Fishery Habitat Investigations on the Santa Ynez River Downstream of Bradbury Dam

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My name is Dr. Charles H. Hanson. I reside in Walnut Creek, California. I am a principal in the firm of Hanson Environmental, Inc. My office is located at 132 Cottage Lane, Walnut Creek, California 94595. I work as a consultant in the area of fisheries surveys and population monitoring, evaluation of factors affecting survival and geographic distribution of various fish species, including, but not limited to, investigations of river flows, estuarine habitat conditions, and water temperature effects on Chinook salmon, steelhead, and other fish species. In addition, I have been extensively involved in both State and federal Endangered Species Act issues, including biological monitoring of listed fish species, participation in listing decisions, preparation of biological assessments, preparation of Habitat Conservation Plans, and as a member of the U.S. Fish and Wildlife Service (USFWS) Sacramento/San Joaquin Delta Native Fishes Recovery Planning Team and as a member of the NOAA Fisheries Biological Review Team for Central Valley salmonids.

My academic training includes Bachelor of Science and Master of Science degrees in fisheries from the University of Washington College of Fisheries, graduate studies in environmental engineering, and a Ph.D. in fisheries and ecology from the University of California, Davis. I have been involved in issues related to the status of fish species in California since 1976. I have been involved in conducting and reviewing results from fishery investigations on the Santa Ynez River since 1993. I have been a participant in the Santa Ynez River Technical Advisory Committee since its inception, and currently participate on the Adaptive Management Committee. I was the principal scientist responsible for preparation of the Santa Ynez River Fishery, Hydrology, and Habitat Synthesis Report completed in 1997. I have also participated in development of the Biological Assessment and Section 7 Consultation addressing Santa Ynez River steelhead protection.

The following testimony briefly describes the life cycle and habitat requirements for steelhead, which serves as part of the foundation for identifying potential fishery management actions that would protect and enhance habitat conditions on the lower Santa Ynez River for the species. The testimony also includes a brief description of a number of the scientific studies and fishery investigations that have been conducted on the lower Santa Ynez River that further provide the technical foundation for developing and evaluating potential fishery management actions.

Cachuma Member Units Exhibit No. 224

Steelhead Life History

Steelhead are an anadromous species, living part of their life in the ocean but returning to freshwater rivers and streams to spawn and for juvenile rearing (Figure 1). Adult steelhead enter freshwater rivers and streams in the winter, usually after the first substantial rainfall, and move upstream to suitable spawning areas. Spawning can occur in winter or spring, generally in riffle areas with clean coarse gravel. During spawning, the female steelhead clears and cleans a depression in the gravel (redd) where eggs are deposited, fertilized, and incubate until hatching. After the eggs hatch, fry emerge from the gravel and disperse through the stream, typically occupying shallow low-velocity areas along stream margins. Juvenile steelhead often move to deeper pools and higher velocity areas as they grow, and remain in freshwater for one to two years before migrating to the ocean. Downstream movement of adults after spawning and juveniles migrating to the ocean usually occurs from March through May, depending on stream flow conditions. Adults can spawn more than once, although most do not spawn more than twice.

Steelhead habitat is generally characterized by clear, cold water, abundant instream cover, well-vegetated stream banks, relatively stable water flow, and stream features including pools and riffles. Although suitable water temperatures for steelhead in California are considered to range from 10 to 20 C, southern steelhead have been observed in streams with peak daily water temperatures above 25 C during summer and early fall.
A well-developed riparian corridor is an important component in southern steelhead streams. Riparian vegetation inhibits erosion of stream banks during high flows, maintains lower stream temperatures, and provides organic input to the stream. Suitable spawning gravels are 0.5 to 3 inches in diameter, 8 inches in depth or more, not heavily compacted, and have low amounts of sand or silt; however, steelhead can successfully spawn in gravels not meeting these characteristics. Good rearing habitat contains low current velocities (such as behind boulders or other velocity barriers) and good cover (e.g., undercut banks, logs or brush, surface turbulence). Cobble embeddedness (amount of sediment surrounding rocky substrate) is a measure of shelter availability for aquatic insects (food for fish) and young fish. Embeddedness also indirectly evaluates habitat suitability for incubation of fish eggs and for salmonid overwintering.

Streamflow within the southern extent of steelhead range varies seasonally and annually. In California coastal drainages, droughts of one or more years can cause intermittent flow in late summer and fall with reductions in pool depths, reducing the quality and quantity of available habitat. Although southern steelhead can withstand substantial seasonal and annual fluctuations in stream flow and other physical conditions, prolonged drought can result in substantial mortality to juvenile fish.

Migration. Adult steelhead tend to migrate upstream from the ocean after prolonged storms when the sand bar at the stream mouth has been breached. The migration seldom begins earlier than December and may extend into May if late spring storms develop. Most adult migration and spawning likely occur during the wettest months, January through March.

Adult steelhead may be blocked in their upstream migration by bedrock falls, shallow riffles and, rarely, major logjams. Man-made structures such as culverts, gauging stations, bridge abutments and dams are often significant migration impediments and/or barriers. Some barriers may completely block upstream migration, but many barriers in coastal streams are passable at higher streamflows (impediments). If the barrier is not absolute, some adult steelhead are able to pass in most years, since they can time upstream movements to match peak flow conditions.

Smolts (young steelhead physiologically transformed in preparation for ocean life) in coastal streams tend to migrate downstream to the lagoon and ocean in March through June. In streams with lagoons, young-of-the-year fish may migrate downstream in late spring and early summer to spend several months in the highly productive lagoon habitat and grow rapidly. Early closure of lagoons by sandbars may adversely affect out-migration of smolts.

Spawning. Steelhead require spawning gravels (from 0.5 to 3-inch diameter) having a minimum of fine material (sand and silt). Increases in fine materials from sedimentation, or cementing of gravels with fine materials, restrict water and oxygen flow through the redd (nest) to the fertilized eggs. These restrictions increase egg mortality. In many streams, steelhead utilize substrates for spawning with high percentages of coarse sand, which may reduce hatching success. Large woody debris forms depositional sites for gravel and spawning habitat.

