where supplemental water would improve instream habitat conditions by either increasing the amount of streamflow at a particular time of year or ensuring that the stream remains a live stream throughout the year (restoring perennial flow). Acquisition of water or water rights to improve streamflow conditions in an ephemeral stream would provide little benefit to rainbow trout/steelhead unless it was shown that rainbow trout/steelhead only inhabited this stream during a portion of the year, most likely during the spawning and incubation periods, and migrated out as juveniles when the stream dried during the summer.

As noted in Alternative 6, the water rights situation in the Santa Ynez River watershed and current land use policies make this alternative unattractive and likely infeasible. Water rights between Bradbury Dam and the Narrows (including tributaries) are riparian rights. These rights are attached to the land and are not transferable. These rights are not licensed. The only know appropriator of consequence on tributaries is the Alisal Ranch. Riparian diverters can be paid not to pump, or the land could be purchased and retired. However, the water rights cannot be transferred. The permitted groundwater diversions are used for M&I purposes. Current land use policies encourage the preservation of agriculture within the water shed. Purchasing riparian land to retire water rights and consequently the supported agriculture would not be consistent with the Santa Barbara County General Plan.

If this alternative were to be considered for implementation, information would be needed on stream reaches that could most benefit, potential sellers, and the amount of historically diverted water that may be available from willing sellers. The SYRTAC studies will provide data on habitat suitability and occurrence of rainbow trout/steelhead that will facilitate selection of target tributary reaches.

Table 3-3. Potential Management Alternatives for the Tributaries Below Bradbury Dam.

Type	Alt. #	Description
Flow-related measures	25.	Purchase water/water rights to increase instream flow
	26.	Pump/siphon Lake Cachuma water to Hilton Creek
	27.	Continuous pump and/or recycle flows in tributaries
	28.	Groundwater wells to augment tributary flows
Habitat Improvements	29.	Instream structures in tributaries
	30.	Place gravel in tributaries
	31.	Conservation easements on tributaries
	32.	Riparian enhancement along tributaries
	33.	Extend channel of lower Hilton Creek
Fish Passage	34.	Passage barrier removal in tributaries
	35.	Trap & truck adults to tributaries below dam
	36.	Trap & truck outmigrants at tributaries

26. Pump/siphon Lake Cachuma water to Hilton Creek

Hilton Creek provides spawning and juvenile rearing habitat for rainbow trout/steelhead when water is available, as demonstrated by the SYRTAC studies. In dry years, flows in the mainstem Santa Ynez River are too low for anadromous steelhead to migrate upstream to Hilton Creek. Winter storms may produce high flows in tributaries such as Hilton Creek, but these flows do not persist long enough for trout to complete their life cycle. Resident fish below Bradbury Dam may enter Hilton Creek to spawn during these brief high flow periods. However, the creek usually dries during the spring or summer before the fry can complete rearing.

Augmenting flow in Hilton Creek by delivering water from Lake Cachuma would benefit the rainbow trout/steelhead population by maintaining and enhancing available rearing habitat. A temporary pumping system installed by the USBR in the spring 1997 has demonstrated the benefits of maintaining flows in Hilton Creek for spawning and rearing. Young-of-the-year rainbow trout/steelhead were observed in the creek by S. Engblom on July 21.

A permanent water delivery system is currently being developed by the USBR and the SYRTAC. Issues for consideration include selection of a release point, design of the intake structure (the intake depth will affect the temperature and DO of release water), capacity of the water delivery system, energy dissipation and oxygenation of the water at the outfall, maintaining suitable water temperatures, and operational strategies.

Two release points for water into Hilton Creek would increase operational flexibility and the amount of potential habitat. Currently the Bureau is releasing water into Hilton Creek at a site selected by CDFG located just above the passage barrier (elevation 625 feet, Site 2 in Stetson Engineers and Hanson Environmental 1997). A second release point should be located at the upstream boundary of the Bureau's property (elevation 680 feet, Site 1). It may be possible in the future through other management activities to remove or improve the passage barrier near Site 1 (Alternative 32). Having the capability to release water further upstream would therefore increase the amount of potential habitat for rainbow trout/steelhead and improve passage through this reach. It seems unlikely, however, that the supplemental flows would be sufficient to provide passage over the existing barrier and bedrock chute, although further analysis is warranted. One concern about the higher release point is the possibility of increased heating of the water as it passes through an open sheetrock reach just above the passage barrier. This could be ameliorated by adjusting releases between the two points. If stream temperatures in Hilton Creek increase to an unacceptable level, a proportion of the total release can be shifted to the lower point, where shading is greater.

The system should be designed with a maximum discharge capacity of 10 cfs, which could be at either release location. This capacity is based on the maximum release authorized in the past by the SYRTAC for fish. Releases will likely be lower than 10 cfs for most of the facility's operations, with the schedule to be determined according to habitat conditions and fish use. The system should have the ability to make releases of as much as 4-5 cfs at any time of year. This may include making releases during drought periods when Lake Cachuma levels are low.

Rainbow trout/steelhead require cool, well-oxygenated water to survive and grow. Placing the intake well within the hypolimnion in Lake Cachuma would provide water that is cool but low in oxygen. The maximum water temperature at the release point should be 15.5°C (60°F). This will ensure acceptable water temperatures for juvenile rainbow trout/steelhead should some warming occur as water moves downstream. Temperature criteria for rainbow trout/steelhead were recommended in the Fisheries Technical Report (ENTRIX 1995), based on the scientific literature (Hokanson et al. 1977) and CDFG standards in central and southern California. Average daily temperatures should be less than 20°C and daily maximum temperatures should be less than 24°C to allow acceptable trout growth.

Since the water will be withdrawn from the hypolimnion, measures will be required to oxygenate the water before it enters the stream. Rainbow trout/steelhead function normally at dissolved oxygen concentrations of 6-8 mg/l, exhibit various distress symptoms at 5-6 mg/l, and are often negatively affected at 4 mg/l or less (Barhardt 1986). The minimum critical dissolved oxygen for rainbow trout/steelhead is 5 mg/l. Dissolved oxygen levels should be at saturation when the water reaches the stream. This can be achieved through use of baffles or energy dissipation structures at the outfalls.

Information is needed on how the habitat conditions in Hilton Creek vary with flow. Habitat mapping surveys were conducted in 1997, water temperature is being monitored (e.g. during the 4 cfs release started in April 1997), and past trapping studies demonstrate habitat use in different flow years: Based on these studies, operational criteria can be developed according to season and life stage. A source of water for the creek also must be identified.

27. Recirculate/recycle flows in live reaches of tributaries

Recirculating base-level stream flows with a pumping system could be used to improve aquatic habitat within a small portion of tributaries with perennial flow. This sort of recirculation may allow for better flow conditions to occur for a longer part of the dry season. This would require construction of a pumping plant at the lower end of the wetted reach, a means to prevent entrainment of fish in the pump, a pipeline to the upstream release point, and a means to elevate dissolved oxygen, lower water temperature, and minimize the erosion potential of the release water.

As described for Alternative 7, however, this system faces serious technological challenges, would be expensive to operate and maintain, and would improve only limited lengths of stream. Maintaining suitable water temperature and water quality in the recirculated reach would be a major problem during the warmer summer months. This would require some sort of refrigeration or cooling system in addition to a pump. The length of stream selected for recirculation will be critical in determining the costs and potential problems. Augmenting flows in a longer reach may enhance more habitat, but would be more expensive and face more problems with maintaining cool water temperatures and suitable dissolved oxygen levels. A longer stream reach will also increase the loss of water in the recirculating system through percolation and evapotranspiration. Landowner agreement would be necessary for the pipeline easement and construction of the pumping facility. Implementation of this alternative would likely require purchasing water rights and/or finding alternative sources of water.

Information is needed on the technology available to cool the recirculating flow, instream habitat conditions to be improved, percolation and evapotranspiration losses, and the amount of recirculated flow necessary in tributaries to make a notable improvement in habitat conditions.

28. Groundwater wells to augment tributary flow

In perennial tributaries, low-flow conditions and seasonally elevated water temperatures can impair habitat conditions during the summer. A series of groundwater wells could be used to augment instream flows and reduce water temperature during critical periods of low flows. The amount of water provided would probably be about 0.5 cfs or less.

Tributaries on the southside of the Santa Ynez Valley that drain the Santa Ynez mountains are more likely to have perennial flow. Relatively little information exists, however, on groundwater conditions or the potential production of a proposed well field in likely watersheds. Geologic studies generally characterize the consolidated rock aquifers in the Santa Ynez mountains as non-water-bearing, except for fractured sandstone deposits. Well yields are likely to vary widely from one location to another. It is uncertain whether well yields can be sustained for an entire summer season or consecutive years. Well productivity during a multiple-year dry cycle can be expected to decrease since storage within fractured rocks is generally low relative to unconsolidated aquifers. A major consideration is whether these geologic units make significant contributions to base streamflow during the summer months, and whether winter rainfall will replenish storage depleted due to the stream augmentation program.

Depending on the site, the potential location of wells would require conveyance facilities to transport water from the wells to the creek. Consideration would need to be given to identifying the location of existing wells in the area, determination of well yields and sustainability, and the extent of irrigation use of local surface or groundwater in the area. Water quality is another factor, such as water temperatures in discharges to the creek and electrical conductivity (the conductivity in some tributaries is unusually high). The costs for construction, operation, and maintenance of wells, pumps, and conveyance structures are likely to be high. Additional constraints would include the accessibility of potential well sites, requirements for access to private lands, and requirements and costs with providing electrical service. It would also be necessary to consider potential adverse effects on local hydrology due to pumping.

If a stream augmentation program were to be considered further, additional investigation would be required to assess its feasibility. Water quality and instream flow information from candidate tributaries should be evaluated to determine reaches that could benefit from seasonal supplementation to increase existing streamflow and reduce temperatures. Geologic evaluations, identification of potential well sites, and test drilling would be necessary.

3.3.2 Habitat Improvements in Tributaries below Bradbury Dam

Non-flow related habitat improvement measures increase fish populations through improved habitat quality and/or increased habitat availability. The first requirement for fish habitat, however, is water. None of the alternatives described below can be fully effective without dependable streamflow of good quality (i.e. daily average temperatures less than 20°C, daily maximum temperature less than 24°C, dissolved oxygen greater than 5 mg/l) .

29. Instream structures in tributaries

Installation of in-stream structures can improve spawning, foraging and rearing habitat in a number of ways. Placement of in-stream structures can stimulate gravel deposition and form bars and riffles. Pool depth and frequency can be established and maintained by anchoring root wads, logs, or boulders at locations to increase scouring. These structures can also provide cover for fish. Structures are most effective when designed within the context of site-specific habitat limitations, geomorphologic processes, hydrology, and sediment production. Good performance of structures would be more difficult in reaches with low summer streamflow or serious sedimentation problems.

Instream habitat structures vary in costs, generally ranging between $500 and $1,500 apiece for small streams. They should be done a few at a time over 3-4 years to reduce annual expenditures. Any program that relies upon structures will require monitoring and periodic maintenance to ensure that structures are repaired or modified as needed, and to ascertain that habitat enhancement objectives are met.

Information needed to implement this alternative includes habitat typing of tributaries (planned) to identify areas that would benefit from instream structures, hydrology data to determine the flows that the structures will experience, and information on sediment load.

30. Place spawning gravels in tributaries

As discussed under Alternative 11 for the lower mainstem, periodic addition of spawning gravel could improve spawning habitat in the tributaries, but would only be effective in enhancing the rainbow trout/steelhead population if spawning habitat is limiting. Upstream and downstream passage must also be provided, as well as adequate flows for spawning and incubating eggs. Addition of gravel would likely need to be repeated after high flow years in order to maintain a reasonable amount of good quality gravel.

River gravel would be inexpensive to obtain in the Santa Ynez. The major cost would be transportation and placement, which might be as high as $100-$200 per cubic yard for small amounts of gravel (less than 100 cubic yards).

Information is needed on the location and condition of spawning habitat to determine which reaches would most benefit from this alternative, and on tributary hydrology to determine where late summer flows are adequate to support juvenile fish. More habitat studies of the tributaries are planned by the SYRTAC. It would also be necessary to assess landowners' willingness to support gravel placement and restrict access to the stream channel by livestock and humans.

31. Conservation easements on tributaries

The acquisition of conservation easements can be very effective at fostering habitat improvement, both where land use is negatively affecting riparian and aquatic habitat (e.g. removal of riparian vegetation, increased sedimentation from stream crossings), or where frequent access to the stream is required for the maintenance of stream improvements. Conservation easements can foster natural recovery of habitat over time, provided that the land use prohibited by the easement was a contributing factor to the habitat degradation being addressed. Conservation easements can also enhance the success of active intervention through other management alternatives, such as planting riparian vegetation. Voluntary participation by private landowners is critical and can be encouraged by providing incentives such as resolution of regulatory compliance issues, tax incentives, or direct payments. For example, conservation easements might be exchanged for the development and maintenance of livestock watering areas away from the stream.

