Information synthesis and priorities regarding steelhead trout (*Oncorhynchus mykiss*) on the Santa Clara River


Photo by: EJ Remson

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for

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Abbreviations

ACOE	Army Corps of Engineers
AF	Acre-feet
Caltrans	California Department of Transportation
CFG	California Fish and Game Department
cfs	Cubic feet per second
CSWRCB	California State Water Resources Control Board
FERC	Federal Energy Regulatory Commission
FOSCR	Friends of the Santa Clara River
LA-RWQCB	Los Angeles Regional Water Quality Control Board
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
pers. comm.	personal communication
POTWs	Publicly Owned Treatment Works
RT	Rainbow Trout
SCR	Santa Clara River
SCREMP	Santa Clara River Enhancement and Management Plan
SP	Santa Paula
TMDLs	Total Maximum Daily Loads
TNC	The Nature Conservancy
UWCD	United Water Conservation District
VFD	Vern Freeman Diversion
WRP	Water Reclamation Plants (or Wastewater Treatment Plants)

Introduction

The findings in this report reflect a 9-month investigation into the state of steelhead trout (*Oncorhynchus mykiss*) in the Santa Clara River of southern California. Prior to the 1940s, the Santa Clara River was the site of a large southern steelhead trout run each year. Southern steelhead are now listed as endangered by the National Marine Fisheries Service (NMFS) under the Endangered Species Act (ESA), and very few run up the Santa Clara. The recovery of this species will depend upon the re-establishment of viable spawning runs on rivers and creeks in southern California. The intent of this study was to understand the state of steelhead on the Santa Clara River, and to devise a list of actions that would lead to rehabilitation of a steelhead trout run on the river.

Information relevant to the restoration of southern steelhead trout was collected - including written and on-line materials, as well as interviews and conversations with people familiar with the Santa Clara River. The summary and findings are organized as follows:

1. **Executive Summary** – provides an overview of the findings of the study.
2. **Methods and Sources** – discusses the methods and sources used during the investigation.
3. **Analysis and Priorities** – presents an overview of all possible actions that could benefit steelhead and prioritizes them.
4. **Appendix** – summarizes and details the information obtained during the investigation.

Executive Summary

Prior to 1940, the Santa Clara River is estimated to have had more than 8,000 adult steelhead run its waters every year.
Next to the Santa Ynez River the Santa Clara was one of the largest steelhead runs in southern California. Fewer than 100 adult fish run either of these rivers' waters now. Unlike other major rivers in southern California, the Santa Clara retains much of its natural features, including major undamned tributaries, and could play an important role in the recovery of southern steelhead.

One of the major problems that steelhead face on the Santa Clara River is artificially reduced flows during migration periods.
The river reach between the estuary and the Vern Freeman Diversion (located approximately 14 miles above the estuary) is often reduced to shallow sheet flows, or becomes dewatered; the connectivity between the mainstem and tributaries is ephemeral and provides inadequate opportunity for either the upstream passage of adult, or the downstream passage of juvenile steelhead. Water is removed from both the surface flow and from groundwater basins for residential, commercial, and

agricultural use. Insufficient information is publicly available regarding the flows in the river, how much and where water is removed, and whether flows could be adjusted to provide sufficient water for migrations while still meeting human needs.

A second major difficulty during migrations is the anthropogenic and natural barriers to migration such as water diversions, road-crossings, and channel modifications for sand and gravel extraction or flood control purposes. While it is known these barriers and impediments exist, almost nothing is known about how significant these barriers are or what solutions there are to the migration difficulties they present.

The tributaries provide the majority of spawning and rearing habitat, while the mainstem of the Santa Clara River is primarily a migration corridor.
Santa Paula and Sespe Creeks are the main steelhead spawning tributaries, though Hopper Creek may also provide some spawning habitat. Piru Creek historically was a major spawning tributary but Santa Felicia Dam now blocks steelhead access. Little is documented about the resident trout populations in the tributaries, their location, the quality, quantity, or location of habitat, or the extent of the exotic fish predator threat from bullhead catfish, bullfrogs, green sunfish, and small and large mouth bass.

The Santa Clara River estuary has been significantly altered, and these changes may be impacting steelhead smolt survival.
A significant portion of the original Santa Clara estuary has been filled by adjacent development. Additionally, between seven to ten million gallons of nutrient-rich effluent are released per day into the estuary from the City of San Buenaventura's Wastewater Treatment Plant. While it is unknown to what extent Santa Clara River smolts used the estuary historically, it has been demonstrated that northern and central coast steelhead smolts use estuaries to gain size and acclimate to the higher concentrations of salt in ocean water. The impact of these changes on Santa Clara River steelhead smolt survival is unknown.