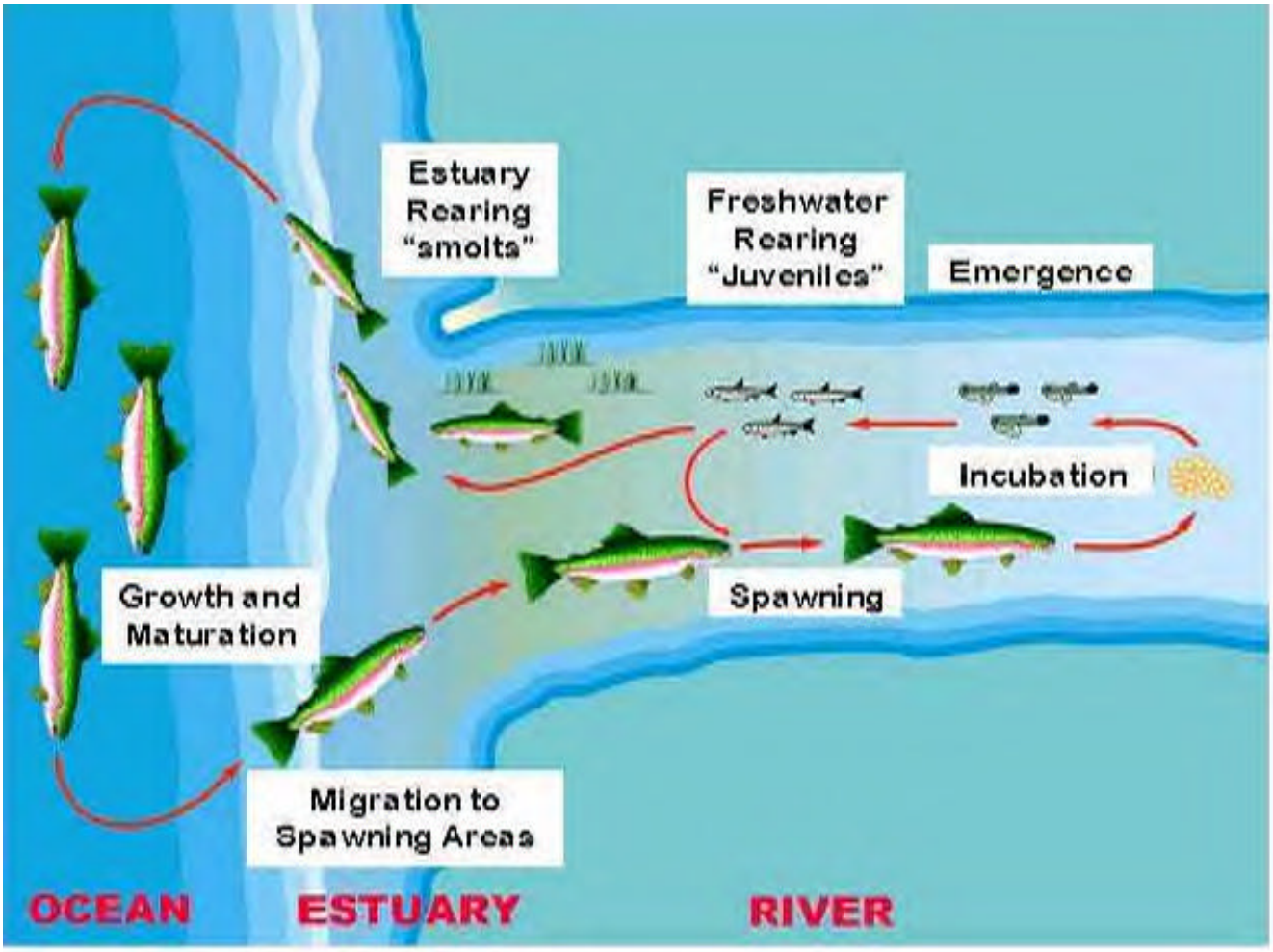
Steelhead that spawn earlier in the winter than others in the population are more likely to have their redds scoured out or buried by sediment deposited during winter storms. Unless hatching success has been severely reduced, survival of eggs and larvae is usually sufficient to saturate the limited available rearing habitat in most coastal streams. Production of young-of-the year steelhead is related to spawning success, which depends on the quality of spawning conditions and ease of spawning access to suitable spawning habitat in the mainstem river or tributaries.

Rearing Habitat. Except in streams with high food production, most juvenile steelhead require two summers of residence before reaching smolt size. In productive systems with suitable water temperature and food availability, a high proportion of steelhead require only one summer of residence before reaching smolt size. Juvenile steelhead are identified as young-of-the-year (first year) and yearlings (second year). Young-of-the-year steelhead growth and survival appears to be regulated by available insect food and water temperatures. Escape cover (hiding areas provided by undercut banks, large rocks not buried or embedded in finer substrate, surface turbulence, etc.) and water depth in pools, runs and riffles are also important, especially for larger fish. Pool and run habitats are the primary rearing areas for steelhead in summer, with pools most important to larger fish. Availability of cover is an important factor affecting juvenile steelhead survival during the low-flow summer months.

Growth rates of yearling steelhead usually show a large incremental increase from March through May. As smolts mature physiologically they emigrate downstream to the ocean. For steelhead, which continue to rear in the stream over a second summer, summer growth is very low (or even negative in terms of weight). A growth period may also occur in fall and early winter after leaf-

drop of riparian trees and before water temperatures decline or water clarity becomes too turbid for feeding.

Overwintering Habitat. Deeper pools, undercut banks, side channels, and large, unembedded rocks provide shelter for steelhead against the high flows of winter. Extreme floods may make overwintering habitat the critical factor in steelhead production in some years. In most years, if pools have sufficient larger boulders or undercut banks to provide summer rearing habitat for yearling steelhead, these elements are sufficient to protect juvenile steelhead against winter flows.