Priority areas for seeking conservation easements should be identified according to their potential contribution to improving habitat conditions, as well as their potential for facilitating implementation of other management alternatives. The persistence of flows, suitability of habitat (or potential for enhancement), and presence of downstream passage barriers need to be thoughtfully considered before easements are openly pursued. Evaluation of this alternative will also require examination of economic viability, the potential for landowner participation, and grant funding sources.

32. Plant riparian vegetation

Riparian zones perform a number of vital functions that affect the quality of salmonid habitats as well as providing habitat for a variety of terrestrial plants and animals (reviewed in Spence et al. 1996). Propagation of native riparian vegetation can improve stream habitat by reducing streambank erosion, providing cover and shade, and contributing woody debris and leaves to the channel. Bank stabilization reduces erosion and enhances development of undercut banks. Fish can use undercut banks and exposed roots for cover. Shading helps keep water temperatures down, and reduces algal growth. Woody debris adds cover elements to the channel, increases channel complexity, and increases the food base for some types of aquatic macroinvertebrates. Leaves and smaller woody debris also contribute to the food base for aquatic macroinvertebrates, which are the principal food of most fish and amphibians. Terrestrial insects that drop into the stream from streamside vegetation are also valuable food.

Planting or enhancement of riparian vegetation should be implemented only after the cause of the current lack of riparian vegetation is clearly understood. Low ground water levels, scouring stream flows, intensive land use, and livestock grazing are among the many factors that contribute to low density of riparian vegetation. Where these factors can be controlled or mitigated, riparian enhancement may be worth pursuing. If the primary causal factor cannot be mitigated, then any attempts at riparian enhancement will likely fail. The enhancement or expansion of streamside vegetation will likely increase transpiration loss within the stream corridor. The species of vegetation selected for propagation can have a measurable effect on streamflow. Deep-rooted vegetation such as sycamore or cottonwood would be preferable to shallow-rooted vegetation such as willow. Riparian enhancement measures can vary in costs depending on the amount of effort put into the project.

Access problems will limit the feasibility of this alternative. Implementation would require cooperation from landowners to obtain access, plant vegetation or conduct other enhancement activities in the riparian zone, and protect new plants.

The status of riparian vegetation in tributaries needs to be determined in order to assess the need for and feasibility of this alternative (some habitat monitoring data has been collected). Information about hydrology may be available from the USGS. Information on ground water levels should also be obtained.

33. Extend channel of lower Hilton Creek

Additional fishery habitat could be created by extending the lower reach of the Hilton Creek channel by approximately 1,500 feet. The channel extension would be constructed on USBR property. The channel would be designed for flows of 4-5 cfs, although the actual flow schedule would be determined according to the season and habitat conditions. A sluice gate with a 20 x 5 ft concrete control structure would be constructed to divert higher flows (above 15 cfs) to a bypass structure in order to reduce channel damage during the high flow periods. The structure would be designed to accommodate the expected 5-year flood event. Modifications to the Hilton Creek channel will require periodic maintenance as part of fisheries management plan activities.

The Hilton Creek channel would include both pool and riffle habitat, and a portion would have a meandering channel. This modified channel would constructed with boulders, woody debris, suitable gravel, and vegetation to create high value stream habitat. The soil along the proposed channel extension is alluvial, and the seepage rate is expected to be significant. To maintain flow in the channel, the channel bed would be lined with impervious or low hydraulic conductivity material, and overlain with a one-foot thick layer of sand, gravel and cobble. Boulders would be placed in the channel to provide shelter and increase meandering. Riparian vegetation would be planted along the channel to provide shading and maintain cool water temperatures. An impervious streambed, however, may not contribute water to support riparian vegetation outside the immediate channel.

The estimated cost for construction is $150,000, or approximately $100 per linear foot. Additional costs would also be incurred with routine channel maintenance, permitting, and establishment and maintenance of riparian vegetation.

3.3.3 PASSAGE AND MIGRATION MEASURES FOR THE TRIBUTARIES

34. Passage barrier removal in tributaries

Boulder cascades, culverts, and Arizona-type road crossings can be passage barriers for upstream migrants. Removal or modification of these barriers could open up additional spawning and rearing habitat in the upstream reaches of tributaries, which may have more perennial flow. Boulder obstructions could be removed by blasting at minimal cost. For example, removal or modification of a bedrock chute barrier in Hilton Creek would open up approximately 700 feet of habitat upstream. Potential impacts to stream hydrology should be evaluated, however, when considering removal of bedrock or boulder barriers.

Box culverts under state and county roads can impede migration if the concrete bottom forms a broad shallow barrier during low flow. Barriers often form downstream of culverts due to scour of the streambed. Downstream boulder weirs can often provide adequate backwater during high streamflows to drown the culvert outfall and provide passage. If site conditions prevent use of backwater weirs, then the bottom of the box culvert might be modified by adding large roughness elements, or the culvert replaced with a bridge or arch culvert.

To further evaluate this alternative, surveys should be conducted on tributaries for passage barriers, both natural and man-made. Habitat conditions above the barriers should be assessed to determine whether removal of the passage barrier will provide much additional habitat, and hydrological data is needed to determine whether flow is sufficient for spawning and rearing. Removing passage barriers will not significantly improve population levels of rainbow trout/steelhead if suitable spawning and rearing habitat are not available upstream of the barrier (e.g. insufficient streamflow, poor physical conditions). Some tributaries (Hilton Creek) have been surveyed by the SYRTAC and additional surveys are planned.

In addition, it would be necessary to assess the consequences of barrier removal or alteration on stream hydrology and channel conditions, both upstream and downstream of the barrier. Impacts to other riparian and aquatic species should also be evaluated when considering removal of natural barriers, since these features may provide habitat for other species.

35. Trap and truck adults to tributaries below Bradbury

As discussed in Alternative 17, trap-and-truck operations can be used to facilitate upstream passage of adult rainbow trout/steelhead around natural or man-made passage barriers in the mainstem to spawning habitat in the tributaries below Bradbury Dam. Downstream passage is not likely to limit fish populations on the tributaries. This operation would need to be conducted every year during the spawning season (about January-March). For this alternative to be successful, adult steelhead could be trapped in the mainstem or allowed to ascend the mainstem Santa Ynez as far as the tributary barrier.

The first step in implementing this alternative would be the identification of quality rearing habitats in tributaries that were not accessible because of downstream passage barriers. Potential release would be tributary reaches with perennial rearing habitat above passage barriers in the mainstem or that tributary. On-site reconnaissance and landowner cooperation would be the principal determinants of release site selection.

36. Trap and truck outmigrants at tributaries below Bradbury Dam

This alternative can be coupled with another measure to provide upstream passage for adult spawners (Alternative 35) or it can provide downstream passage for residualized steelhead. Trap-and-truck operations can assist downstream migrating juveniles and spawned-out adults if physical barriers or low streamflow conditions prevent downstream passage to and/or through the mainstem. As noted in Alternative 17, downstream transport of juveniles and adults in other systems has generally been less successful than upstream transport of adults because it is more difficult to collect downstream migrants, due to typical high streamflow conditions. Furthermore, large numbers of juveniles must be transported in order to produce a discernible effect in the number of returning adults. Should such an operation be implemented, the release point should be far enough downstream (e.g. the estuary) to avoid other passage problems, and the release should be made in a manner that minimizes thermal shock and/or predation.

This operation would need to be conducted in years when natural flow conditions are likely to substantially reduce outmigrant success. During years when the downstream trap-and-truck operation is in place it would need to be conducted during the spawning (for adults) and outmigration (for juveniles) season (about February-June).

3.4 MAINSTEM SANTA YNEZ RIVER ABOVE BRADBURY DAM

The range of potential management alternatives for the mainstem above Bradbury Dam are outlined in Table 3-4. These actions, however, should be tailored to preserve existing fishery resources above Bradbury Dam and their recreational value. Benefits would be realized only if upstream and downstream passage is provided around Bradbury Dam and Lake Cachuma.

3.4.1 FLOW-RELATED MEASURES FOR THE MAINSTEM ABOVE BRADBURY DAM

37. Modify flow releases from Gibraltar Dam

Habitat in the mainstem Santa Ynez River between Lake Cachuma and Gibraltar Dam could benefit from water released from Gibraltar Reservoir. Water released from Gibraltar Dam would subsequently be recovered and stored in Lake Cachuma, which would provide fisheries and habitat benefit with a minimum of water supply impact. Existing water tight releases (Gin Chow releases) from Gibraltar Reservoir can be coordinated with the proposed releases to minimize transit losses in summer months. According to the Gin Chow decision, the City of Santa Barbara must release up to 616 AF per year, with the actual amount dependent on summer inflow to Gibraltar Reservoir. In dry years, the amount to be released is lower and the flow often percolates into the ground before reaching Lake Cachuma.

This alternative would complement trap-and-truck operations that transport adults to the mainstem above Lake Cachuma (Alternative 39) and trap downstream migrants in the mainstem (Alternatives 17 and 40).

To assess this alternative, information on habitat conditions in the mainstem between Lake Cachuma and Gibraltar is needed. Information regarding habitat-flow relationships would need to be developed for this portion of the river to determine a beneficial release pattern (magnitude and timing) while maintaining water supplies and meeting water rights requirements. Hydrology data is available from the USGS. Some information was collected during the Contract Renewal EIR/EIS (ENTRIX 1995). Water temperature data were collected this past summer during the Gin Chow releases. The other principal consideration will be a means of passing steelhead around Lake Cachuma.

3.4.2 HABITAT IMPROVEMENTS

38. Place gravel in mainstem above Lake Cachuma

Spawning habitat was historically present in the mainstem that is now covered by Lake Cachuma. As discussed for the lower mainstem under Alternative 11, periodic addition of spawning gravel could improve spawning habitat in the mainstem above Cachuma. This measure assumes that the rainbow trout/steelhead population is limited principally by the lack of good quality spawning gravel. However, this alternative would be effective in improving the rainbow trout/steelhead population downstream of Bradbury

Table 3-4. Potential Management Alternatives for the Mainstem Santa Ynez River Above Bradbury Dam.

Type	Alt. #	Description
Flow-related measures	37.	Modify flow releases from Gibraltar Dam
Habitat Improvements	38.	Place gravel in mainstem above Lake Cachuma
Fish Passage	39.	Trap & truck adults from mainstem below dam to mainstem above Lake Cachuma
	40.	Trap and truck downstream migrants in the mainstem above Lake Cachuma
Predator Control	41.	Remove warmwater fish from mainstem above Lake Cachuma
	42.	Remove warmwater fish in L. Cachuma
	43.	Remove warmwater fish in Gibraltar Reservoir
	44.	Remove warmwater fish in Jameson Lake

Dam only if steelhead (outmigrating juveniles and possibly upstream-migrating adults) could be passed around or through Lake Cachuma with very low mortalities. Adequate streamflows for spawning, incubation and fry rearing must also be present.

Geomorphic processes in the channel must be considered in the design of this alternative (Kondolf et al. 1996). The potential stability of a gravel supplementation program will depend on erosion and sediment transport at the site. The current lack of gravels in this reach indicates that gravels do not tend to accumulate there in the long term. This could also have consequences for downstream habitat (e.g. filling of pools). Therefore, spawning gravel would likely need to be replaced after high flow years in order to maintain a reasonable amount of good quality gravel. In cases where fine sediments have covered spawning gravels, the long-term solution should address reduction of fine sediment inputs to the stream.

River gravel itself is inexpensive. The major cost is transportation and placement, which can easily make the total cost of placing small amounts of gravel (less than 100 cubic yards) $100-$200 per cubic yard. It is unknown at this time how much gravel should to be placed to supplement existing spawning habitat.

Information is needed on the location and condition of spawning habitat in the upper mainstem to determine which reaches would benefit. Information is also needed on mainstem and tributary hydrology to determine where flows are adequate for spawning and incubation, as well as the likelihood of flows carrying gravel away. Habitat typing information is needed to determine if adequate rearing habitat is available to support any young produced from the additional spawning areas. Watershed inputs to the reach should be examined to determine the magnitude of fine sediment recruitment that could silt up the gravel. USFS has collected some data to assess habitat quality in the Santa Ynez River upstream of Lake Cachuma. Habitat mapping was performed during the Contract Renewal EIR/EIS for the reach from Los Prietos campground to Gibraltar Dam (ENTRIX 1995).

3.4.3 FISH PASSAGE

39. Trap and truck adults from mainstem below dam to mainstem above Lake Cachuma

This alternative is similar to Alternative 17, except that upstream migrants would be transported further upstream and released in the mainstem Santa Ynez River above Lake Cachuma to continue their upstream migration to spawning habitat in the tributaries. This would address a potential problem of upstream navigation through the large reservoir in the absence of directional flow cues. Downstream migrants would be trapped above Lake Cachuma and transported downstream to be released to the estuary or the river just downstream of Bradbury Dam, depending on the habitat conditions and the age of migrants. This operation will need to be conducted every year during the spawning and outmigration season (about January-June), even in dry years; although spawning adults may not enter the Santa Ynez River in dry years, juveniles born in previous years may attempt outmigration.