There are very few adult steelhead trout that have been counted making their way upstream in the Santa Clara River over the past ten years.
However, the number of smolts observed emigrating out of the system has increased by an order of magnitude over the same period. This indicates that there is natural reproduction of *Oncorhynchus mykiss* in the Santa Clara River watershed, and that if migration and habitat issues can be addressed there is a good possibility this fish stock can be rehabilitated.

Southern steelhead trout ecology and biology are generally unknown.
There is little data or information on life history, habitat usage, historical numbers, length of time required for up-stream migration, timing of downstream emigration, or the population age-class structure for southern steelhead. The majority of information and data regarding steelhead are the result of studies of northern pacific stocks. While the steelhead in southern California have been shown to be genetically and physiologically different from their northern counterparts, there is very little data or studies on southern

steelhead ecology or biology.

The LA-Regional Water Quality Control Board is establishing TMDLs (Total Maximum Daily Loads) for the Santa Clara River in order to lower the amounts of excess chlorides and other pollutants in the river.
A chloride TMDL of 100 mg/L, has been established for the upper river. Other TMDLS scheduled to be determined are: toxaphene, fecal coliform, and nitrate.

Methods and Sources

The sources for the documents and data obtained during this investigation included the Mark H. Capelli Southern California Steelhead Watershed Archive at the University of California at Santa Barbara's Davidson Library, the United Water Conservation District's (UWCD) library in Santa Paula, various websites on the Internet, and a variety of individuals. The documents that are a part of this summary are listed in the bibliography.

In addition to the documents, in-person or telephone interviews were conducted with 17 individuals who were familiar either with the Santa Clara River or southern steelhead. The findings from these interviews are incorporated into the Appendix.

The information from these documents and interviews were collated and organized into the various sections of the Appendix. The following section discusses the topical areas evaluated and potential actions for rehabilitating southern steelhead in the Santa Clara River. The actions discussed below were derived from individual suggestions, from work on other rivers, or are the result of conceptual analysis on the part of the author.

Analysis and Priorities

Potential issues for steelhead on the Santa Clara River were eventually organized into four categories: physical impediments to steelhead passage, steelhead ecology, water flow and balance, and point source and non-point source pollution. The issues discussed are either possible challenges that face steelhead on the Santa Clara River, ways to address challenges that face steelhead, or represent a lack of knowledge regarding steelhead and their environment.

These issues were reviewed and revised at a meeting at the University of California at Santa Barbara on May 28, 2003. Present at that meeting were Mark Capelli, Dr. Ramona Swenson, E.J. Remson, Dr. Elise Kelley, and Dr. Mark Reynolds and Dr. Scott Morrison via phone. Each of the issues was discussed in depth and prioritized. Reasons for an issue receiving either a high or low priority rating had to do with timing associated with it, the capacity of the organizations involved to address the issue, and the likelihood that resolution of the issue would increase the number of steelhead utilizing the Santa Clara River.

Dr. Peter Kareiva, Mark Capelli, Dr. Leal Mertes, Dr. Mark Reynolds, Dr. Scott Morrison, Dr. Elise Kelley, and E.J. Remson conducted a final review of the prioritized issues at the University of California at Santa Barbara on June 3, 2003.

In general it was realized that there was insufficient information in several areas to develop a steelhead restoration plan for the river, and that additional basic information was needed. Issues discussed at the June 3rd meeting are presented below within their category and as action items. The items determined as having the highest priority are discussed in greater depth following the initial presentation.

I. Physical Impediments To Steelhead Passage

The items in this category are focused on assessing anthropogenic and natural barriers to steelhead passage that occur on the river.