Steelhead trout life-cycle.

Figure 1. Steelhead life cycle.

Fishery Habitat Investigations on the Santa Ynez River Downstream of Bradbury Dam

A program of cooperative fisheries investigations has been underway on the lower Santa Ynez River, between Bradbury Dam and the Santa Ynez River Lagoon since 1993. The fishery investigations and monitoring program are ongoing. Participants in the program include the U.S. Bureau of Reclamation (USBR), California Department of Fish and Game (CDFandG), U.S. Fish and Wildlife Service (USFWS), various water project operators, and local environmental interest groups. The overall framework for the program of investigations has been established through a "Memorandum of Understanding (MOU) for Cooperation in Research and Fish Maintenance" on the Santa Ynez River, downstream of Bradbury Dam. The MOU established a Santa Ynez River Technical Advisory Committee (SYRTAC) and Adaptive Management Committee (AMC) with the ultimate goal of "developing recommendations for long-term fisheries management, projects, and operation" in the lower river. The MOU and SYRTAC were established in response to State Water Resources Control Board (SWRCB) actions dealing with Bradbury Dam and the lower Santa Ynez River that culminated in the SWRCB requesting flow recommendations for maintenance of Public Trust Resources in the lower river. The MOU and SYRTAC/AMC were also established to broaden the scope of management options to protect Public Trust Resources within the lower river with specific emphasis on steelhead which have been listed for protection under the federal Endangered Species Act (ESA), to attempt to accommodate the needs of all interested parties, and ultimately to develop mutually acceptable management options to balance competing needs for water and other resources associated with the Santa Ynez River.

The waters of the Santa Ynez River have many uses, including maintenance of Public Trust Resources, both within Lake Cachuma and downstream of Bradbury Dam, as well as consumptive urban and agricultural uses within the Santa Ynez Valley and along the coastal plain encompassing the City of Santa Barbara. Water management, urban encroachment, agriculture, flood control, and gravel mining have all raised concerns over the condition of the Public Trust Resources of the lower river. The existence of these activities has also raised concern about the economic and social impacts of efforts to significantly alter the existing flow regime of the river.

In order to respond to concerns about providing a reasonable balance in the allocation of Santa Ynez River water between Public Trust Resources and competing consumptive uses, as well as between Public Trust Resources within Lake Cachuma and Public Trust Resources downstream of Bradbury Dam, a series of monitoring studies was initiated to provide the technical basis for developing management and policy decisions regarding aquatic resources and their associated habitat downstream of the dam. The overall goal of these studies has been to identify reasonable flow and non-flow measures that will improve habitat conditions for steelhead migration, spawning, and juvenile rearing in the Santa Ynez River and its tributaries within the context of overall management objectives and competing demands on the Santa Ynez River. Specific

objectives of the ongoing scientific studies performed on the river are to develop baseline and technical information regarding:

1. The diversity, abundance, and condition of steelhead and other Public Trust fishery resources within the lower river;

2. Conditions, including both habitat quality and quantity and water quality and quantity, which may limit the diversity, abundance, or condition of steelhead and other Public Trust fishery resources within the lower river and tributaries;

3. Alternative flow regimes for the Cachuma Project which could be expected to change the conditions that act to limit the diversity, abundance, or condition of steelhead and other Public Trust fishery resources within the lower river; and

4. Non-flow measures which could be undertaken to change conditions that act to limit the diversity, abundance, or condition of steelhead and other Public Trust fishery resources within the lower river.

Data collected from the ongoing fishery studies have been used to identify and evaluate potential alternative management actions that are based, in part, on the following objectives:

- Improve habitat conditions to maintain fish populations in good condition;

- Protect, maintain, and improve habitat conditions for steelhead that are listed for protection under the Federal Endangered Species Act (ESA);

- Improve the availability and suitability of stream corridor and channel habitat for a diversity of species of fish and wildlife.

Using data developed as part of this cooperative program of investigations, alternative management recommendations were identified, developed and evaluated in context with other management objectives for the river. The comparative feasibility of various alternative actions in achieving these management objectives was evaluated with respect to the following criteria:

- The proposed management action has a reasonable probability of achieving the desired benefit;

- The proposed management action can be reasonably implemented considering the constraints imposed by natural hydrologic conditions.

The cooperative scientific studies, which began in 1993 and are continuing, have been used to develop a program of recommended actions which will meet the overall objectives of the Santa Ynez River in terms of fishery and aquatic resources for presentation to the State Water

Resources Control Board. The fisheries, water quality, and habitat studies have been designed and conducted to provide useful background information on the status of the aquatic resources, and to identify factors influencing the abundance and distribution of various fish species and life stages. Descriptions of the study elements and data developed as part of this program have been documented by SYRTAC (1994, 1997a, 1997b, 1998, 1999a, 1999b, 2000), Engblom (1998, 2000, 2003), USBR (1999), and Entrix (1995). Results of these scientific investigations have been used as the foundation for a Biological Assessment (BA) and Biological Opinion (BO) issued by National Marine Fisheries Service (NOAA Fisheries) under Section 7 of the ESA. Although the primary species of interest in developing these studies has been rainbow trout/steelhead, all of the fish species comprising the Santa Ynez River aquatic community downstream of Bradbury Dam have been included as part of the studies.

From 1993 to 1996 studies were organized on an annual basis. In 1996, it was identified that development of a long-term study plan and fishery monitoring program to organize these scientific investigations and establish priorities for the investigations would provide an important framework for meeting the overall objectives of developing and providing a recommended plan of actions to the State Water Resources Control Board. In an iterative process that included the Consensus Committee, the Technical Advisory Committee, and the Biology Subcommittee, a long-term study plan was developed and adopted as part of the 1996 MOU (SYRTAC 1997b).