Efforts should be made to minimize transport time in order to reduce stress and potential mortalities of the adults in the tanker truck. During the spring, trap-and-truck operations would also be necessary to transport downstream migrating juveniles and spawned-out adults.

At low flows, trapping and trucking can be an effective and relatively inexpensive method of moving fish upstream, but can cause stress and mortality because of the high water temperatures that often accompany low flows. During high flows traps can be very difficult to operate successfully because of the large amount of water to be "trapped", high velocities, and large amounts of floating debris and sediment. Even during low-flow years when trapping has the potential to be most effective, runoff events will occur which are capable of damaging trapping facilities not removed from the channel.

Trapping of upstream migrants should occur in a relatively stable single thread portion of the mainstem some distance above the estuary. A weir would be required to direct fish into the trap. Above Lake Cachuma, a single trapping site for downstream migrants could be established on the mainstem (Alternative 40), or trapping sites could be established on individual tributaries (Alternative 47).

Surveys would be necessary to identify likely trapping sites above and below Lake Cachuma where flow rates and debris loads are manageable. On-site reconnaissance and landowner cooperation would be the principal determinants of site selection. Information would also be required on the quantity and quality of spawning and rearing areas above Lake Cachuma. Successful implementation of this alternative would likely need to be in combination with releases from Gibraltar (Alternative 37) to improve habitat.

All alternatives that transport upstream-migrating adult steelhead above Bradbury Dam (Alternatives 17 and 45) and thus place an endangered species into "new" habitat will need to consider the potential impacts on existing land and recreational uses and possible institutional conflicts.

40. Trap and truck downstream migrants in the mainstem above Lake Cachuma with a "fish gulper"

Downstream-migrating steelhead smolts and spawned-out adult rainbow trout/steelhead from the mainstem Santa Ynez River above Lake Cachuma would have great difficulty navigating downstream in the large reservoir in the absence of flow cues, and young fish would be vulnerable to predatory warmwater fish. A "fish gulper" could facilitate downstream passage by collecting the fish as they migrate downstream in the mainstem above Lake Cachuma. The collected fish would then be transported via a tanker truck to a release site in the mainstem downstream of Bradbury Dam.

The fish gulper facility would require a reasonably stable channel reach that could be completely screened probably with removable screens. The collection mechanism involves placing a screen (1/4" mesh or smaller) diagonally across the stream channel, which will funnel fish down into the narrow apex. The "fish gulper" is a pipe at the apex of the funnel. Water velocity increases as the water is funneled down, so the fish are sucked into the gulper and carried through a pipe to a holding tank. The water is then bypassed or pumped back to the river.

A fish screen and fish gulper would be most applicable and likely to succeed where the streamflow and debris load is very predictable (e.g. in a water diversion facility). Such a facility is not well suited for the flashy debris-laden flows of the Santa Ynez River. The approach velocity of fish screens is typically less than 0.5 ft/sec, which means that any appreciable flows would require a great length of screen. A rough cost estimate is $1,000 per linear foot of screen (4-5 feet tall). High flow events and debris would seriously damage the screens. One solution to this problem would be to remove screens when flows are high. However, anadromous fish like steelhead, typically use the high flows to migrate downstream thus pulling the screens at the collection facility would result in downstream migrants entering Lake Cachuma. Therefore, the fish gulper would be most effective in years with low or moderate flow, but not in years containing high flow. A fish gulper facility would require continuing maintenance during the spring migration season for the removal, cleaning, and installation of screens, as well as supervision of fish capture and transfer.

Information to be sought if the feasibility of a fish gulper is to be considered further would be the duration and magnitude of high flows, typical debris loads, and a survey of the channel to find a suitable site. It would also be useful to estimate the proportions of annual outmigrants moving with high streamflow events.

3.4.4 PREDATOR CONTROL

41. Remove warmwater fish from mainstem above Lake Cachuma

As discussed in Alternative 19, non-native warmwater fish, such as largemouth bass, bluegill sunfish, and catfish, can prey on small fish, such as young rainbow trout/steelhead and arroyo chub. Removal of these predatory fish could benefit native fish, but the benefits would be temporary because of recolonization by survivors or warmwater fish from other areas (the mainstem, Lake Cachuma, spill from Gibraltar Reservoir, and/or the tributaries). It is also unknown whether such predators are a problem above Cachuma. Removal methods can vary, but physical capture methods (e.g. nets, traps) that selectively remove predators are preferable to chemical methods (rotenone) that can kill all fish in a region. However, such capture methods usually do not capture all fish, especially when a large area is being treated. In general, fish removal programs in other systems have often failed or had only short-term success (Meronek et al. 1996).

42. Remove warmwater fish in Lake Cachuma

As discussed in Alternative 19, non-native warmwater fish, such as largemouth bass, bluegill sunfish, and catfish, can prey on small fish, such as young rainbow trout/steelhead and arroyo chub. The warmwater fish population in Lake Cachuma also act as a source of predators for the Santa Ynez River upstream and downstream of the lake. Undertaking removal of warmwater fishes from Lake Cachuma would be technically and economically infeasible, due to the large size of the reservoir, the large numbers of fishes, and the importance of the sport fishery for these species.

43. Remove warmwater fish in Gibraltar Reservoir

As discussed in Alternative 19, removal of non-native warmwater fish, such as largemouth bass, bluegill sunfish, and catfish, has been suggested to reduce predation on small native fish. Warmwater fish in Gibraltar Reservoir can both prey on small fish in the reservoir and invade stream habitat by swimming upstream or being spilled downstream over the dam. Predator removal occurred through natural means several years ago when Gibraltar Reservoir dried up (1989-1991). This incident provides a test of the long-term effectiveness of fish removal in a reservoir. If warmwater fish are currently abundant in Gibraltar Reservoir, this would suggest that a predator removal program would only provide short term benefits. Undertaking removal of warmwater fishes from Gibraltar Reservoir by means other than reservoir drawdown would likely be technically infeasible. If additional flow releases were made from Gibraltar Reservoir in an effort to improve downstream habitat (Alternative 37), the reservoir would be more susceptible to drawdown during drought periods. The frequency of drawdowns could then be evaluated as a potential predator control strategy.

44. Remove warmwater fish in Jameson Lake

As discussed in Alternative 19, non-native warmwater fish, such as largemouth bass, bluegill sunfish, and catfish, can prey on small fish, such as young rainbow trout/steelhead and arroyo chub. The warmwater fish population in Jameson Lake may also act as a source of predators for the Santa Ynez River upstream and downstream of the lake. However, fish removal programs have often failed or had only short-term success (Meronek et al. 1996). Undertaking removal of warmwater fishes from Jameson Lake would likely be technically infeasible.

3.5 TRIBUTARIES ABOVE BRADBURY DAM

The range of potential management alternatives for the tributaries above Bradbury Dam are outlined in Table 3-5. Benefits would be realized only if upstream and downstream passage is provided around Bradbury Dam.

3.5.1 FISH PASSAGE

45. Trap and truck adults from mainstem below Bradbury Dam to tributaries above Lake Cachuma

This alternative is essentially the same as Alternative 17, except that the fish would be released in the tributaries, rather than the mainstem above the dam. This may avoid potential passage problems along the mainstem and in the tributaries.

Information is needed about the quantity and quality of spawning and rearing habitat in the tributary streams, as is information about any passage barriers on these streams. Hydrological information would also need to be developed for the tributaries to determine whether there is sufficient flow available to maintain fish populations on a year-round basis. Some of this information may be available from the USGS. If a stream is considered viable for supporting rainbow trout/steelhead, suitable release points in these tributaries must be identified.

As noted earlier, all alternatives that transport upstream-migrating adult steelhead above Bradbury Dam (Alternatives 16, 17, 18, and 39) and thus place an endangered species into "new" habitat will need to consider the potential impacts on existing land and recreational uses and possible institutional conflicts.

46. Trap and truck outmigrants at tributaries above Bradbury Dam

This alternative is essentially the same as Alternative 17, except the fish traps would be placed in the tributaries rather than on the mainstem. Downstream migrants would be trapped within the tributaries and transported downstream via tanker truck to be released in the river just downstream of Bradbury Dam or the estuary. One potential location for implementation would be Devil's Canyon just below Gibraltar Dam. The City of Santa Barbara is reconstructing their diversion facility near the mouth, and trapping facilities could be incorporated into the design. This alternative would avoid any potential passage problems on the upper mainstem, and would avoid passage problems through the reservoir.

Prior to implementing trap-and-truck operations, surveys would be necessary to identify likely trapping sites where flow rates and debris loads are manageable. The information needed to evaluate this alternative is the same as that for Alternative 39.

Table 3-5. Potential Management Alternatives for Tributaries Above Bradbury Dam.

Type	Alt. #	Description
Fish Passage	45.	Trap & truck adults from mainstem below dam to tributaries above dam
	46.	Trap & truck outmigrants at tributaries
Predator Control	47.	Remove warmwater fish from tributaries above Lake Cachuma
Fish Supplementation	48.	Supplemental rearing facilities on tributaries

3.5.2 Predator Control

47. Remove warmwater fish from tributaries above Lake Cachuma

As discussed in Alternative 19, non-native warmwater fish, such as largemouth bass, bluegill sunfish, and catfish, can prey on small native fish, such as young rainbow trout/steelhead and arroyo chub. Where warmwater fish populations exist in the tributaries above Lake Cachuma, they may impact native species. Reduction of these populations may increase survival of rainbow trout/steelhead and other native species. However, fish removal programs have often failed or had only short-term success (Meronek et al. 1996). Recolonization by fish from Cachuma would be expected in accessible areas of these tributaries.

An assessment of the current population of warmwater fish in the tributaries would need to be conducted to determine the extent of the potential problem. Information is also needed on whether warmwater fish are stocked in the area. As with the other predator removal alternatives, a literature review of the effectiveness of predator removal in enhancing populations would be needed as well. Finally, it should be determined that predators, not habitat, is a serious limiting factor for native fish.

3.5.3 Fish Supplementation

48. Supplemental rearing facilities on tributaries

This alternative would enhance production by providing supplemental rearing opportunities on perennial tributaries upstream of Lake Cachuma, where water is more plentiful. Rearing ponds could be constructed beside the creek. Alternately, sections of one or more creeks could be used as natural raceways, with a weir to confine fish temporarily to the reach and feeder boxes to provide supplemental food for rearing juvenile rainbow trout/steelhead. Implementation of this alternative would require consultation with the U.S. Forest Service for construction of facilities on Forest Service land.

3.6 Biological Benefits Provided by Alternatives

Tables 3-6 through 3-9 review the biological benefits provided by each of the 48 potential management alternatives.

Table 3-6. Biological Benefits Provided by Various Management Alternatives - Mainstem Below Bradbury Dam.

	Management Alternative	Biological Need								
		Improve Habitat	Make new habitat avail	Im-prove water temps	Water Quality (other than temp)	Up-stream passage	Down-stream passage	Veget. and wildlife	Predator control	Supple-ment fish popul.
	Flow-related Measures									
1.	Conjunctive use of water rights releases	X		X	X			X		
2.	Alternate release points along mainstem	X				X?	X?	X?		
3.	Manage flood-control spills	X?				X	X?			
4.	Additional mainstem flow releases	X	X	X	X			X		
5.	Surcharge reservoir for additional mainstem flow releases	X		X	X			X		
6.	Purchase water and/or water rights for flows	X			X	X		X		
7.	Recirculate/recycle flows in mainstem	X		X	X			X		
	Habitat Enhancements									
8.	Riparian enhancement along mainstem	X		X				X		
9.	Mainstem stream channel modifications	X		X	X	X	X			
10.	Instream structures in mainstem (e.g. woody debris, boulders)	X								
11.	Place gravel in mainstem	X								
12.	Conservation easements along mainstem	X			X			X		

Table 3-6. Biological Benefits Provided by Various Management Alternatives - Mainstem Below Bradbury Dam (concluded).

	Management Alternative	Biological Need								
		Improve Habitat	Make new habitat avail	Im-prove water temps	Water Quality (other than temp)	Up-stream passage	Down-stream passage	Veget. and wildlife	Predator control	Supple-ment fish popul.
Fish Passage										
13.	Passage barrier removal in mainstem					X	X			
14.	Passage channel at lagoon beach barrier					X	X			
15.	Fish ladder at Bradbury Dam		X			X				
16.	Hilton Creek as a fish ladder at Bradbury Dam		X			X				
17.	Trap & truck adults from mainstem below dam to Lake Cachuma above dam		X			X				
18.	Trap & truck SYR adults to outside SYR drainage		X							
Predator Removal										
19.	Remove warmwater fish below Bradbury Dam								X	
Fishing Regulations										
20.	Fishing moratorium below Bradbury Dam								X	
Fish Supplementation										
21.	Wild steelhead hatchery									X
22.	Use upstream broodstock for supplementation									X
23.	Streamside incubators along mainstem									X
24.	Spawning channels along mainstem		X							X

Table 3-7. Biological Benefits Provided by Various Management Alternatives - Tributaries Below Dam.