The action items are:

1. Encourage California Department of Transportation (Caltrans) to modify the apron of the Highway 150 bridge at Thomas Aquinas College. It has been noted that this apron is impassable to steelhead at certain flows, with some jump pools being too shallow among other problems.
2. Encourage the Army Corps of Engineers (ACOE) to repair and/or modify the fish passage facility in its flood control project on Santa Paula Creek. Currently the first jump pool in the “ladder” structure of this flood control project is too shallow to allow up-stream migrating adult steelhead to enter the facility.
3. Conduct a Steelhead Cumulative Impact Analysis. Given the challenges that steelhead encounter in their migrations it would be useful to know the amount of energy steelhead expend overcoming anthropogenic and natural barriers during their migration, and whether that energy expenditure adversely affects their reproductive success. This analysis would include the probability of steelhead making it past all barriers and spawning.
4. Monitor structures on the river to make sure that steelhead can get past these barriers.
5. Evaluate the benefits on steelhead passage of reducing sedimentation to Santa Paula Creek from Mud Creek.
6. Evaluate the role of sediment transport in the mainstem of the Santa Clara River, in steelhead migration.
7. Inventory and assess all physical barriers to steelhead passage within the mainstem of the Santa Clara River and on all major tributaries.

Of these potential actions, three have been selected as priorities.

Encourage Caltrans to modify the apron for the Highway 150 bridge at Thomas Aquinas College.
As of spring 2003, Caltrans had the funding available to correct this problem; however no action has been taken to remedy the situation.

Encourage ACOE to repair the first step in the ladder for the flood control project near the mouth of Santa Paula Creek.
At least an interim solution to the problem does not appear to be involved or costly. The first jump pool needs to be deepened by drilling and then reformed to prevent sediment accumulation.

Inventory and assess all physical barriers to steelhead passage.
It is unclear how much of a barrier the various diversions, flood control projects, and other facilities along the mainstem of the river or its major tributaries, present to steelhead passage. There is also the potential for natural barriers to occur. A barriers analysis would provide an understanding of the obstacles that affect the steelhead run, and a list of the actions that could be taken to eliminate or modify those obstacles.

II. Steelhead Ecology

The primary objective of these actions is to increase the understanding of southern steelhead trout ecology, especially the populations within the Santa Clara River watershed.

The eleven actions discussed include:

1. Assess the steelhead and rainbow trout population structure (age-class numbers and distribution, genetic make-up, etc.).
2. Study the in- and out-migration ecology of southern steelhead (timing and duration of adults and smolts, acclimation time in estuary, etc.).
3. Characterize and evaluate steelhead habitats (spawning, rearing, and refugia) on Santa Paula, Hopper, Sespe Creek, and Piru Creeks.
4. Identify non-native and native predators of southern steelhead, and survey population numbers, sources, and locations.
5. Assess smolt utilization and survival in the estuary.
6. Evaluate how the fish counters work at the Harvey and Freeman diversions and what, if anything, can interfere with a reliable count being obtained.
7. Compare how many adults spawn in other southern California rivers, along with egg, fry, and smolt numbers. This would provide general information regarding the southern steelhead population and would help put fish counts on the Santa Clara into perspective.
8. Study the ocean ecology of southern steelhead and their degree of straying from their natal streams.
9. Acquire properties in the tributaries that contain pristine or restorable steelhead habitat in order to protect spawning and rearing areas.
10. Assess the native gene pool of resident fish to determine the degree of introgression between native southern steelhead and descendants of hatchery trout.
11. Research historical evidence regarding steelhead runs in the Santa Clara River prior to 1955.

Of these eleven actions, six were selected as priorities. One other is discussed because it is going to be conducted by the NMFS.

Assess steelhead and rainbow trout population structure.
Locate and evaluate habitat on Santa Paula, Hopper, Sespe, and Piru Creeks.
Assess smolt utilization of and survival in the estuary.
Identify non-native and native predators, population numbers, sources, and locations.

These four actions were condensed into the single action of conducting habitat and population surveys in three of the tributaries (Santa Paula, Hopper and Sespe Creeks) and the estuary. The surveys will provide baseline information on trout survival, threats, and actions necessary to reduce those threats. It will provide the location of land within the tributaries that are good candidates for restoration. These actions were selected as priorities and are therefore discussed in the later section on habitat and population analyses in more detail.

Evaluate how the fish counters work at the Freeman and Harvey diversions.
It would be helpful to understand more clearly how effectively the fish counters operate, and what, if anything, might interfere with a reliable fish count.

Assess native gene pool in resident fish.
The NMFS will be conducting genetic studies of steelhead trout throughout southern California in the summer of 2003 and in the future. The Santa Clara River will be included in these genetic assessments with collections being conducted in Piru, Sespe, and Santa Paula Creeks.

III. River Water Flow and Balance

The objective of these actions is to evaluate water flow and balance in the river and determine sufficient flows for steelhead passage.