To assist in the overall planning process and management of the program of investigations, the 1996 MOU required the compilation, synthesis, and analysis of information collected on the fishery resources and habitat conditions of the lower Santa Ynez River. Following completion of the synthesis report in 1997 (SYRTAC 1997a), results of the fishery monitoring program have been documented in a series of annual and biannual technical reports and reports on specific monitoring activities. The following testimony briefly documents the results of the synthesis and evaluation of technical information characterizing the habitat conditions and fishery resources of the lower Santa Ynez River, including the mainstem, lagoon, and tributaries. The fishery investigations and monitoring program have been ongoing since 1993 and the results have been used in identifying fishery management program actions for the lower river and tributaries. A Fish Management Plan (SYRTAC 2000) has been prepared, based upon data collected during these studies, which identifies management actions on the lower Santa Ynez River and tributaries, and uses information for evaluating the limitations, constraints, and feasibility of implementing potential actions, in addition to evaluating anticipated biological benefits.

Scientific Monitoring Investigations and Analysis

The synthesis and analysis of scientific information collected on the fishery resources and habitat conditions of the lower Santa Ynez River and tributaries includes data characterizing hydrologic conditions and reservoir operations for Bradbury Dam on the Santa Ynez River. Water quality monitoring has also been performed, focusing on water temperature, dissolved oxygen, and salinity measurements, collected at various locations including Lake Cachuma, along the longitudinal gradient of the mainstem Santa Ynez River from Bradbury Dam downstream to the lagoon, and within major tributaries. Results of stream corridor and channel habitat mapping surveys within the mainstem river, lagoon, and tributaries also provide information used in developing the Fish Management Plan. Fishery resources observed from locations downstream of Bradbury Dam, including major tributaries and the lagoon have also been compiled.

Results of the scientific investigations, monitoring, synthesis, and analysis of data on fishery resources and habitat conditions on the Santa Ynez River and tributaries used as part of the foundation for developing the Fish Management Plan, and subsequently in identifying and implementing actions designed to protect and enhance conditions for steelhead in compliance with the ESA, have been documented in the synthesis report (SRYTAC 1997) and as part of ongoing scientific investigations and monitoring within the mainstem river and tributaries (Engblom 1998, 2000, 2003). Results of these investigations are briefly summarized below.

Hydrology

Hydrologic conditions within the Santa Ynez River basin and tributaries are characterized by:

- High seasonal and inter-annual variability of instream flows and inflow to Cachuma Reservoir, which reflect patterns in seasonal precipitation and storm water runoff;

- During the period from 1991 through 2003, spills from Cachuma Reservoir occurred during the winter-spring of 1993 (280,698 AF), 1995 (354,107 AF), 1998 (386,055 AF), 2000 (6,067 AF, and 2001 (112,313 AF) in response to periods of high precipitation and inflow to the reservoir. Flow within the mainstem Santa Ynez River as measured at the USGS gauge at Solvang, showed extremely high variability within and between years. For example, instream flows during the 1993-1996 period ranged from 0 to over 13,000 cfs. A similar pattern of high seasonal and inter-annual variability in Santa Ynez River flows is also apparent at the Narrows, near Lompoc;

- Controlled releases from Bradbury Dam have been made to recharge downstream groundwater basins to meet downstream water rights in accordance with SWRCB decision WR 89-18. Controlled releases were performed during 1991 (June-October), 1992 (July-October), 1994 (July-October), 1996 (July-October), 1997 (April, July-

October), 2000 (July, September-October, December), 2002 (June-July, August-October). Flows during controlled releases were up to approximately 150 cfs;

- Beginning in 1993 the Santa Ynez River MOU established a fish reserve account of 2,000 AF of water within Cachuma Reservoir, which has been managed to (1) maintain and protect fisheries resources downstream of the dam, and (2) conduct specific experimental studies used to evaluate the relationship between instream flow releases and the corresponding response in water quality and/or biological resources at downstream locations. Releases from the fish reserve account (at a rate of 3 to 10 cfs, 6 to 20 AF per day) were made on a seasonal basis;

- Instream flow releases for steelhead are currently being made to the lower Santa Ynez River in compliance with the Fish Management Plan and flow release schedule outlined in the NOAA Fisheries Biological Opinion;

- Tributaries to the Santa Ynez River downstream of Bradbury Dam show high variability in flow seasonally and between years, reflecting precipitation and storm water runoff within the basin. Peak seasonal flows within several of the tributaries have exceeded 1,000 cfs. Many of the tributaries are characterized by intermittent flows, having no measurable surface flow during the late spring, summer, and early fall, at least in these lower reaches. Several of the creeks, including Salsipuedes and San Miguelito creeks had surface flow (although typically less than 1 cfs) throughout the year;

- A sandbar is present at the confluence between the Santa Ynez River and the Pacific Ocean. The sandbar creates a physical blockage for fish movement into or out of the Santa Ynez River, and also creates a lagoon characterized by a salinity gradient ranging from freshwater at the upstream boundary to full strength seawater at the downstream boundary. Periodically, the sandbar is breached (opened) allowing surface flow from the Santa Ynez River to enter the ocean, and creating an opportunity for both the upstream and downstream passage of migratory steelhead. Factors contributing to the opening and closure of the Santa Ynez River lagoon include coastal sand transport, tidal action, storm activity, and wave action, in addition to freshwater inflow from the Santa Ynez River and local storm water runoff. Breaching of the lagoon typically occurs during winter months, coincident with storm activity and increased flows within the Santa Ynez River. In the past, the mouth of the lagoon has also been breached mechanically, using a bulldozer, to reduce water elevation within the lagoon, and reduce the risk of localized flooding;

- Based on results of biological and hydrologic monitoring studies conducted and analyzed as part of the fishery investigations it was concluded that seasonal and inter-annual variability of instream flows within the mainstem Santa Ynez River and tributaries represents a major factor influencing habitat quality and availability for steelhead and other fish species and associated water quality conditions. Instream flows also influence

breaching of the sandbar and conditions for upstream and downstream passage of migrating steelhead (e.g., water depths and velocities) within the Santa Ynez River tributaries and mainstem. The influence of these flow conditions on water quality (temperature, dissolved oxygen, and salinity), habitat characteristics, and the distribution of fish species within the system are discussed in the 1997 synthesis report (SYRTAC 1997) and in subsequent annual fishery monitoring reports prepared as part of the ongoing Fish Management Plan activities (Engblom1998, 2000, 2003).