	Management Alternative	Biological Need								
		Improve Habitat	Make new habitat avail	Im-prove water temps	Water Quality (other than temp)	Up-stream passage	Down-stream passage	Veget. and wildlife	Predator control	Supple-ment fish popul.
	Flow-related Measures									
25.	Purchase water/water rights to increase trib flow	X			X	X		X		
26.	Pump/siphon L. Cachuma water to Hilton Creek				X	X				
27.	Continuous pump and/or recycle flows in Tributaries				X	X				
28.	Groundwater wells to augment flow				X	X				
	Habitat Enhancements									
29.	Instream structures in tributaries				X					
30.	Place gravel in tributaries	X			X					
31.	Conservation easements on tributaries	X			X			X		
32.	Riparian enhancement along tributaries	X			X			X		
33.	Extend channel of lower Hilton Creek	X	X		X					
	Fish Passage									
34.	Passage barrier removal in tributaries		X			X	X			
35.	Trap & truck adults to tributaries below dam					X				
36.	Trap & truck outmigrants at tributaries						X			

Table 3-8. Biological Benefits Provided by Various Management Alternatives - Mainstem Above Bradbury Dam.

	Management Alternative	Biological Need								
		Improve Habitat	Make new habitat avail	Im-prove water temps	Water Quality (other than temp)	Up-stream passage	Down-stream passage	Veget. and wildlife	Predator control	Supple-ment fish popul.
	Flow-related Measures									
37.	Modify flow releases from Gibraltar Dam	X				X	X	X		
	Habitat Enhancements									
38.	Place gravel in mainstem above Lake Cachuma	X								
	Fish Passage									
39.	Trap & truck adults from mainstem below dam to mainstem above Cachuma					X				
40.	Trap and truck downstream migrants in the mainstem above Lake Cachuma						X			
	Predator Control									
41.	Remove warmwater fish from mainstem above Lake Cachuma								X	
42.	Remove warmwater fish in Lake Cachuma								X	
43.	Remove warmwater fish from Gibraltar Reservoir								X	
44.	Remove warmwater fish from Jameson Lake								X	

Table 3-9. Biological Benefits Provided by Various Management Alternatives - Tributaries Above Bradbury Dam.

	Management Alternative	Biological Need								
		Improve Habitat	Make new habitat avail	Im-prove water temps	Water Quality (other than temp)	Up-stream passage	Down-stream passage	Veget. and wildlife	Predator control	Supple-ment fish popul.
Fish Passage										
45.	Trap & truck adults from mainstem below dam to tributaries above dam		X			X	X			
46.	Trap & truck outmigrants at tributaries		X				X			
Predator Control										
47.	Remove warmwater fish from tributaries above Lake Cachuma								X	
Fish Supplementation										
48.	Supplemental rearing facilities on tributaries									X

4.1 OVERVIEW OF THE PROCESS

In the previous chapter, potential management alternatives were described that would improve conditions for fishery resources, especially rainbow trout/steelhead, in the Santa Ynez River and its tributaries. In this chapter, these potential management alternatives are screened and ranked using the criteria described below. The purpose of this screening and ranking is: (1) to eliminate infeasible alternatives from further consideration; and (2) to develop a prioritized list of alternatives for further development and evaluation.

Two processes were used to conduct the screening and ranking. The first process involved a two-stage method. In the first stage, screening criteria were applied to each potential management alternative to determine if the action is infeasible and should be dismissed from further consideration. The removal of a proposed alternative occurred only if there is a clear obstacle to implementation that cannot be removed under current funding, legal, land use, or institutional conditions.

In the second stage, the candidate management alternatives were evaluated to assess qualitatively their relative advantages and disadvantages and to rank them according to the degree to which they meet the overall objectives of the management planning process. Several ranking criteria were applied in a three-step hierarchical approach to each candidate management alternative. This three-step ranking process recognized that some criteria are more important than others in evaluation of the alternatives. Members of the Biological Subcommittee and technical experts from the SYRTAC. Were asked to screen and rank each alternative individually.

The second process of screening and ranking used a more holistic approach and involved group discussion. Two workshops were conducted in January in Santa Barbara and Sacramento with members of the Biological Subcommittee and technical experts from the SYRTAC. The objective was to discuss the management alternatives and to identify the most promising suite of alternatives for further development and study. This "top-down" approach complemented the "bottom-up" method of rating each alternative individually. Results from this group process were used to check the results of the individual ranking worksheets.

4.2 SCREENING OF MANAGEMENT ALTERNATIVES

Each candidate management alternative was evaluated relative to the screening criteria listed below. All screening criteria have equal importance, and any alternative that does not pass all criteria is dismissed.

4.2.1 Screening Criteria

1. *Legal or institutional obstacles* – Will existing legal obligations or prohibitions, and/or property rights clearly preclude the implementation of the conservation action? Such obstacles that are not likely to be resolved in a timely and cooperative manner amongst public agencies and private interests would preclude implementation.
2. *Technical infeasibility* – Are proven technical solutions not available to implement the conservation action?
3. *Cost infeasibility* – Are the costs of the conservation action prohibitive for the involved agencies, taking into account: (1) the current financial and legal constraints facing public agencies as they meet their operational costs and debt obligations; and (2) the economic, legal, and political difficulties of developing additional public funds for the capital and operational costs of a conservation action?
4. *Other unacceptable environmental impacts* – Are anticipated detriments to the natural environment, public health and safety, and overall public interest associated with implementation of the conservation action so severe that the action is unlikely to be approved by a regulatory agency?
5. *Not allowable under the Endangered Species Act* – Would the management alternative likely result in jeopardy to listed species along the Santa Ynez River? Listed species include steelhead and tidewater goby.

4.2.2 Screening Process

Most management alternatives successfully passed the screening process except two: installation of a fish ladder at Bradbury Dam (Alternative 15) and removal of predatory fish from Lake Cachuma (Alternative 42). Installation of a fish ladder at Bradbury Dam would be technologically infeasible, due to the dam's great height. Institutional conflicts with the Fish and Game Commission were also a serious impediment to both alternatives. Putting steelhead, an endangered species, directly into Lake Cachuma or removing non-native predatory warmwater fish from the lake would have serious consequences for the important recreational fishery of Lake Cachuma.

4.3 Evaluation of Management Alternatives

4.3.1 Ranking Process

The candidate management alternatives that were not eliminated during the screening process were evaluated using several criteria that address biological benefits, resource allocation, legal or institutional constraints, and incidental environmental impacts. In the process of ranking the candidate management alternatives, we considered eight different criteria. Some evaluation criteria were more important to the decision-making process than others. For example, the likelihood of success should have more influence on the decision than additional environmental benefits. A candidate management alternative with a low likelihood of success should rank lower than a measure with a high likelihood of success and few additional environmental benefits. Similarly, a measure with high likelihood of success and additional environmental benefits should outrank both of the other measures. To provide for different degrees of importance to the ranking process, we used a hierarchical three-step approach.

Level 1 Benefit to Fishery Resources

- **Level 2 Cost and Success Variables**
  - Likelihood of Success
  - Total Cost (capital, operations, maintenance and monitoring)
  - Land and Water requirements
  - Incidental environmental impacts
  - **Level 3 Other Considerations**
    - Operational and maintenance requirements
    - Access to land and stream
    - Institutional coordination and agreements
    - Potential for other incidental biological benefits

We assigned the greatest importance to the biological significance of the alternative relative to improving fishery resources in the lower Santa Ynez, particularly rainbow trout/steelhead. The second highest level of importance was assigned to cost and success variables and included an evaluation of the likelihood of success, total cost, and the need to acquire or reallocate land and water resources. Along with the benefit to rainbow trout/steelhead and other fishes, these are criteria that most heavily influenced the overall ranking of candidate management alternatives. These variables were used to determine which of the highly beneficial alternatives would provide a better alternative than the other similarly ranked beneficial alternatives. In this level, we recognized the technical and biological feasibility and risk of failure. We also include the fiscal costs as well as issues related to reallocation of water and land resources. The final set of variables evaluated included other considerations such as other biological benefits, incidental environmental impacts, the need for institutional coordination, and the effort associated with operations and maintenance. These variables are important to consider but usually they should not outweigh biological benefits, success or resource allocation criteria. Using this hierarchical analysis allowed us to incorporate the evaluation criteria at the appropriate point in the decision process.

Evaluation ratings are relative in nature. That is, the ratings for each action are relative to other actions. For each criterion, there are five rating levels: 1 being the least beneficial or most problematic to 5 being the most beneficial or least problematic. The evaluation criteria are described in more detail in the following sections.

4.3.2 PRIMARY RANKING ACCORDING TO BIOLOGICAL BENEFITS

The most important consideration in evaluating the range of management alternatives is "Will it benefit rainbow trout/steelhead and other fishery resources?" Ranking according to the biological benefits was therefore the first step. The ranking criterion is as follows:

- *Biological benefits* - To what extent would the successful implementation of the management alternative improve habitat conditions for fish (especially rainbow trout/steelhead), population levels, and/or reproduction along the lower Santa Ynez River system ?

Highly ranked management alternatives were those that addressed the most serious factors limiting native fishery resources in the basin, addressed multiple factors, or provided benefits over a wide geographic range or prolonged time period. The primary rankings for the candidate management alternatives are presented in Table 4-1.

The highest biological benefit rankings were given to four alternatives that increased streamflows below Bradbury Dam to improve habitat, both in the mainstem (Alternatives 1, 4, and 5) and in Hilton Creek (Alternative 26). Poor conditions for rearing and oversummering are a problem due to lack of water and poor water quality conditions during the warm, dry summer. Mainstem summer rearing habitat would benefit greatly from flow supplementation through management of water rights releases (Alternative 1) in conjunction with additional releases from the Fish Account (Alternative 4). Surcharging the reservoir with flashboards (Alternative 5) would increase the amount of water available for downstream habitat maintenance and enhancement. In Hilton Creek, a permanent siphon system (Alternative 26) would extend the period when streamflows are present. This is particularly valuable because this creek, which is the closest tributary downstream of Bradbury Dam and is used for rainbow trout/steelhead spawning, frequently dries during the summer rearing period.

Ten other alternatives received relatively high ratings for biological benefit. These included removing passage barriers in the mainstem (Alternative 13) and tributaries (Alternative 34) below Bradbury Dam, and providing passage over Bradbury Dam by constructing a ladder a fish ladder from Hilton Creek (Alternative 16). Habitat enhancement measures included extending the lower channel of Hilton Creek (Alternative 33), and improving certain reaches of the mainstem below Bradbury Dam by installing instream structures to increase habitat complexity (Alternative 10) and modifying the stream channel to provide more pool habitat (Alternative 9). A moratorium on fishing downstream of Bradbury Dam (Alternative 20) was also highly recommended to complement the other management measures. In addition, alternatives to increase flows by purchasing water rights along the mainstem and tributaries (Alternatives 6 and 25) were deemed to have the potential to provide high benefits.

A large number of alternatives were rated as providing moderate biological benefits. These included several measures to improve habitat in tributaries below Bradbury Dam,

Table 4-1. Primary Ranking According to Biological Benefits of Potential Management Alternatives.

Scale: 1 = very low benefit, 5 = very high benefit

	Potential Management Alternatives	Biological Benefits
MAINSTEM BELOW DAM		
Flow-related Measures		
1.	Conjunctive use of water rights releases	5
2.	Alternate release points along mainstem	3
3.	Manage flood-control spills	1
4.	Additional mainstem flow releases	5
5.	Surcharge reservoir for additional mainstem flow releases	5
6.	Purchase water and/or water rights for flows	3
7.	Recirculate/recycle flows in mainstem	2
Habitat Enhancements		
8.	Riparian enhancement along mainstem	3
9.	Mainstem stream channel modifications	4
10.	Instream structures in mainstem (e.g. woody debris, boulders)	4
11.	Place gravel in mainstem	3
12.	Conservation easements along mainstem	3
Fish Passage		
13.	Passage barrier removal in mainstem	4
14.	Passage channel at lagoon beach barrier	1
16.	Hilton Creek as a fish ladder at Bradbury Dam	4
17.	Trap & truck adults from mainstem below dam to Lake Cachuma above dam	2
18.	Trap & truck SYR adults to outside SYR drainage	1
Predator Removal		
19.	Remove warmwater fish below Bradbury Dam	3
Fishing Regulations		
20.	Fishing moratorium below Bradbury Dam	4
Fish Supplementation		
21.	Wild steelhead hatchery	3
22.	Use upstream broodstock for supplementation	3
23.	Streamside incubators along mainstem	2
24.	Spawning channels along mainstem	3

Table 4-1. **Primary Ranking According to Biological Benefits of Potential Management Alternatives (continued).**