1. Assess and model water flow and usage for the mainstem and tributaries
    a. Determine when and for how long connectivity exists between the tributaries and the mainstem.
    b. Determine the amount of flow from Sespe, Santa Paula, and Piru creeks.
    c. Determine the amount of water historically available to steelhead from November to May.
    d. Determine the location and number of wells and diversions, and the amount diverted or pumped from the mainstem and the major spawning tributaries.
    e. Develop a water budget: determine how much surface water flow there is in normal years and in drought years, how much comes from the State Water Project; and how much water has been appropriated to support out-of-stream uses.
    f. Determine how much water is used residentially, agriculturally and industrially.

   g. Determine the effects on surface flows in the mainstem of the Santa Clara River resulting from the current pattern of releases from Santa Felicia dam.
   h. Model the amount of water necessary for steelhead to make it up and down the river and over what time periods.
2. Evaluate the suitability of different levels of flow downstream of the Vern Freeman Diversion to pass adult steelhead, with particular attention to flow depth and width. Until 2003 after a major storm when the river had dropped below 415 cfs, UWCD released 40 cfs for the first 24 hours post-storm, and 20 cfs for the second 24 hours after a storm. However it is unclear that this is enough water for a long enough period of time to allow steelhead migration to occur from the estuary (the distance from the estuary to the diversion itself is approximately 11 miles). UWCD has begun changing its flow regime to release more water post-storm, and this action will provide an evaluation of the ability of fish to make it from the estuary to the Vern Freeman Diversion.
3. Consider buying water rights on the mainstem and tributaries. Buying water rights might position The Nature Conservancy (TNC) to negotiate with UWCD to allow that water to remain in the river for fish passage, or to allow UWCD to take that water in the summer, but pass more along in the winter when steelhead are migrating. This idea has not been discussed yet with UWCD, and the details of whether and how it could work are unknown.
4. Inventory the types of crops in the valley (which are increasing or decreasing) and determine the amounts of water used by each.
5. Once the types of crops and water usage are determined, assess whether a demonstration project using soil sensitive irrigation equipment would be appropriate.
6. Assess potential for water saving measures such as xeriscaping; use of reclaimed water; water metering where it isn't currently being used; and consumer water saving fixtures.
7. Assemble a diverse working group that would evaluate sustainable water management in the Santa Clara River valley.

Of these eight actions only the first one was determined to be both a priority and within the scope of The Nature Conservancy. This action would be conducted in two parts. The first being a water balance and assessment of inflows and outflows to the Santa Clara surface and groundwater resources. The second would be a hydrological analysis with models to assess the amount of water flow necessary in all lower segments of the river in order to provide sufficient water for steelhead passage during the winter months.

For the purposes of re-licensing the hydro-facility at Santa Felicia Dam, UWCD is studying the effects of different levels of water releases. While the scope of this work is limited and is unlikely to provide a comprehensive review of fish flow requirements for the Santa Clara River, it should provide some data on the effects of certain release levels.

IV. Point source and non-point source pollution

The objective of these actions would be identify and evaluate the sources of pollutants into the mainstem of the Santa Clara River, and major tributaries.

The potential actions include:

1. Conduct water testing near landfills and wastewater recovery plants (WRPs) to determine if there is pollution or leaching.
2. Determine where and when water quality assessments are taking place in the tributaries.
3. Support the Los Angeles Regional Water Quality Control Board's designation of the Santa Clara River as a Significant Natural Resource. Obtaining such a designation for the Santa Clara River would be akin to a beneficial use designation and would limit the permissible hydrologic and water quality impacts of further urbanization on the watershed.
4. Assess contribution of non-point sources of pollution, including fine sediments stemming from various land use practices such as developments and agricultural crops on steep slopes.
5. Conduct a survey for evidence of species existing in the estuary prior to the presence of the wastewater treatment plant.
6. Summarize all water quality assessments on the Santa Clara River and identify gaps in collecting areas and tests.

Of these five actions, none was identified as being as critical to steelhead trout restoration as those prioritized above. Non-point sources of pollution, particularly find sediments, may limit rearing in some tributaries. These are issues that should be investigated, but were determined to be beyond The Nature Conservancy's current scope.

The Priority Actions

The three major actions that were selected as high priorities and that merit a more detailed discussion are habitat and population assessments, a steelhead barriers assessment, and water flow and management.

Habitat and Population Assessments

The objective of these assessments would be to provide baseline information regarding steelhead populations and habitat within the lower sections of the Santa Clara River, and major tributaries. Currently there is no baseline information on steelhead habitat or population structure that can be used for decision-making or to promote change in the facilities or activities that adversely affect steelhead within the watershed.