Water Quality

Water quality monitoring conducted as part of the Santa Ynez River fishery investigations has primarily focused on water temperature and dissolved oxygen concentrations. Monitoring has been performed within Lake Cachuma, the mainstem Santa Ynez River, selected tributaries, and the lagoon. In addition, salinity has been monitored within the lagoon. Observations and results of the water quality monitoring program are briefly summarized below.

Mainstem Water Temperature

Results of water temperature monitoring on the Santa Ynez River have generally shown:

- Cachuma Reservoir becomes thermally stratified during the summer and fall and destratified (relatively uniform temperatures from the surface to the bottom) during the winter. During the period of stratification water temperature and dissolved oxygen concentrations are greatest in the upper part of the water column (epilimnion), with the coolest water temperatures and dissolved oxygen concentrations decreasing below 2 mg/l within the lower part of the water column (hypolimnion). After fall turnover, water temperature and dissolved oxygen concentrations (6-8 mg/l) were relatively consistent throughout the water column;

- Water temperature follows a general seasonal pattern with increasing temperatures during the spring and summer and decreasing temperatures during the fall and winter, coincident with the seasonal pattern in air temperature;

- Water temperature, particularly during summer, is lowest near Bradbury Dam, with a longitudinal gradient of increasing temperature moving downstream;

- Daily variation in water temperature, particularly during the summer, is generally lowest near Bradbury Dam, with a longitudinal gradient of increasing daily variation in water temperature at locations further downstream;

- Results of temperature monitoring during flow provided by the 1996 WR 89-18 releases showed that water temperatures increased rapidly downstream of the dam, despite instream flow releases of 50 to 135 cfs. These temperature monitoring results are consistent with general trends in the geographic distribution of water temperatures within the mainstem river observed in recent years;

- Several temperature models have been developed for the lower Santa Ynez River based upon predicted environmental conditions and the use of empirical data in statistical regression analyses. Results of these models are generally consistent in describing the longitudinal gradient in water temperatures occurring at locations downstream of Bradbury Dam;

- Seasonal patterns of water temperature within the Santa Ynez River lagoon are typically cooler, particularly during the summer, than water temperatures occurring at locations further upstream, with the exception of those immediately below Bradbury Dam;

- Information on thermal tolerance and the physiological response of rainbow trout/steelhead to elevated water temperatures (e.g., stress, reduced growth rates, etc.) are available primarily for steelhead stocks from the northern part of their geographic distribution (Oregon, Washington, and British Columbia). It has been hypothesized, however, that thermal tolerance of northern populations may be lower than the actual tolerance for stocks inhabiting the southern end of their geographic distribution. No definitive data are available on the thermal tolerance for southern steelhead stocks for use in developing thermal tolerance indices. Thermal tolerance criteria (frequency of average daily temperatures greater than 20 C, and frequency of maximum daily temperatures greater than 25 C) should, therefore, not be used as absolute thermal thresholds, but rather to represent general guidelines for assessing the biological significance of water temperature conditions observed within the river and tributaries;

- Evaluation of average daily and maximum daily water temperatures, with respect to thermal tolerance indices for rainbow trout/steelhead, showed water temperatures are within acceptable ranges at all locations downstream of Bradbury Dam during the late fall, winter, and early spring;

- Water temperatures at a number of mainstem monitoring sites exceed temperature criteria (average daily water temperature greater than 20 C, or maximum daily temperature greater than 25 C) for rainbow trout/steelhead during the summer;

- The frequency and magnitude of daily temperatures that exceed criteria for rainbow trout/steelhead increased as a function of distance downstream from Bradbury Dam, with the exception of temperature conditions occurring within the lagoon;

- Water temperature within the reach from the dam downstream to Highway 154 is suitable for steelhead, based on the available temperature monitoring data. Riparian vegetation along the reach provides shading. Results of water temperature monitoring, in combination with favorable habitat conditions, were important factors in the selection of the reach upstream of Highway 154 as a high priority in developing the Fish Management Plan actions;

- Maximum water temperatures recorded from surface thermographs on one or more days during the summer months exceeded the estimated incipient lethal threshold (>25 C) at the Refugio Habitat Unit X (3.4 miles downstream of Bradbury Dam), and at all habitat units monitored further downstream, with the exception of the lagoon;

- Based upon the general temperature guidelines, maximum temperatures observed in the lower reaches of the river (downstream of Highway 154) would be expected to result in physiological stress and/or mortality for rainbow trout/steelhead, thereby making summer habitat conditions unacceptable at a number of the locations monitored on the mainstem Santa Ynez River. However trout continue to occupy several locations, and appear to remain in good health and increase in size; and

- In summer, when flows are low (or at low flow releases), localized cool groundwater upwelling may provide acceptable conditions for rainbow trout/steelhead to successfully inhabit pools and other areas downstream of Bradbury Dam. For example, the number of rainbow trout/steelhead inhabiting the Alisal reach remained relatively constant between August (34 fish) and December 1995 (31 fish), despite elevated water temperatures during the later summer. Steelhead were also observed to successfully oversummer in the Refugio X reach pools (3.4 miles downstream of the dam) in 1998 despite elevated surface water temperatures. The extent of localized groundwater downstream of Bradbury Dam and the percentage of pool habitats affected by cool groundwater are being studied as part of the fishery program to provide additional information on seasonal temperature conditions within the lower river.