Scale: 1 = very low benefit, 5 = very high benefit

	Potential Management Alternatives	Biological Benefits
TRIBUTARIES BELOW DAM		
Flow-related Measures		
25.	Purchase water/water rights to increase tributary flow	4
26.	Pump/siphon L. Cachuma water to Hilton Creek	5
27.	Continuous pump and/or recycle flows in Tributaries	2
28.	Groundwater wells to augment flow	3
Habitat Enhancements		
29.	Instream structures in tributaries	3
30.	Place gravel in tributaries	3
31.	Conservation easements on tributaries	4
32.	Riparian enhancement along tributaries	3
33.	Extend channel of lower Hilton Creek	4
Fish Passage		
34.	Passage barrier removal in tributaries	4
35.	Trap & truck adults to tributaries below dam	2
36.	Trap & truck outmigrants at tributaries	2
MAINSTEM ABOVE DAM		
Flow-related Measures		
37.	Modify flow releases from Gibraltar Dam	3
Habitat Enhancements		
38.	Place gravel in mainstem above Lake Cachuma	3
Fish Passage		
39.	Trap & truck adults from mainstem below dam to mainstem above L. Cachuma	3
40.	Trap and truck downstream migrants in the mainstem above L. Cachuma with "fish gulper"	3
Predator Control		
41.	Remove warmwater fish from mainstem above Lake Cachuma	1
43.	Remove warmwater fish from Gibraltar Reservoir	1
44.	Remove warmwater fish from Jameson Lake	1

Table 4-1. **Primary Ranking According to Biological Benefits of Potential Management Alternatives (concluded).**

Scale: 1 = very low benefit, 5 = very high benefit

	Potential Management Alternatives	Biological Benefits
TRIBUTARIES ABOVE DAM		
Fish Passage		
45.	Trap & truck adults from mainstem below dam to tributaries above dam	3
46.	Trap & truck outmigrants at tributaries	3
Predator Control		
47.	Remove warmwater fish from Tributaries above L. Cachuma	1
Fish Supplementation		
48.	Supplemental rearing facilities on tributaries	3

such as adding gravel for spawning (Alternative 3), improving riparian vegetation (Alternative 32), installing instream structures (Alternative 9), and using groundwater wells to supplement tributary flows (Alternative 28). In the mainstem below Bradbury Dam, moderate biological benefits were expected from habitat enhancements, such as adding gravel (Alternative 11) enhancing riparian vegetation (Alternative 8), obtaining conservation easements (Alternative 12), and constructing a spawning channel (Alternative 24), and from removal of non-native predatory fish (Alternative19).

Several alternatives deemed moderately beneficial included trap-and-truck measures, stock supplementation, and alternate release sites for downstream water rights releases, although there was some disagreement regarding relative rankings. Compared to other reviewers, CDFG staff ranked trap-and-truck and supplementation measures lower and alternate release sites higher in terms of relative biological benefits. We gave four trap-and-truck measures a moderate rating because such actions would open up more spawning and rearing habitat in the upper basin, but would have drawbacks associated with handling the fish. This included transporting migrating adult steelhead from below Bradbury Dam to sites upstream of Lake Cachuma (Alternatives 39 and 45) and, conversely, transporting outmigrating juveniles from the mainstem (Alternatives 39 and 40) or tributaries (Alternative 46) above Lake Cachuma to the lower mainstem. Stock supplementation measures that were judged to be moderately beneficial included moving broodstock from the upper Santa Ynez basin to the lower basin (Alternative 22) and temporarily using a wild steelhead hatchery (21) to boost numbers. Stocking is recommended as a short-term measure to ensure that native wild steelhead stock will be present in the lower Santa Ynez River to benefit from habitat improvements. Use of alternate release sites (Alternative 2) was also rated as providing moderate benefits. This measure may maintain a higher water table in the lower river and thereby improve passage conditions early in the winter migration season, as well as reduce mixing of SWP and Cachuma water at Bradbury Dam outlet works and in the mainstem reaches near the dam during water rights releases.

Several alternatives were judged as providing only low biological benefits. Efforts to recirculate flows in the mainstem or tributaries (Alternatives 7 and 27) received a low rating because they would benefit only a small stream section and maintaining appropriately cool water temperatures would be difficult. Trap-and-truck operations to provide fish passage to and from tributaries below Bradbury Dam (Alternatives 35 and 36) or to place fish directly into Lake Cachuma (Alternative 17) would not be as beneficial as transporting fish directly to habitat above Lake Cachuma. Low-rated alternatives for fish supplementation included instream incubators in the mainstem below Bradbury Dam (Alternative 23) and supplemental rearing facilities on tributaries upstream of Lake Cachuma (Alternative 48).

Finally, seven alternatives were rated as having very low biological benefit for fishery resources because the outcome is questionable or it did not benefit rainbow trout/steelhead and native fishes in the Santa Ynez basin. These included all predator removal measures upstream of Lake Cachuma (Alternatives 41, 43, 44 and 47), managing flood control releases (Alternative 3), constructing a passage channel at the lagoon (Alternative 14), and transporting rainbow trout/steelhead out of the Santa Ynez River system (Alternative 18).

4.3.3 Requirements for Land or Water Rights

Once the management alternatives were ranked according to the biological benefits provided, the second step was to evaluate how well the alternative would perform to benefit native fishes, especially rainbow trout/steelhead, i.e. the likelihood for success. Another important consideration are the costs: economic, land and water, and environmental. Economic costs include both initial and continuing. Another potential obstacle is the land and water rights necessary for implementation of a management alternative. Finally, consideration is made of incidental environmental impacts that could occur as a result of implementation. These ranking criteria are described as follows:

1. *Likelihood of success* - What is perceived as the probability that the management alternative can be implemented in the envisioned manner and will result in the anticipated benefits to natives fishes, especially rainbow trout/steelhead? The likelihood of success included an evaluation of the technical feasibility of the alternative and the degree to which innovative or unproven technology would be required to accomplish the management alternative. It also includes an evaluation of whether fish will respond to the action as anticipated, i.e. will a trapping program be successful in capturing migrating steelhead given poor trap performance in high flows. [Rating: 1 = very low probability of success, 2 = low probability, 3 = moderate probability, 4 = high probability, 5 = very high probability]

2. *Total costs* – What are the estimated costs for the management alternative, including initial planning and permitting costs, capital costs for facilities, and long-term operations and maintenance costs? [Rating: 1 = very high costs, 2 = high costs, 3 = moderate costs, 4 = low costs, 5 = very low costs]

3. *Land and water right requirements* – What is the relative degree of difficulty in acquiring private property or easements, water rights, or legal agreements needed to implement the management alternative? [Rating: 1 = very high difficulty, 2 = high difficulty, 3 = moderate difficulty, 4 = low difficulty, 5 = very low difficulty]

4. *Incidental environmental impacts* – What is the magnitude of associated environmental impacts that would affect other biological resources, public health and safety, water quality, aesthetics, recreation, land use, and socioeconomic conditions? [Rating: 1 = very high impacts, 2 = high impacts, 3 = moderate impacts, 4 = low impacts, 5 = very low impacts].

Table 4-2 presents the results of the secondary ranking. First, the alternatives were divided into five ranked groups according to the biological benefits they provide, ranging from very high to very low. Within each benefit group, the alternatives are roughly arranged according to overall secondary rankings.

Several alternatives received relatively poor rankings (rank = 1 or 2) for one or more criteria, including some alternatives that could provide moderate to high biological benefits. Using Hilton Creek as the first part of a fish ladder over Bradbury Dam (Alternative 16) faces serious problems in terms of technological feasibility, costs, and providing sufficient water for passage flows in the ladder. Technological constraints are also an obstacle for successfully recirculating streamflows (Alternatives 7 and 27). Some alternatives have a low likelihood of successfully improving conditions for native fishes in the lower river, such as handling and transporting fish outside the Santa Ynez basin (Alternative 18), removing predatory warmwater fish from the reservoirs (Alternatives 43 and 44), managing flood control releases in a way that would benefit fish (Alternative 3). Even if a passage channel is constructed at the lagoon barrier when streamflows are insufficient to breach it, upstream passage may not be achieved due to the lack of passage flows in the stream (Alternative 14).

Below Bradbury Dam, great difficulties in acquiring land or water rights would be faced in purchasing water to supplement flows (Alternatives 6 and 25), obtaining conservation easements (Alternative 12 and 31). High costs were also a concern for purchasing water rights, obtaining mainstem conservation easements, installing a "fish gulper" to capture downstream migrating rainbow trout/steelhead (Alternative 40), and installing and powering pumps for streamflow supplementation (Alternatives 7, 27, and 28). The risk of incidental environmental impacts is a problem for the passage channel at the lagoon (Alternative 14) due to tidewater gobies, predator removal strategies (Alternatives 19, 41, 43, 44, and 47), passage barrier removal (e.g. willows, beaver dams) in the mainstem (Alternative 13), and exporting rainbow trout/steelhead to other streams (Alternative 18).

4.3.4 Tertiary Ranking According to Other Criteria

In the final ranking stage the remaining management alternatives were evaluated according to the following criteria:

1. *Operations and maintenance requirements* – What is the relative effort of operation and/or maintenance activities associated with the management alternative? [Rating: 1 = very high effort, 2 = high effort, 3 = moderate effort, 4 = low effort, 5 = very low effort]

2. *Access* – What is the relative degree of difficulty in acquiring access to land, public or private, needed to implement the management alternative? [Rating: 1 = very high difficulty, 2 = high difficulty, 3 = moderate difficulty, 4 = low difficulty, 5 = very low difficulty]

Table 4-2. Secondary Ranking of Potential Management Alternatives.

Rating levels (1 to 5) 1 = Least beneficial or most problematic, 5 = Most beneficial or least problematic

	Location	Potential Management Alternatives	Secondary Ranking Criteria			
			Likelihood of Success	Total Costs	Land & Water Require.	Incidental Environ. Impacts
		VERY HIGH BIOLOGICAL BENEFIT				
5.	Mainstem below Bradbury	Surcharge reservoir for additional mainstem releases	4	4	5	4
26.	Tribs below Bradbury	Pump/siphon L. Cachuma water to Hilton Creek	5	3	4	5
1.	Mainstem below Bradbury	Conjunctive use of water rights releases	5	4	3	4
4.	Mainstem below Bradbury	Additional mainstem flow releases	4	3	2	3
		HIGH BIOLOGICAL BENEFIT				
34.	Tribs below Bradbury	Passage barrier removal in tributaries	5	4	4	3
33.	Tribs below Bradbury	Extend channel of lower Hilton Creek	4	3	4	5
20.	Mainstem & Tribs below Bradbury	Fishing moratorium below Bradbury Dam	3	4	5	4
10.	Mainstem below Bradbury	Instream structures in mainstem	3	4	4	4
9.	Mainstem below Bradbury	Mainstem stream channel modifications	3	4	4	4
13.	Mainstem below Bradbury	Passage barrier removal in mainstem	4	3	4	2
25.	Tribs below Bradbury	Purchase water/water rights to increase tributary flow	4	3	2	5
31.	Tribs below Bradbury	Conservation easements on tributaries	4	3	2	5

Table 4-2. Secondary Ranking of Potential Management Alternatives (continued).

Rating levels (1 to 5) 1 = Least beneficial or most problematic, 5 = Most beneficial or least problematic

	Location	Potential Management Alternatives	Secondary Ranking Criteria			
			Likelihood of Success	Total Costs	Land & Water Require.	Incidental Environ. Impacts
16.	Mainstem below Bradbury	Hilton Creek as a fish ladder at Bradbury Dam	1	2	2	3
6.	Mainstem below Bradbury	Purchase water and/or water rights for flows	3	1	1	4
		MODERATE BIOLOGICAL BENEFIT				
30.	Tribs below Bradbury	Place gravel in tributaries	4	5	5	4
37.	Mainstem above Bradbury	Modify flow releases from Gibraltar Dam	4	5	4	5
32.	Tribs below Bradbury	Riparian enhancement along tributaries	4	4	4	5
29.	Tribs below Bradbury	Instream structures in tributaries	4	4	5	4
22.	Mainstem below Bradbury	Use upstream broodstock for supplementation	3	4	5	4
38.	Mainstem above Bradbury	Place gravel in mainstem above L. Cachuma	3	4	5	4
11.	Mainstem below Bradbury	Place gravel in mainstem below Bradbury	3	4	4	4
8.	Mainstem below Bradbury	Riparian enhancement along mainstem	3	4	3	5
39.	Mainstem above Bradbury	Trap & truck adults from mainstem below dam to mainstem above L. Cachuma	3	3	5	4
45.	Tribs above Bradbury	Trap & truck adults from mainstem below dam to tributaries above dam	3	3	5	4

Table 4-2. Secondary Ranking of Potential Management Alternatives (continued).