The main purpose of the assessments would be to document steelhead ecology. This would include gathering information on:

- Steelhead and resident rainbow trout age-class structure, density, genetic structure, and location
- Numbers and locations of predator species
- Location, quality and quantity of habitat, and habitat carrying capacity
- Quality and state of estuarine habitat
- Smolt utilization of and survival in the estuary

These assessments would be from the county line to the mouth of the river, including the tributaries and the mainstem.

This information would provide the foundation for monitoring the state of steelhead within the Santa Clara watershed, the basis for generating a list of potential lands for acquisition and/or restoration, and a list of activities related to improving the steelhead run.

Some of the issues that could arise with this study are gaining access to lands in order to conduct the surveys, difficulty conducting surveys on Sespe Creek due to the rugged terrain, and finding a cost-effective method of evaluating smolt utilization and survival in the estuary.

River Barriers Assessment

The objective of a river barriers assessment would be to identify both anthropogenic and natural impediments to steelhead passage. There are a number of known partial and potential anthropogenic barriers to steelhead passage on the mainstem and on the tributaries. There are also potential natural barriers within the mainstem and at the confluences of the mainstem and each tributary. A barriers analysis would provide:

- An inventory of all barriers, natural and manmade.
- An analysis of each individual barrier and specific problems related to that barrier.

The information from this assessment would be the first thorough, independent evaluation of the barriers to steelhead migration on the Santa Clara River. The likely biggest challenge facing steelhead on the Santa Clara River is being able to complete their migration runs, both as adults migrating to spawning areas, and as juveniles emigrating to the estuary and the ocean. Without an understanding of the challenges and obstacles that steelhead encounter during their migrations, it will be very difficult to rehabilitate a significant run of steelhead in the Santa Clara River.

Water Balance and Flow

Another obstacle to steelhead migration is a lack of adequate surface flows (timing, level and duration) during the migration season. The water balance and hydrology of the Santa Clara River have not been studied outside of a commercial or human use context. A study of water flow and the natural and anthropogenic impacts on water availability would assist in the development of a hydrologic regime that meets both steelhead and human needs.

Information on rainfall and pumping would be available from Ventura County Watershed Protection District and UWCD. UWCD has also done some modeling of groundwater and surface water interactions. A cooperative working relationship with the water agencies is important if we are to find a workable solution for all.

The deliverables associated with this work would be:

1. A mass water balance spreadsheet checked against existing data and information that encompasses the current flow scenario including information on water rights, inputs, outputs, wells, diversions, and trading. Alternative scenarios would also be considered for critical high and low water years.

2. A hydrologic model of flows on the Santa Clara River and scenarios for water management. These scenarios will determine amount of water needed for fish passage up to and including Hopper Creek.

Conclusion

A significant amount of information regarding the Santa Clara River and its steelhead populations has been compiled and synthesized through this effort. The main conclusions from that effort are that steelhead face three major challenges to increasing their population size and spawning runs. The first is a lack of adequate flows to reach prime spawning and rearing areas in major tributaries. The second is impacts on migratory, spawning, and rearing habitats from anthropogenic changes to the river such as flood control structures, water extraction facilities, the alteration of the estuary, and the introduction of exotic fish predators. The third challenge is a general lack of detailed information on the amount, location, and quality of spawning and rearing habitat. In order to assess the level of threats that these challenges represent, and to establish a foundation of knowledge regarding steelhead in this river the following it is proposed that the following be done:

1. An analysis of barriers to steelhead migration,
2. An assessment of the water balance and amount of water flow needed for steelhead passage, and
3. A steelhead habitat and population density survey.

Appendix

A Brief Introduction

This appendix synthesizes information gathered during a 9-month investigation into the state of steelhead trout on the Santa Clara River. Much of the information contained here is directly quoted from the original material. Seventeen people were also interviewed and their comments along with comments from other conversations and emails are noted as "personal communication".

Citations are provided for almost all the material with the references listed in the bibliography. The citation for a source generally follows the last sentence in a bulleted paragraph when all the information is from one source. Where different sources are used in a paragraph, the citations are contained within the relevant sentence.