Mainstem Dissolved Oxygen

Results of dissolved oxygen monitoring within the mainstem Santa Ynez River have generally shown:

- Extensive algal production between late spring and early fall contributes to substantial diel variation in dissolved oxygen concentrations and may adversely affect habitat quality for resident fish;

- Dissolved oxygen concentrations at night (measured during pre-dawn surveys) showed dissolved oxygen concentrations within many habitats ranging from 1 to 3 mg/l. Low diel

dissolved oxygen concentrations would be expected to result in severe physiological stress and/or acute mortality to many fish species;

- A vertical gradient in dissolved oxygen concentrations has been observed within several deeper pool habitat units, with daytime dissolved oxygen concentrations being greatest near the surface, with a marked decline in dissolved oxygen near the bottom. A similar vertical gradient in water temperature was observed at many of these locations, with highest water temperatures near the surface, and lowest water temperatures near the bottom. These results are consistent with the hypothesis that vertical stratification tends to develop within deeper pool habitats. Vertical stratification within these habitats during the summer presents a potential conflict in habitat selection by species such as rainbow trout/steelhead in which areas of the habitat having sufficient dissolved oxygen concentrations may also have elevated, and potentially stressful, water temperature conditions;

- Early morning dissolved oxygen concentrations during the fall are typically substantially higher than those during the summer, coincident with a seasonal decline in algal cover and decreased temperatures; and

- River flow provided by WR 89-18 releases is sufficient to remove much of the algae from pool habitats and create sufficient turbulence and mixing to sustain higher dissolved oxygen concentrations (7 mg/l) during the critical morning hours. The reduction in algal accumulations within the mainstem Santa Ynez River resulting from flow releases from Bradbury Dam directly improves habitat conditions for fish downstream of the dam.

Santa Ynez River Lagoon

Results of water quality monitoring within the Santa Ynez River lagoon have generally shown:

- No substantial differences were observed in water quality measurements (water temperature, dissolved oxygen, and salinity) across transects within the lagoon, however, when the lagoon was both open and closed, water quality differences were observed between upstream and downstream monitoring locations;

- The lagoon water depth has been observed to double after the lagoon breach closed. Vertical gradients have been observed in water temperature, dissolved oxygen, and salinity within deeper areas of the lagoon during periods when the lagoon breach was closed. Vertical stratification in water quality parameters varied substantially between locations and survey periods;

- Average daily and maximum daily water temperatures within the lagoon during the summer have been consistently lower than water temperatures measured at upstream

monitoring locations, with the exception of locations immediately downstream from Bradbury Dam;

- Dissolved oxygen concentrations have been generally greater than 5 mg/l in the upper three quarters of the water column during months when stratification within the lagoon had developed. The lower one quarter of the water column had dissolved oxygen levels less than 4 mg/l, with concentrations less than 1 mg/l developing at the bottom one foot at most sites;

- Salinity levels within the lagoon follow a consistent longitudinal pattern, with salinity near brackish/full strength sea water at Ocean Park, decreasing to freshwater at the upstream location; and

- Salinity levels vary between months, reflecting seasonal variation in the balance between freshwater inflow and tidal influence. Higher salinity concentrations are observed at high tide, particularly when the lagoon breach is open.

Tributary Water Temperature

Water temperature monitoring within various tributaries to the lower Santa Ynez River has shown:

Hilton Creek

- Summer (June-August) water temperatures in 1995 within Hilton Creek (250 feet upstream of the confluence with the Santa Ynez River) showed maximum daily water temperatures ranging from 16.4 to 26.3 C. Water temperatures measured in upper Hilton Creek (approximately 2900 feet upstream of the confluence at the Crawford property boundary) during the summer of 1998 did not exceed 21 C while temperatures in 1999 remained less than 20 C. Temperature data show a trend of increasing maximum temperatures with distance downstream within Hilton Creek. Young-of-the-year rainbow trout/steelhead have been observed to be generally healthy and actively feeding within Hilton Creek at temperatures exceeding 25 C. The discrepancy between the observation of young-of-year rainbow trout/steelhead inhabiting Hilton Creek when measured water temperatures were greater than 25 C, used as the incipient lethal threshold for these analyses, supports the general hypothesis that southern stocks have a greater thermal tolerance than more northerly populations;

- Based on results of investigations of potential habitat opportunities and constraints developed through the fishery monitoring program, the Fish Management Plan identified an opportunity to enhance and improve habitat quality and availability for steelhead

within Hilton Creek. Low summer flows and exposure of juvenile rearing steelhead to elevated water temperatures within Hilton Creek were both identified through these early analyses as factors limiting habitat conditions for over-summering juvenile steelhead. As part to the Fish Management Plan, and subsequently included as part to the project description and biological opinion issued by NOAA Fisheries, a watering system has been designed and constructed to provide improved instream flows and water temperature conditions within Hilton Creek. Installation and operation of the Hilton Creek water supply system, which releases water from Lake Cachuma into Hilton Creek, was developed as part of the early implementation of the Fish Management Plan actions designed to benefit steelhead within the Santa Ynez River watershed and enhance habitat quality and availability for juvenile steelhead rearing. Results of subsequent monitoring have shown that the Hilton Creek water supply system has substantially improved instream flows and summer water temperatures, directly contributing to enhanced habitat quality and availability for juvenile steelhead rearing within Hilton Creek, as reflected by the numbers of juvenile steelhead rearing within the creek in recent years.

- A deeper water pool (upper Chute Pool) exists within Hilton Creek immediately downstream of the potential fish passage barrier, located approximately 1,200 feet upstream of the confluence, which represents an area where adult rainbow trout/steelhead accumulate, and/or juvenile rearing occurs. Summer water temperatures within the pool were substantially lower than temperatures measured within Hilton Creek further downstream;

- As part of the Fish Management Plan opportunities were identified to improve fish passage upstream of the upper chute pool and to provide flexibility within the Hilton Creek water supply system to also deliver water to support instream flows and temperature conditions within the reach upstream the chute pool to further provide enhanced habitat conditions for steelhead spawning and juvenile rearing within Hilton Creek.

Nojoqui Creek

- Average daily and maximum daily water temperatures within Nojoqui Creek exceeded the temperature criteria during the summer. Water temperatures exceeded the potential incipient lethal threshold (25 C) during June - August.