Rating levels (1 to 5) 1 = Least beneficial or most problematic, 5 = Most beneficial or least problematic

	Location	Potential Management Alternatives	Secondary Ranking Criteria			
			Likelihood of Success	Total Costs	Land & Water Require.	Incidental Environ. Impacts
46.	Tribs above Bradbury	Trap & truck outmigrants at tributaries	3	3	5	4
2.	Mainstem below Bradbury	Alternate release points along mainstem	3	4	3	4
21.	Mainstem & Tribs below Bradbury	Wild steelhead hatchery	3-4	3	4	3
24.	Mainstem below Bradbury	Spawning channels along mainstem	2	3	4	4
40.	Mainstem above Bradbury	Trap and truck downstream migrants in the mainstem above L. Cachuma using a fish gulper	2	2	5	4
12.	Mainstem below Bradbury	Conservation easements along mainstem	3	2	1	5
19.	Mainstem below Bradbury	Remove warmwater fish below Bradbury Dam	2	3	5	2
28.	Tribs below Bradbury	Groundwater wells to augment flow in tributaries	2	2	3	3
		LOW BIOLOGICAL BENEFIT				
17.	Mainstem below Bradbury	Trap & truck adults from mainstem below dam to L. Cachuma above dam	3	3	5	4
48.	Tribs above Bradbury	Supplemental rearing facilities on tributaries	4	3	4	4
35.	Tribs below Bradbury	Trap & truck adults to tributaries below dam	3	3	4	4
36.	Tribs below Bradbury	Trap & truck outmigrants at tributaries	3	3	4	4
23.	Mainstem below Bradbury	Streamside incubators along mainstem	2	4	5	4

Table 4-2. **Secondary Ranking of Potential Management Alternatives (concluded).**

Rating levels (1 to 5) 1 = Least beneficial or most problematic, 5 = Most beneficial or least problematic

	Location	**Potential Management Alternatives**	**Secondary Ranking Criteria**			
			Likelihood of Success	Total Costs	Land & Water Require.	Incidental Environ. Impacts
27.	Tribs below Bradbury	Pumps to recirculate/recycle flows in Tributaries	1	2	3	4
7.	Mainstem below Bradbury	Pumps to recirculate/recycle flows in mainstem	1	1	2	3
VERY LOW BIOLOGICAL BENEFIT						
47.	Tribs above Bradbury	Remove warmwater fish from tributaries above L. Cachuma	2	4	5	2
41.	Mainstem above Bradbury	Remove warmwater fish from mainstem above L Cachuma	2	3	5	2
14.	Mainstem below Bradbury	Passage channel at lagoon beach barrier	2	4	4	1
3.	Mainstem below Bradbury	Manage flood-control releases	1	4	4	3
18.	Mainstem below Bradbury	Trap & truck SYR adults to outside SYR drainage	1	3	5	2
43.	Mainstem above Bradbury	Remove warmwater fish from Gibraltar Res.	1	3	5	2
44.	Mainstem above Bradbury	Remove warmwater fish from Jameson Lake	1	3	5	2

3. *Institutional coordination and agreements* – What is the relative degree cooperation needed among land owners, sponsor agencies, interest groups, and regulatory agencies to implement the management alternative? Action that require the cooperation of a large number of parties were ranked lower than those requiring the cooperation of a few parties. Alternatives requiring active participation of a local landowners were ranked lower than those requiring the active participation of local governmental agencies or organized groups. [Rating: 1 = very high coordination, 2 = high coordination, 3 = moderate coordination, 4 = low coordination, 5 = very low coordination].

4. *Potential for other incidental biological benefits* – What is the likelihood of incidental beneficial effects occurring to other biological resources or species? [Rating: 1 = very low benefit, 2 = low benefit, 3 = moderate benefit, 4 = high benefit, 5 = very high benefit]

The results of this tertiary ranking are presented in Table 4-3.

Access issues will be especially challenging for obtaining conservation easements (Alternative 12) and purchasing water or water rights (Alternatives 6). Obtaining landowner permission for access will also be problematic (rating = 1 or 2) for several alternatives in the lower Santa Ynez basin, such as mainstem channel modifications (Alternative 9), instream structures (Alternatives 10 and 29), spawning gravel supplementation (Alternative 11 and 30), riparian enhancement (Alternatives 8 and 32), pumps to recirculate streamflow (Alternatives 7 and 27), groundwater wells to supplement tributary flows (Alternative 28), and warmwater fish removal (Alternative 19).

Operations and maintenance requirements will be significant for trap-and-truck operations (Alternatives 35, 36, 39, 40, 45, and 46), pumps to recirculate streamflows (Alternatives 7 and 27), pumps for groundwater wells (Alternative 28), and stock supplementation measures such as a hatchery (Alternative 21), streamside incubators (Alternative 23), and supplemental rearing facilities on upper tributaries (Alternative 48). Operations and maintenance requirements are generally lower for many of the physical habitat enhancements and measures involving water releases from Lake Cachuma.

Greater institutional coordination will be required for certain alternatives. For example, trap-and-truck operations will likely require coordination with the National Marine Fisheries Service, the Department of Fish and Game, and the Forest Service, as well as any landowners where weirs or trapping facilities would be placed.

4.4 CONCLUSIONS

Of the 48 management alternatives originally proposed, only two were screened out prior to the ranking process. A fish ladder at Bradbury Dam (Alternative 15) would be technically infeasible. Removal of predatory warmwater fish from Lake Cachuma

Table 4-3. Tertiary Rating of Potential Management Alternatives.

Alternatives are first arranged according to biological benefit. Within each of the biological benefit groupings, the alternatives are then arranged according to overall secondary ratings. Rating levels (1 to 5) 1 = Least beneficial or most problematic, 5 = Most beneficial or least problematic

	Location	Potential Management Alternatives	Secondary Ranking Criteria			
			O&M Require-ments	Access	Institut. Coordin.	Other Environ Benefits
VERY HIGH BIOLOGICAL BENEFIT						
5.	Mainstem below Bradbury	Surcharge reservoir for additional mainstem releases	4	5	3	3
26.	Tribs below Bradbury	Pump/siphon L. Cachuma water to Hilton Creek	3	5	4	4
1.	Mainstem below Bradbury	Conjunctive use of water rights releases	4	5	3	4
4.	Mainstem below Bradbury	Additional mainstem flow releases	4	5	3	3
HIGH BIOLOGICAL BENEFIT						
34.	Tribs below Bradbury	Passage barrier removal in tributaries	3	2	2	3
33.	Tribs below Bradbury	Extend channel of lower Hilton Creek	4	5	4	3
20.	Mainstem & Tribs below Bradbury	Fishing moratorium below Bradbury Dam	3	4	3	2
10.	Mainstem below Bradbury	Instream structures in mainstem	3	1	3	4
9.	Mainstem below Bradbury	Mainstem stream channel modifications	3	1	3	3
13.	Mainstem below Bradbury	Passage barrier removal in mainstem	2	2	2	2
25.	Tribs below Bradbury	Purchase water/water rights to increase tributary flow	5	2	2	4
31.	Tribs below Bradbury	Conservation easements on tributaries	5	2	2	5

Table 4-3. Tertiary Rating of Potential Management Alternatives (continued).

	Location	Potential Management Alternatives	Secondary Ranking Criteria			
			O&M Require-ments	Access	Institut. Coordin.	Other Environ Benefits
16.	Mainstem below Bradbury	Hilton Creek as a fish ladder at Bradbury Dam	2	5	3	1
6.	Mainstem below Bradbury	Purchase water and/or water rights for flows	5	2	3	4
MODERATE BIOLOGICAL BENEFIT						
30.	Tribs below Bradbury	Place gravel in tributaries	3	2	3	3
37.	Mainstem above Bradbury	Modify flow releases from Gibraltar Dam	4	5	3	4
32.	Tribs below Bradbury	Riparian enhancement along tributaries	4	2	2	4
29.	Tribs below Bradbury	Instream structures in tributaries	3	2	3	4
22.	Mainstem below Bradbury	Use upstream broodstock for supplementation	3	3	2	1
38.	Mainstem above Bradbury	Place gravel in mainstem above L. Cachuma	3	4	3	3
11.	Mainstem below Bradbury	Place gravel in mainstem below Bradbury	3	1	3	4
8.	Mainstem below Bradbury	Riparian enhancement along mainstem	3	2	3	4
39.	Mainstem above Bradbury	Trap & truck adults from mainstem below dam to mainstem above L. Cachuma	2	4	3	1
45.	Tribs above Bradbury	Trap & truck adults from mainstem below dam to tributaries above dam	2	4	2	1
46.	Tribs above Bradbury	Trap & truck outmigrants at tributaries	2	4	2	1
2.	Mainstem below Bradbury	Alternate release points along mainstem	3	3	2	3

Table 4-3. Tertiary Rating of Potential Management Alternatives (continued).

	Location	Potential Management Alternatives	Secondary Ranking Criteria			
			O&M Requirements	Access	Institut. Coordin.	Other Environ Benefits
21.	Mainstem & Tribs below Bradbury	Wild steelhead hatchery	2	5	2	1
24.	Mainstem below Bradbury	Spawning channels along mainstem	3	4	4	3
40.	Mainstem above Bradbury	Trap and truck downstream migrants in the mainstem above Lake Cachuma	2	4	3	1
12.	Mainstem below Bradbury	Conservation easements along mainstem	3	1	3	3
19.	Mainstem below Bradbury	Remove warmwater fish below Bradbury Dam	3	2	2	2
28.	Tribs below Bradbury	Groundwater wells to augment flow in tributaries	2	2	3	4
LOW BIOLOGICAL BENEFIT						
17.	Mainstem below Bradbury	Trap & truck adults from mainstem below dam to L. Cachuma above dam	2	4	2	1
48.	Tribs above Bradbury	Supplemental rearing facilities on tributaries	2	3	2	1
35.	Tribs below Bradbury	Trap & truck adults to tributaries below dam	2	2	2	1
36.	Tribs below Bradbury	Trap & truck outmigrants at tributaries	2	2	2	1
23.	Mainstem below Bradbury	Streamside incubators along mainstem	2	4	3	1
VERY LOW BIOLOGICAL BENEFIT						
27.	Tribs below Bradbury	Pumps to recirculate/recycle flows in Tributaries	2	2	2	4
7.	Mainstem below Bradbury	Pumps to recirculate/recycle flows in mainstem	1	1	3	3
47.	Tribs above Bradbury	Remove warmwater fish from tributaries above L. Cachuma	3	4	2	2

Table 4-3. Tertiary Rating of Potential Management Alternatives (concluded).

	Location	Potential Management Alternatives	Secondary Ranking Criteria			
			O&M Require-ments	Access	Institut. Coordin.	Other Environ Benefits
41.	Mainstem above Bradbury	Remove warmwater fish from mainstem above L. Cachuma	3	3	2	2
14.	Mainstem below Bradbury	Passage channel at lagoon beach barrier	3	4	2	1
3.	Mainstem below Bradbury	Manage flood-control releases	3	5	2	3
18.	Mainstem below Bradbury	Trap & truck SYR adults to outside SYR drainage	2	3	1	1
43.	Mainstem above Bradbury	Remove warmwater fish from Gibraltar Res.	3	4	2	2
44.	Mainstem above Bradbury	Remove warmwater fish from Jameson Lake	3	4	2	2

(Alternative 42) would face serious problems with institutional conflicts in the management of this important recreational fishery.

The most promising 27 alternatives are listed in Table 4-4. Most of these alternatives focus on the lower Santa Ynez River basin below Bradbury Dam. Management alternatives that improved habitat conditions in the lower Santa Ynez basin for oversummering and juvenile rearing received the highest rankings for biological benefits, especially alternatives that would increase flows in the mainstem below Bradbury Dam and in Hilton Creek. Measures to increase flows will be more likely to succeed in the mainstem reaches immediately below Bradbury Dam, where suitable water temperatures can be maintained, and in Hilton Creek, which is close enough to Lake Cachuma to allow flow supplementation. Flow-related alternatives (e.g. conjunctive use of water rights releases, additional mainstem releases from a Fish Account, and Hilton Creek siphon) have the advantage of not requiring access to private property, unlike some of the recommended physical habitat modifications (e.g. mainstem channel modifications, instream structures to improve habitat, adding gravel, and riparian enhancement). On the other hand, habitat enhancement activities are useful for improving conditions at targeted sites to make the most of what water is available. There may be more opportunities to successfully implement physical habitat enhancement on the tributaries, where the stream channels may be more stable and of a more manageable scale. Passive measures, such as purchasing water rights or securing conservation easements, would be valuable for protecting habitat and have little need for continuing management, although they would be expensive and difficult to obtain.

Additional spawning and rearing habitat could also be gained for steelhead by transporting fish around Bradbury Dam. As explained earlier, however, trap-and-truck operations are difficult to implement in high flow years, when the most productive habitat conditions exist, and especially during high flow events, when steelhead would be moving upstream. In low flow years, when trapping would be more feasible, much of the habitat may be either already occupied by resident rainbow trout stock or may be inhospitable for rearing. Because the number of returning adult steelhead is probably low at this time, it may be better initially to implement just the downstream trap-and-truck operations for outmigrating fish from the upper basin. Even with measures to enhance existing habitat below Bradbury Dam and to provide access to habitat above Bradbury Dam, there may be too few rainbow trout/steelhead below Bradbury Dam to sustain the population. Therefore, stock supplementation measures, such as a wild steelhead hatchery or transfer of upper basin broodstock to the lower basin, would be valuable to boost production in the early years while habitat enhancement is underway or to support the population during periods of extended drought or other adverse environmental conditions.

Measures to reduce direct mortality of rainbow trout/steelhead may also be useful, such as a complete moratorium on angling downstream of Bradbury Dam. Removal of warmwater fish from the mainstem below Bradbury Dam could reduce predation on

Table 4-4. Management alternatives recommended for further development and evaluation

(Biological benefits: VH - very high, H - high, M - moderate).