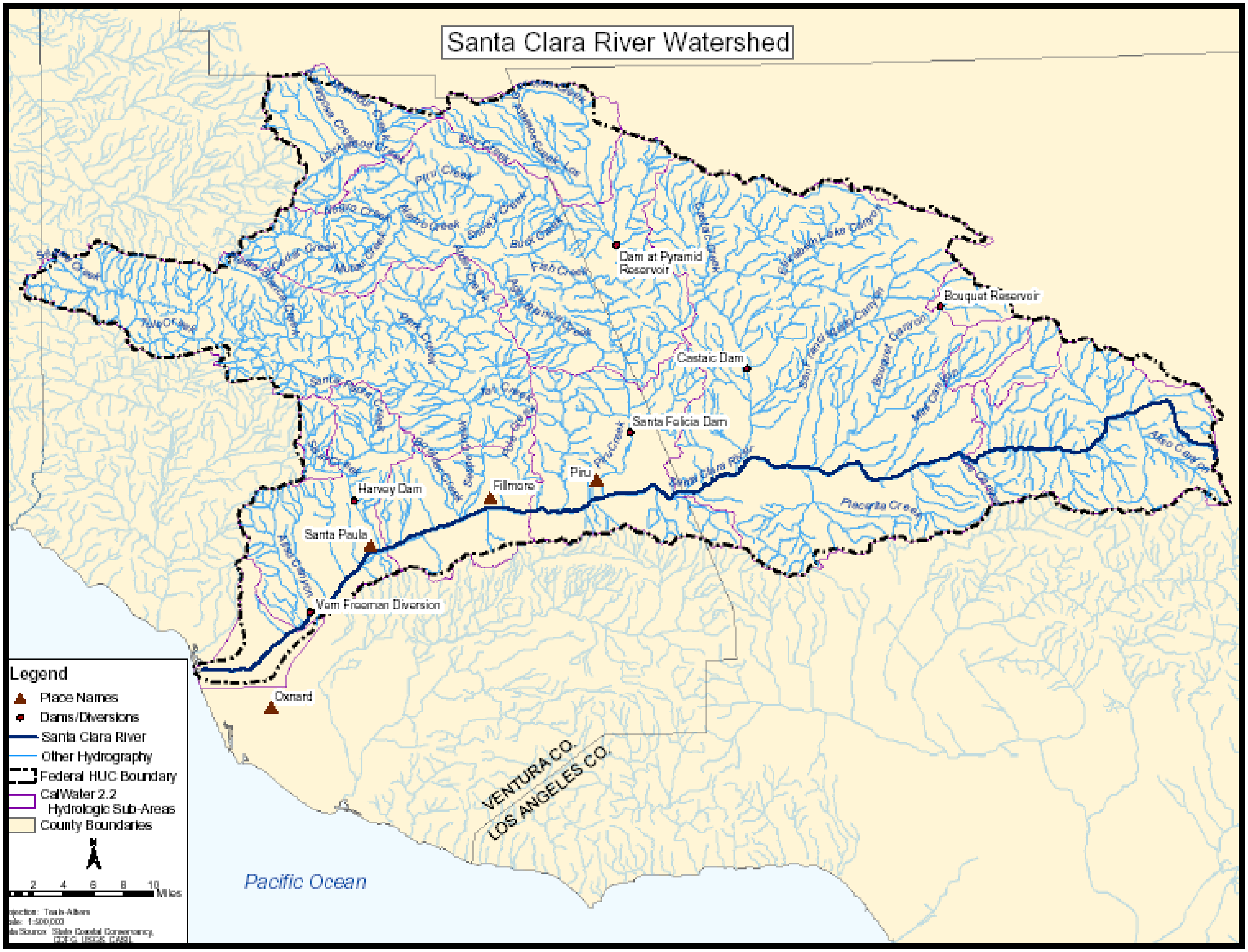
In general, the Appendix chapters conform to the following format:

1. **Issues** – a summary of the most important issues related to that topic. Issues are not listed in any particular order.
2. **Potential research questions** – a list of research areas and action items for that topic
3. **Section I. Santa Clara River** – information specific to that topic and the Santa Clara River
4. **Section II. General Information** – information specific to that topic, but more general in geography or scope than Section I.