Salsipuedes Creek

- Upper Salsipuedes Creek is characterized by having an intact riparian corridor with abundant canopy within which water temperatures were substantially cooler than those

observed in either El Jaro or lower Salsipuedes Creek. The streambed is wider and the canopy less abundant in the lower section of Salsipuedes Creek, which may also contribute to the higher observed water temperatures within this reach of the tributary. Maximum daily water temperatures are typically less than 25 C with average daily temperatures typically less than 20 C.

El Jaro Creek

- Inflows during the summer from El Jaro Creek have been observed to contribute to substantially higher average daily and maximum daily water temperatures within lower Salsipuedes Creek. Average daily and maximum daily summer temperatures within Salsipuedes Creek downstream of the confluence with El Jaro Creek typically are greater than the 20 and 25 C temperature guidelines. Maximum daily temperatures have been observed to exceed 27 C on occasion, representing conditions potentially above the incipient lethal level for rainbow trout/steelhead;

- Water temperature monitoring data during the summer months from El Jaro Creek confirmed higher average daily and maximum daily water temperatures than those observed within upper Salsipuedes Creek. The relatively high and sustained average daily temperatures during the summer, in combination with maximum daily temperatures observed to be over 26 C during summer months within El Jaro Creek are expected to contribute to physiological stress, reduced growth rates, and potentially incipient lethal conditions for rainbow trout/steelhead; and

- Rainbow trout/steelhead have been observed during snorkeling surveys in numerous habitat units in El Jaro Creek, including young-of-year and size classes up to approximately 8-10 inches. Microhabitat selection of rainbow trout/steelhead reflects a behavioral adaptation to water temperature conditions, and may also reflect a physiological adaptation of southern stocks to greater tolerance to elevated water temperature conditions occurring within this part of their geographic distribution.

Habitat Characteristics

Fish habitat in the Santa Ynez River mainstem has been surveyed extensively upstream of Highway 101 in Buellton and in a section near Lompoc. Mesohabitat characteristics (pool, riffle, run) have been described in that section of the river. Habitat conditions in other sections of the mainstem have been characterized qualitatively. Habitat surveys have also been conducted within the tributaries in recent years as part of the ongoing fishery investigations and monitoring program. Results of habitat surveys on the mainstem Santa Ynez River and tributaries have shown:

- The mainstem, in surveyed reaches, contains a generally diverse mix of habitat types during periods when the river is flowing but the utility of riffle and run habitats is limited during low flow periods. Pool habitat exists even at low flow, and provides good habitat between the dam and Highway 154. The utility of pool habitat downstream of Highway 154 may be limited for rainbow trout/steelhead by lack of flow, elevated summer water temperature and low dissolved oxygen levels;

- From a fisheries perspective, riparian vegetation is poorly developed in the mainstem and in most areas downstream of Highway 154 does not provide significant shade. Observations indicate portions of some tributaries are well shaded;

- Instream vegetation in the mainstem in the form of algal mats can be extensive during summer months. Algae is not usually extensive in the reach immediately downstream of Bradbury Dam (except in some pools), but can dominate the aquatic habitat in the Refugio and Alisal reaches during summer low flow conditions. WR 89-18 releases reduced or eliminated algal mats. Reductions in algal biomass accumulation within the mainstem Santa Ynez River as a direct consequence of releases from Bradbury Dam results in improved habitat conditions (e.g., increased dissolved oxygen concentrations) for fish resident in these areas;

- Pools, particularly deep pools, provide habitat for juvenile and older age classes of rainbow trout/steelhead, largemouth bass and sunfish. During low flow conditions these may be the only aquatic habitat available. These pools can be thermally stratified with relatively cool water at the bottom of deeper pools (thermal stratification can occur in pools as shallow as 3-4 feet). Thermal stratification within pools downstream of Highway 154 during summer months is variable within and among years;

- Substrate in the form of gravel of suitable size for spawning rainbow trout/steelhead is found in all the surveyed reaches but its utility is dependent on the volume of streamflow. Quality of spawning gravel in the Lompoc reach was poor due to accumulations of fine sediments;

- The only passage barriers found in the mainstem are due to shallow conditions during low flows, and some beaver dams at low to moderate flows;

- Alisal Creek has been blocked just upstream of the mouth by a concrete structure, which subsequently washed away during January, 1995; and

- Two cascades below bridges in Salsipuedes Creek were identified as passage impediments to the migration of rainbow trout/steelhead at lower flows, particularly smaller resident fish. A bridge on El Jaro Creek was also identified as a passage impediment. Passage barrier removal and improvements are identified as actions within

the Fish Management Plan (passage improvement projects have begun) to provide improved access for steelhead to suitable habitat within the tributaries.

Fishery Resources

Results of fishery surveys on the mainstem Santa Ynez River and tributaries have shown:

- The Santa Ynez River downstream of Bradbury Dam supports fluctuating and transient populations of fish. The most abundant species are those that have tolerance for widely fluctuating conditions of streamflow, temperature, and dissolved oxygen. The fish community in larger, deeper pools is dominated by introduced species, including largemouth and smallmouth bass, green sunfish, bluegill, redear sunfish, channel catfish and bullheads, species preferring warm, non-flowing aquatic habitats. Largemouth bass, in particular, reproduce successfully and are abundant in the river below Bradbury Dam. Bass fry have been observed in the long pool. All of the native species reported for the river in the 1940s are still present. The observations of adult and larval Pacific lamprey indicates that, although this species is not abundant, conditions exist that allow for completion of its anadromous life cycle;

- Results of surveys conducted in the Santa Ynez River mainstem indicate that rainbow trout/steelhead are most abundant in the reach downstream of the dam to Highway 154 and less abundant in the Refugio reach and Alisal reach. Surveys in the tributaries indicate that self-sustaining rainbow trout/steelhead populations may be abundant in some areas. It is not known whether these are resident or anadromous populations. Trapping studies have been done in recent years to assess both adult and juvenile rainbow trout/steelhead migration into and out of the tributaries in addition to snorkel surveys within the tributaries and mainstem river. Surveys have not been conducted in a way that allows easy quantitative comparison of population density in the tributaries to that in the mainstem**;**