	Management Alternatives	Biol. Benefit		Management Alternatives	Biol. Benefit
MAINSTEM BELOW DAM			**TRIBUTARIES BELOW DAM**		
	Flow-Related Measures			**Flow-related Measures**	
1.	Conjunctive use of water rights releases	VH	25.	Purchase water rights to increase tributary flow	H
2.	Alternate release points along mainstem	M	26.	Pump/siphon Lake Cachuma water to Hilton Creek	VH
4.	Additional water releases (Fish Account)	VH		**Habitat Enhancements**	
5.	Surcharge reservoir for additional water releases	VH	30.	Place gravel in tributaries	M
			31.	Conservation easements on tributaries	H
	Habitat Enhancements		32.	Riparian enhancement along tributaries	M
9.	Mainstem stream channel modifications	H	33.	Extend channel of lower Hilton Cr.	H
10.	Instream structures in mainstem	H		**Fish Passage**	
11.	Place gravel in mainstem	H	34.	Passage barrier removal in tributaries	H
12.	Conservation easements along mainstem	M	**MAINSTEM ABOVE DAM**		
	Fish Passage			**Flow-related measures**	
13.	Passage barrier removal in mainstem	H	37.	Modify releases from Gibraltar Reservoir	M
	Predator Removal			**Fish Passage**	
19.	Remove warmwater fish below Bradbury Dam	M	39.	Trap & truck adults from below dam to mainstem above Cachuma	M
	Fishing Regulations		40.	Trap & truck downstream migrants in the mainstem above Cachuma with "fish gulper"	M
20.	Fishing moratorium in basin below Bradbury Dam	H	**TRIBUTARIES ABOVE DAM**		
	Fish Supplementation			**Fish Passage**	
21.	Wild steelhead hatchery	M	45.	Trap & truck adults from mainstem below dam to tributaries above dam	M
22.	Use upstream broodstock for supplementation	M	46.	Trap & truck outmigrants at tributaries	M
24.	Spawning channels along mainstem	M			

native fishes, although the longevity and effectiveness of such efforts would need to be investigated further.

Many of the alternatives are interdependent. For example, habitat enhancement and flow-related measures to improve habitat upstream of Bradbury Dam are worthwhile only if passage around Bradbury Dam is provided. Spawning habitat improvements downstream of Bradbury Dam, such as adding spawning gravel or creating spawning channels along the mainstem, will aid rainbow trout/steelhead production only if downstream passage barriers are removed.

5.1 INTRODUCTION

In the earlier chapters of this report, we reviewed the hydrological context of the Santa Ynez River, described a range of alternatives for managing fishery resources of the lower Santa Ynez River, and evaluated the merits of each alternative according to the biological benefits provided and constraints for successful implementation. In this chapter we will highlight the most promising alternatives and integrate these into suites of related actions for further development. The prioritized list of management alternatives will help focus and prioritize future SYRTAC investigations and actions. The SYRTAC may decide in the future to revisit or incorporate other alternatives that were not highlighted, should future analysis or a change in circumstances (e.g. improved fish ladder technology) make such alternatives more beneficial or feasible.

This report evaluates a comprehensive range of alternatives and begins a transition to a more detailed plan focused on those actions that have the greatest potential for successfully benefiting fishery resources. It is the next stage in the development of the Fisheries Management Plan that will be required for the SWRCB hearings. The most promising alternatives, as assessed in Chapter 4, are listed again in Table 5-1. These can be integrated into the following suites of actions:

1. Flow-related measures to improve habitat in the mainstem below Bradbury Dam and Hilton Creek
2. Enhancement of physical habitat in the mainstem and tributaries below Bradbury Dam
3. Removal of passage barriers in the mainstem and tributaries below Bradbury Dam
4. Trap-and-truck measures to provide access to habitat above Lake Cachuma
5. Stock supplementation measures
6. Reduction of direct mortality from anglers or predators in the lower basin

Table 5-1. Management Alternatives Recommended for Further Development and Evaluation.

(Biological benefits: VH - very high, H - high, M - moderate).

	Management Alternatives	Biol. Benefit		Management Alternatives	Biol. Benefit
MAINSTEM BELOW DAM			**TRIBUTARIES BELOW DAM**		
	Flow-Related Measures			**Flow-related Measures**	
1.	Conjunctive use of water rights releases	VH	25.	Purchase water rights to increase tributary flow	H
2.	Alternate release points along mainstem	M	26.	Pump/siphon Lake Cachuma water to Hilton Creek	VH
4.	Additional water releases (Fish Account)	VH		**Habitat Enhancements**	
5.	Surcharge reservoir for additional water releases	VH	30.	Place gravel in tributaries	M
			31.	Conservation easements on tributaries	H
	Habitat Enhancements		32.	Riparian enhancement along tributaries	M
9.	Mainstem stream channel modifications	H	33.	Extend channel of lower Hilton Cr.	H
10.	Instream structures in mainstem	H		**Fish Passage**	
11.	Place gravel in mainstem	H	34.	Passage barrier removal in tributaries	H
12.	Conservation easements along mainstem	M	**MAINSTEM ABOVE DAM**		
	Fish Passage			**Flow-related measures**	
13.	Passage barrier removal in mainstem	H	37.	Modify releases from Gibraltar Reservoir	M
	Predator Removal			**Fish Passage**	
19.	Remove warmwater fish below Bradbury Dam	M	39.	Trap & truck adults from below dam to mainstem above Cachuma	M
	Fishing Regulations		40.	Trap & truck downstream migrants in the mainstem above Cachuma with "fish gulper"	M
20.	Fishing moratorium in basin below Bradbury Dam	H	**TRIBUTARIES ABOVE DAM**		
	Fish Supplementation			**Fish Passage**	
21.	Wild steelhead hatchery	M	45.	Trap & truck adults from mainstem below dam to tributaries above dam	M
22.	Use upstream broodstock for supplementation	M	46.	Trap & truck outmigrants at tributaries	M
24.	Spawning channels along mainstem	M			

The following sections briefly review the key features of each suite of actions, the data available to further evaluate and flesh out the actions, and some data gaps that will require additional study. These themes will be developed in greater detail in the upcoming draft Management Plan. The SYRTAC studies, as described in the updated Long Term Study Plan(SYRTAC 1997b), are investigating various aspects of the lower Santa Ynez River, including distribution of different stream habitat types, habitat-flow relationships, fish use of mainstem and tributary habitat, temperature and dissolved oxygen conditions, and genetics of rainbow trout/steelhead. In many cases, these studies have or will generate appropriate data to further evaluate and develop the management actions. For other alternatives, however, additional studies or analyses are necessary.

5.2 SUITES OF MANAGEMENT ACTIONS

5.2.1 FLOW-RELATED MEASURES BELOW BRADBURY DAM

Conjunctive Use of Water Right Releases and the Fish Reserve Account

Water releases can be managed to improve instream flow conditions for fishery resources. This can be achieved through operation of water right releases (Alternative 1) in conjunction with releases from the Fish Reserve Account (Alternative 4). One potential source of water for the Fish Account would come from surcharging the reservoir (Alternative 5). Water would be released either through Bradbury Dam (water rights or Fish Reserve Account releases) or the Hilton Creek siphon (Alternative 26 using Fish Reserve Account water)

The opportunities for and operations of such actions will be affected by annual and interannual variation in rainfall and streamflow. During wet periods there appears to be adequate water for all uses because the reservoir is full, tributary flows are high, and the riparian groundwater basins are relatively full. Extended dry periods will not provide any opportunity for surcharging and use of the Fish Reserve Account will draw the reservoir supplies down below previous levels. Natural flow in the mainstem and tributaries will cease in summer and fall. Releases will be lower, meaning groundwater replenishment in the riparian zone will be less, and any Fish Account releases will have greater percolation, resulting in surface flow moving less far downstream. Also, the Hilton Creek siphon (Alternative 26) cannot function if the reservoir level drops below 720 feet. The Fish Reserve Account would be adaptively managed to reflect these variations in hydrologic conditions. Depending on reservoir storage and spills, the Fish Reserve Account allocation would range from less than 2,000 AF to 3,000 AF, with a maximum carryover each year of 4,000 AF.

One potential source of additional water to benefit downstream fishes is to surcharge Cachuma Reservoir (Alternative 5). To further develop this alternative, information is needed on the amount of additional water that can be stored by surcharging without compromising dam safety. The U.S. Bureau of Reclamation has been analyzing the feasibility and operations of such an action, and conclusions are expected this spring.

The SYRTAC studies of habitat-flow relationships in the mainstem will provide information on habitat conditions that can be expected for a given flow release, while the temperature monitoring and modeling data will identify the mainstem locations where flow augmentation can be effective. More analysis will be required, however, to determine the circumstances under which these actions can be implemented.

To further evaluate the benefits and investigate implementation of making water releases from an alternate site near the Narrows (Alternative 2), we need to understand groundwater relationships in the below Narrows area to determine how releases directly into the recharge area from the CCWA pipeline will affect the water table and streamflow in the lower mainstem below Salsipuedes Creek.

Hilton Creek Siphon

Flow supplementation of Hilton Creek via a siphon from Cachuma Reservoir will be adaptively managed depending on streamflow conditions, availability of Fish Reserve Account water, and the presence of spawning and/or rearing fish. Understanding habitat-flow relationships in Hilton Creek at different flows will be useful in determining seasonal flow requirements for supplementation. We have data on habitat conditions during the 4 cfs releases made in 1997. Additional observations at flows in the 1-10 cfs range will flesh out this picture. However, the peak flows from the heavy 1997-1998 winter storms have dramatically altered the geomorphology of Hilton Creek, and thus new surveys will likely be required.

5.2.2 Physical Habitat Enhancement

Preservation (e.g. purchase of conservation easements) and enhancement of physical habitat conditions (e.g. plant riparian vegetation, install instream structures, modify channel morphology, and place spawning gravel) can be valuable for maintaining and improving conditions at targeted sites to take advantage of available streamflow. This includes actions for the mainstem just below Bradbury Dam (Alternatives 10, 11, 12, and 13) and tributaries such as Salsipuedes-El Jaro Creeks and Hilton Creek (Alternatives 29, 30, 31, and 32). Another promising alternative involves extending the lower channel of Hilton Creek (Alternative 33) to take advantage of the supplemental flows that will be provided by the Hilton Creek siphon.

Successful implementation of physical habitat enhancements may be more likely on the tributaries, where the stream channels are often at a more manageable scale and have a more stable bed than the middle reaches of the mainstem. Prior to implementation, more site-specific information will be necessary to ensure that the particular action chosen will address the problem and will persist. For example, study of the channel geomorphology at selected sites may be warranted to determine whether a boulder or tree stump will be retained and will produce the desired habitat feature. Identification of sites that could potentially benefit from habitat enhancements will come from review of the habitat mapping data collected by SYRTAC field biologists on the mainstem and tributaries, especially Hilton Creek and Salsipuedes-El Jaro Creeks. The extremely high flows experienced in this El Nino winter, however, may necessitate repeating some surveys. Availability of access to the sites will also need to be investigated and pursued.

5.2.3 Passage Barrier Removal

Surveys to identify passage barriers have been conducted in the past, particularly on the mainstem. SYRTAC habitat mapping surveys have been conducted on the mainstem and some tributaries, and passage barriers have been identified. However, the location of some types of barriers (e.g. beaver dams, debris blockages, willows, and sometimes boulders), may vary from year to year. Given the exceedingly high stream flows from this winter's El Nino storms, an additional survey this year is likely warranted. In locations that have not yet been surveyed, habitat conditions above the barriers should be assessed to determine whether removal of the passage barrier will provide much additional habitat, and hydrological data is needed to determine whether flow is sufficient for spawning and rearing.

In addition, it will be necessary to assess the consequences of barrier removal or alteration on stream hydrology and channel conditions, both upstream and downstream of the barrier. Impacts to other riparian and aquatic species should be evaluated when considering removal of natural barriers, since these features may provide habitat for other species.

5.2.4 Trap-and-Truck around Lake Cachuma

Four alternatives offered variations on the themes of upstream transport of spawning adult steelhead to habitat above Lake Cachuma (Alternatives 39 and 45) and downstream transport of outmigrating adults and juveniles (Alternatives 40 and 46). The regions above Lake Cachuma, Gibraltar Reservoir, and Jameson Reservoir have been suggested. Because most of this area is in the Los Padres National Forest, efforts to restore access and enhance habitat conditions here will be coordinated with the U.S. Forest Service.

To further develop these alternatives, more information will be needed on habitat conditions in the upper basin to assess likely sites for releasing adults and capturing outmigrants. The SYRTAC studies to date have focused on the watershed below Bradbury Dam. Some surveying of the habitat in upper tributaries or mainstem reaches will be necessary. Investigation of construction and operation of weir structures and trapping facilities (e.g. fish gulper) should also be undertaken.

If trap and truck is pursued, and the mainstem between Lake Cachuma and Gibraltar is to be used as a release and/or capture site, then habitat enhancement measures in this reach will be investigated (Alternative 37). This will require a survey of habitat conditions in this reach and look at habitat-flow relationships, although the Forest Service has accomplished much of this survey work.