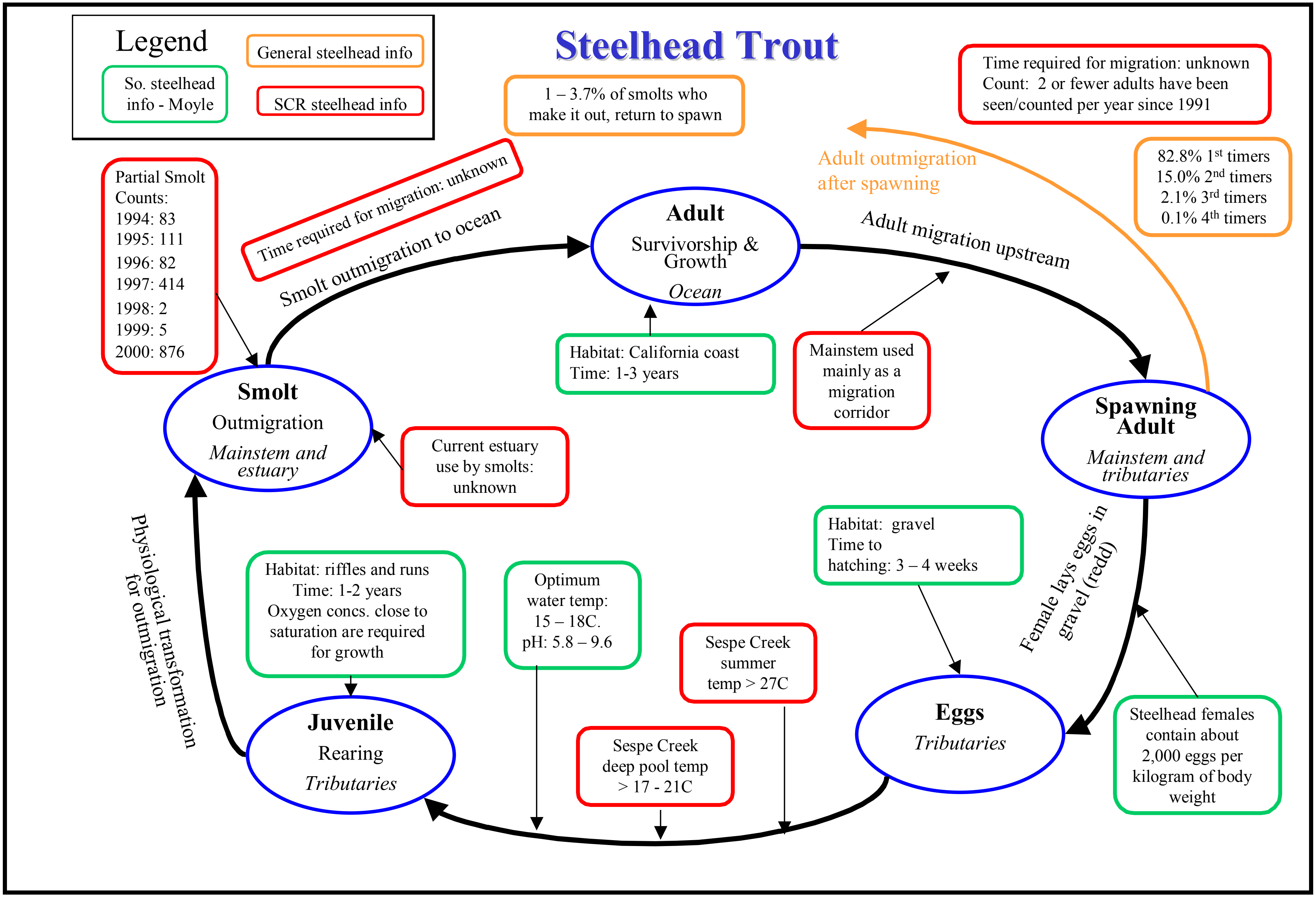
Subheadings are contained within both Sections I and II, in order to better organize the material.

The information presented here was gathered from a variety of sources and these sources do not always agree with each other. The purpose of the Appendix is not to choose amongst these sources, but rather to present published reports or informed opinions regardless of their agreement.

Map


Santa Clara River Watershed
Dam at Pyramid Reservoir
Bouquet Reservoir
Castaic Dam
Santa Felicia Dam
Piru
Fillmore
Harvey Dam
Santa Paula
Vern Freeman Diversion
Oxnard
VENTURA CO.
LOS ANGELES CO.
Pacific Ocean
Legend
Place Names
Dams/Diversions
Santa Clara River
Other Hydrography
Federal HUC Boundary
CalWater 2.2 Hydrologic Sub-Areas
County Boundaries
Miles