- Rainbow trout/steelhead juveniles have been observed to survive, apparently in healthy condition, in isolated pools in the Santa Ynez River mainstem downstream of Highway 154 through the summer months in spite of water temperature and dissolved oxygen conditions that exceeded standard tolerance guidelines for the species. If trout inhabiting the Santa Ynez River or its tributaries are of native southern steelhead stocks they may be adapted to warmer temperatures than more northern stocks. Survival in these habitats may have been related to upwelling of cool water under low flow conditions, the presence of extensive riparian canopy, reduced abundance of floating algal mats, lack of large predatory fish (largemouth bass), or a combination of these factors;

- Young-of-year rainbow trout/steelhead have been found in the mainstem only in the Highway 154 reach and within the tributaries including Hilton Creek. These are thought

to have originated in Hilton Creek since numerous young-of-year have been seen in Hilton Creek. Evidence of steelhead spawning (redds) in the mainstem downstream of Bradbury Dam has been observed, although in low numbers, in 1998, 2000, and 2002. Surveys for spawning steelhead in the mainstem are difficult to conduct as a result of increased flow and reduced visibility during winter and early spring months;

- The tributaries support populations of primarily native species including rainbow trout/steelhead, stickleback, and sculpin though the introduced arroyo chub is also widespread;

- Evidence of steelhead spawning (redds) has been documented in Hilton Creek, Quiota Creek, Upper Salsipuedes Creek, Lower Salsipuedes Creek, El Jaro Creek, and San Miguelito Creek based on surveys conducted between 1995 and 20002;

- Salsipuedes and El Jaro creeks support a reproducing population of rainbow trout/steelhead based on the presence of a range of age classes, including young-of-year. The fish appear to be healthy. The capture of juvenile rainbow trout/steelhead exhibiting evidence of smoltification indicates the presence of anadromous traits within the tributary population; and

- Fish habitat and fish population surveys in the tributaries have shown the presence of a range of age classes including young-of-year. Populations of rainbow trout/steelhead have also been observed in the headwaters of Alisal Creek and a tributary of Quiota Creek. Numerous young-of-year rainbow trout/steelhead were seen in San Miguelito Creek. No evidence of rainbow trout/steelhead has been found in the lower sections of Nojoqui Creek but good spawning and rearing habitat exists there. Spawning and the production of young-of-year rainbow trout/steelhead have occurred in Hilton Creek. A passage barrier approximately 1200 feet upstream from the mouth of Hilton Creek limits or preclude access to the upper reaches of the stream. General observations indicate that the upper reaches of the creek offer potentially suitable habitat.

Identification of Limiting Factors for Steelhead and Management Actions

Fishery investigations and water quality monitoring conducted on the Santa Ynez River identified a variety of factors, which may have adversely impacted rainbow trout/steelhead on the Santa Ynez River mainstem below Bradbury Dam and its tributaries. These factors include, but are not limited to, elevated water temperatures, depressed dissolved oxygen concentrations, seasonal flows, passage barriers, and general instream habitat conditions. Using data collected from the fishery and water quality monitoring program, both within the mainstem Santa Ynez River and tributaries, management actions have been identified that would protect and enhance conditions for steelhead and other aquatic resources within the mainstem river and tributaries. Results of the scientific investigations undertaken as part of this program represent the best available scientific

information and have been used as the foundation for identifying a range of management actions that have been presented in the Fish Management Plan (SYRTAC 2000) as described in the testimony of Jean Baldrige, which have been or are currently being implemented within the Santa Ynez River watershed.

The scientific information developed through this program was also used as the foundation for preparing a Biological Assessment (BA) submitted to NOAA Fisheries as part of the Section 7 consultation. NOAA Fisheries critically reviewed the management actions and supporting scientific information from this program in the non-jeopardy Biological Opinion (BO) for steelhead for the Cachuma project and its operations.

Results of monitoring hydrology, water quality, habitat conditions, and fishery populations within the Santa Ynez River and its tributaries over the 1993-2003 period of investigation has demonstrated that conditions affecting habitat quality and availability for steelhead are variable within and among years, and within various reaches of the mainstem river and tributaries. As part of development of the Fish Management Plan the uncertainty and inherent variability in environmental conditions affecting steelhead and other public trust resources within the Santa Ynez River system have been recognized and used as the foundation for developing both the ongoing monitoring and reporting program and flexibility and adaptive management as a key component to the successful implementation of the Fish Management Plan. Adaptive management allows for the opportunity to use information collected through the ongoing monitoring program to modify specific management actions and respond to opportunities and constraints for protecting and enhancing habitat conditions for steelhead within the Santa Ynez River system. The testimony presented by Jean Baldrige provides additional information regarding the Adaptive Management Committee (AMC) and the approach, based upon the available scientific information and ongoing monitoring program, for addressing variability and uncertainty on the Santa Ynez River within the framework established by the Fish Management Plan and terms and conditions of the NOAA Fisheries biological opinion.

Scientific investigations and monitoring are continuing on the Santa Ynez River and tributaries, which provide additional information for use in evaluating the performance and success of management actions implemented as part of this program, the identification of additional actions and/or refinements in modifications, and as critical input to the Santa Ynez River Adaptive Management Committee. Currently scientific information and results of analyses from the 1993-2003 monitoring program are being compiled and synthesized into a single technical report, which will update the synthesis of available information completed in 1997 (SYTAC 1997), as part of the continuing effort to provide the most comprehensive scientific and technical foundation possible for evaluating performance of the management actions implemented as part of the Fish Management Plan. The strength and breadth of the scientific investigations conducted on the Santa Ynez River and tributaries provide the necessary foundation for the Fish Management Plan and the actions identified and implemented to protect and enhance conditions for steelhead and other aquatic resources.

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