5.2.5 Stock Supplementation Measures

Efforts to supplement rainbow trout/steelhead stocks in the lower Santa Ynez through use of a wild steelhead hatchery (Alternative 21) or transferring adults broodstock from the upper basin to habitat below Bradbury Dam (Alternative 22) will require data on potential source stocks and suitable habitat for releasing young fish. Previous studies suggest that the most likely source would be fish from tributaries high in the basin (e.g. above Gibraltar Dam and Jameson Lake) (Nielsen et al. 1994). Genetic analysis of rainbow trout/steelhead tissues collected in the lower Basin by the SYRTAC studies will also be useful in guiding stocking decisions by identifying localities that may benefit from supplementation with fish of southern stock origin.

Regarding identification of potential release sites, SYRTAC studies have collected information on habitat conditions and fish populations in candidate creeks and reaches for stocking, including Salsipuedes, El Jaro, and Hilton Creeks and the mainstem Santa Ynez River immediately downstream of Bradbury Dam. The specific release sites should have stream flows of suitable water quality (e.g. temperature, dissolved oxygen) and habitat complexity (e.g. feeding and refuge habitat) to support rearing juvenile rainbow trout/steelhead, especially during the summer.

5.2.6 Reduction of Direct Mortality from Anglers or Predators in the Lower Basin

A complete moratorium on recreational angling in the mainstem below Bradbury Dam and associated tributaries would reduce predation pressure on all fishes in the lower basin.

Removal of nonnative warmwater fish in the mainstem below Bradbury Dam (Alternative 20) was rated as moderately beneficial, although questions regarding the likelihood of success nearly cut it from the list. While complete eradication of nonnative predatory fish is impossible, some benefits could be achieved from periodically reducing the predator population. The dewatering of the stilling basin in April 1997 provided the opportunity to assess this alternative further, although the February 1998 spills over Bradbury Dam may have reintroduced warmwater fish from Lake Cachuma. The biannual snorkel survey of relative fish distribution and abundance can be adjusted and expanded in the mainstem immediately below Bradbury Dam to provide information on the recovery of the warmwater fish community, as well as the corresponding relative abundance of native fishes.

5.3 Development of Specific Elements of the Management Plan

This report has reviewed a wide range of management alternatives that could be applied to the Santa Ynez River by providing conceptual descriptions of the actions, discussing the potential biological benefits and the data available from SYRTAC studies and other sources on hydrology, water quality, and fisheries, and discussing some areas for modifying or expanding SYRTAC studies. In the next phase of developing the Fisheries Management Plan, project-level analyses will need to be performed. Examples include:

- Develop project-specific design criteria
- Develop preliminary and final engineering plans

- Develop estimates of capital and annual operating and maintenance costs
- Identify CEQA and/or NEPA environmental documentation requirements and permitting
- Identify specific agencies and/or individual landowners responsible for the review and approval of proposed project elements
- Obtain access agreements to lands not under the direct control of USBR
- Develop detailed plans for project construction and operation
- Develop detailed plans for project monitoring and evaluation

The specific information required to identify and implement actions as part of the Fisheries Management Plan will vary depending on the proposed action, limitations and constraints including requirements for public safety, approvals and authorizations, and compliance with environmental regulations and permitting, such as the Endangered Species Act.

Avery, E. L. 1996. Evaluations of sediment traps and artificial gravel riffles constructed to improve reproduction of trout in three Wisconsin stream. North American Journal of Fisheries Management 16:282-293.

Bams, R. A. 1985. Comparison of three instream incubation techniques for coho salmon. North American Journal of Fisheries Management 5:159-172.

Bates, K. M. 1997. Fishway design guidelines for Pacific salmon. Washington Department of Fish and Wildlife. Working Paper 1.6, 1/97.

Bovee, K. D. 1978. Probability of use criteria for the family Salmonidae. Instream flow information paper number 4. U.S. Fish and Wildlife Service. FWS/OBS-78/07. 53 pp.

California Department of Water Resources. 1988. Cachuma Lake Enlargement Fish and Wildlife Resources 1987 Annual Report.

Capelli, M. 1997. Tidewater goby (*Eucyclogobius newberryi*) management in California estuaries. Proceedings of the California and World Ocean Conference, March 24-27, 1997, San Diego, CA.

ENTRIX. 1995. Fish resources technical report for the EIS/EIR, Cachuma Project Contract Renewal. December 5, 1995. Prepared for Woodward-Clyde Consultants.

Harshbarger, T. J. and P. E. Porter. 1982. Embryo survival and fry emergence from two methods of planting brown trout eggs. North American Journal of Fisheries Management 2:84-89.

Hokanson, K. E., C. F. Kleiner, and T. W. Thorsland. 1977. Effects of constant temperatures and diel temperature fluctuations on specific growth and mortality rates and yield of juvenile rainbow trout, *Salmo gairdneri*. Journal of the Fisheries Research Board of Canada 34:639-648.

Jones and Stokes Associates. 1997. Santa Ynez River Vegetation Monitoring Study, Santa Barbara County, California: Final Phase 1 Report. September 1997. Prepared for the Santa Ynez River Vegetation Oversight Committee.

Kondolf, G. M., J. C. Vick, and T. M. Ramirez. 1996. Salmon spawning habitat rehabilitation on the Merced River, California: an evaluation of project planning and performance. Transactions of the American Fisheries Society 125:899-912.

LaFreniere and French. 1968. *Ground-Water Resources of the Santa Ynez Upland Ground-Water Basin, Santa Barbara County, California.* United States Geological Survey Open File Report.

Meronek, T. G., P. M Bouchard, E. R. Buckner, T. M. Burri, K. K. Demmerly, D. C. Hatleli, R. A. Klumb, S. H. Schmidt, and D. W. Coble. 1996. A review of fish control projects. North American Journal of Fisheries Management 16:63-74.

Moyle, P. B., B. Vondracek, and G. D. Grossman. 1983. Responses of fish populations in the North Fork of the Feather River, California, to treatments with fish toxicants. North American Journal of Fisheries Management 3:48-60.

Mullner, S. A. and W. A. Hubert. 1995. Selection of spawning sites by kokanees and evaluation of mitigative spawning channels in the Green River, Wyoming. North American Journal of Fisheries Management 15:174-184.

Nielsen J. , J.M. Wright, D..B. Morris, W.K. Thomas. 1994. Biogeographic distributions of mitochondrial and nuclear markers for southern steelhead. Molecular Marine Biology and Biotechnology 3(5):281-293.

Pollock, R.D. 1969. Tehama-Colusa Canal to serve as spawning channel. Progressive Fish-Culturist 31:123-130.

Santa Barbara County Flood Control and Water Conservation Agency. 1990. *Precipitation Data Report.*

Santa Barbara County Flood Control and Water Conservation District. 1992. Environmental Impact Report: Channel Maintenance Program. Santa Ynez River near Lompoc.

Santa Barbara County Flood Control and Water Conservation District. 1993. *Precipitation Report and Hydrology Methods.*

Santa Ynez River Technical Advisory Committee. 1997a. Synthesis and Analysis of Information on the Fisheries Resources and Habitat Conditions of the Lower Santa Ynez River: 1993-1996.

Santa Ynez River Technical Advisory Committee. 1997b. Long term study plan, 1997 update.

Shelton, J. M. and R. D. Pollock. 1966. Siltation and egg survival in incubation channels. Transactions of the American Fisheries Society, 95:183-187.

Spence, B. C., G. A. Lomnicky, R. M. Hughes and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. Report prepared for National Marine Fisheries Service, Environmental Protection Agency, and U.S. Fish and Wildlife Service by Management Technology. December 1996. TR-4501-96-6057. 356 pp.

Stetson Engineers and Hanson Environmental. 1997 Preliminary report on feasibility of Hilton Creek Siphon Project. January 8, 1997.

Swift et al. 1997. Biology and Distribution of the Tidewater Goby, Eucyclogobius newberryi, on Vandenberg Air Force Base, Santa Barbara County, California.

Woodward Clyde Consultants. 1995. *Final Environmental Impact Report/Statement. Cachuma Project Contract Renewal*

APPENDIX A

FLOW GAGING SITES - SANTA YNEZ RIVER AND TRIBUTARIES

Table A-1. Gaging Stations - Santa Ynez River and Tributaries above Bradbury Dam.

Stream Gage	USGS Station ID	Period of Gage Record (Water Years)	Unit Area (sq. mi.)	Distance to Ocean (miles)	Comments
		TRIBUTARIES			
Blue Canyon		None found		80	Left bank, no flow information
Mono Creek		City of Santa Barbara, 1929-35, miscellaneous		75	Enters SYR just above Gibraltar Reservoir (right bank), has silted up dam
Camuesa Creek		City of Santa Barbara 1929-35, miscellaneous		73	Drains into Gibraltar Reservoir (right bank)
Gidney Creek		City of Santa Barbara 1929-35, miscellaneous		72	Drains into Gibraltar Reservoir (left bank)
Devil's Canyon		City of Santa Barbara 1931, 1995-7		70	Diversions to City of Santa Barbara, below Gibraltar, left bank
Hot Springs Creek		City of Santa Barbara, 1929-35		59	Left Bank, at top of Cachuma Reservoir
Santa Cruz Creek above Stuke Canyon	11124000	1947-52	64.9	51	Drains into Cachuma Reservoir (right bank)
Santa Cruz Creek	11124500	1941-1994?	74.0	51	Drains into Cachuma Reservoir (right bank)
Cachuma Creek	11125000	1951-62	23.8	48	Drains into Cachuma Reservoir (right bank)
		MAIN STEM			
Santa Ynez at Jameson Lake	11121000	1989-present	13.9	85	
Gibraltar Dam Release	11121010	1989-present, City of Santa Barbara, 1920-present	NA	71	Used for Gin Chow Release
Santa Ynez above Gibraltar Dam	11122000	1904-1918, 1920-present	216.0	75	Reports inflow to Gibraltar
Santa Ynez below Gibraltar Dam	11123000	1920-present	216.0	71	Spills and releases below the dam
Santa Ynez below Los Laureles Cyn	11123500	1947-present	277.0	58?	Measures inflow to Cachuma Reservoir

Table A-2. Gaging Stations - Santa Ynez River and Tributaries below Bradbury Dam.

Stream Gage	USGS Station ID	Period of Record (Water Years)	Unit Area (sq. mi.)	Distance to Ocean (miles)	Comments
		TRIBUTARIES			
Hilton Creek				48	Left bank, little historical flow data, permanent watering system planned
San Lucas Creek	11127000	1953-54	3.2	46	
Santa Agueda Creek	11126500	1941-71; 1977-78 City of Santa Barbara, 1929-35	55.8	44	Right Bank
Zanja de Cota Creek	11127500	1955-61 City of Santa Barbara 1929-35	13.8	41	Right Bank, same as Santa Cota Creek?
Quiota Creek		None found		40	Left Bank, little flow data
Alamo Pintado Creek	11128250	1971-85; 1990-92 City of Santa Barbara 1929-35	29.4	39	Right Bank
Alisal Creek	11128400	1955-1957-72 City of Santa Barbara, 1929-35	12.3	38	Left Bank, flow barrier, dam upstream
Nojoqui Creek	11129000	1953-54 City of Santa Barbara, 1929-35		34	Left Bank
Zaca Creek	11129800	1964-1992	32.8	33	Right Bank
	11130000	1941-63	39.4		
Santa Rosa Creek		City of Santa Barbara, 1929-35		26	Right Bank
Santa Rita Creek		None found		20	Right Bank
Salsipuedes Creek	11132500	1941-present City of Santa Barbara 1929-35	47.0	15	Left Bank
Purisima Creek	11133700	1970-75	4.8	11	Right Bank
Miguelito Creek	11134800	1970-present	11.6	9	Left Bank, lined & straightened through Lompoc

Table A-2. Gaging Stations - Santa Ynez River and Tributaries below Bradbury Dam (concluded).

Stream Gage	USGS Station ID	Period of Record (Water Years)	Unit Area (sq. mi.)	Distance to Ocean (miles)	Comments
MAIN STEM					
Bradbury Dam Spill and Releases		1956-present	417		Bureau of Reclamation
Santa Ynez near Santa Ynez	11126000	1930-76; 1994-present	422	45	San Lucas Bridge
Santa Ynez at Grand Avenue, near Santa Ynez	11128000	1955-1965	513	?	
Santa Ynez at Solvang	11128500	1929-40; 1947-present	579.0	38	
Santa Ynez at Buellton	11129500	1955-59 1952-74	611		Unclear where these gages were located
Santa Ynez near Buellton	11130500	City of Santa Barbara 1929-35	668		
Santa Ynez at Narrows near Lompoc	11133000	1947-present	789.0	14	Measures BNA
Santa Ynez near Lompoc	11133500	1907-18; 1925-60	790.0	13	
Santa Ynez at Pine Canyon near Lompoc	11135000	1941-46; 1964-83	884.0	7.5	
Santa Ynez at barrier, near Surf	11135500	1947-65	895	0	Poor record influenced by tides