Conceptual Model of Steelhead Trout on the SCR



Legend
General steelhead info
So. steelhead info - Moyle
SCR steelhead info
Steelhead Trout
1 – 3.7% of smolts who make it out, return to spawn
Time required for migration: unknown
Count: 2 or fewer adults have been seen/counted per year since 1991
Adult outmigration after spawning
82.8% 1st timers
15.0% 2nd timers
2.1% 3rd timers
0.1% 4th timers
Partial Smolt Counts:
1994: 83
1995: 111
1996: 82
1997: 414
1998: 2
1999: 5
2000: 876
Time required for migration: unknown
Smolt outmigration to ocean
Adult
Survivorship & Growth
Ocean
Adult migration upstream
Habitat: California coast
Time: 1-3 years
Mainstem used mainly as a migration corridor
Smolt
Outmigration
Mainstem and estuary
Current estuary use by smolts: unknown
Spawning Adult
Mainstem and tributaries
Physiological transformation for outmigration
Habitat: riffles and runs
Time: 1-2 years
Oxygen concs. close to saturation are required for growth
Optimum water temp: 15 – 18C.
pH: 5.8 – 9.6
Habitat: gravel
Time to hatching: 3 – 4 weeks
Female lays eggs in gravel (redd)
Sespe Creek summer temp > 27C
Juvenile
Rearing
Tributaries
Sespe Creek deep pool temp > 17 - 21C
Eggs
Tributaries
Steelhead females contain about 2,000 eggs per kilogram of body weight

Santa Clara River Timeline

1769	Observations by Father Juan Crespi of tall and thick cottonwoods and oaks in the Santa Clara riverbed. He described it as an arroyo with a great deal of water which runs in a moderately wide valley, well grown with willows and cottonwoods. [1]
1769	Father Juan Crespi names the river after Saint Clare of Assisi who had an upcoming feast day.[1]
1785	San Buenaventura Mission established by Spanish priests.[1]
1820s – 1860s	Livestock raised on large rancheros. [1]
1842	Gold mining begins. [1]
Mid-1800s	870 acres of estuary are estimated to have existed at the mouth of the river. [1]
1850s	Timber and willows along the creek filled the whole valley between the ridges on either side; freshwater marsh in the same region.[1]
1860s	Euro American immigrants began arriving. [1]
1870s	Agriculture and oil; dry farming techniques. [1]
1870's through the end of WWI	Arrival of Euro-American immigrants results in increasing control of water usage and land for agriculture. [1]
1870s	First artesian wells drilled in the Oxnard Plain.[1]
1876	Main line of the Southern Pacific railroad completed.[1]
1883	Water quality lowered by livestock waste; increased erosion resulting from grazing of riparian groundcover. Lowell Hardison recalled, "the valley was so full of dust that South Mountain was only an outline against the sky. The SCR became a dry bed of sand."[1]
1887	A Southern Pacific branch line extended from Newhall west down the length of the river to Ventura.[1]
1890s	Demand for water in Oxnard reduces water pressure and first pumps are installed.[1]
Early 1900s	Over 16,000 acres irrigated by the surface flows.[1]
Prior to 1910	Harvey Dam built.[2]
1917	29,000 acres of orchard land in Ventura County.[1]
Before 1920	Lowlands in the Oxnard Plain had a high water table.[1]
1918 – 1934	Increased use of groundwater.[1]
Mid-1920s	Water rights becoming an issue.[1]
1920s	Increased urban demand for dairy products led to increased planting of alfalfa for cattle feed.[1]
March 12, 1928	St. Francis Dam disaster.[1] Reshaped the topography of valley lands.[3]
1928	Water diversion commences east of Saticoy; precursor to Vern Freeman Diversion[12]
1930s	Seawater intrusion becomes an issue on Oxnard Plain.[1]
1938	Large flood, over 100, 000 cfs.[1]
1939 - 1969	Harvey Dam fish ladder operational.[2]
Early 1940's	Fish hatchery at Fillmore opened.[1]
1944	21,000 steelhead from Santa Ynez river were planted in the Santa Clara lagoon.[4]
1930s and 1940s	SCR estuary large; fresh/saline mixture; surrounding vegetation/ saltgrass, etc. variety of flora and fauna including smelt/grunion, etc.[5]
1930's to today	Loss of riparian thickets along gravel bars and floodplain; especially near aggregate extraction operations downstream because of lowered water tables from mining and natural scouring.[1]
Pre-1946	Large numbers of huge basking sharks started arriving in Pierpont Bay during the summer months.[6]
1946	Basking sharks in Pierpont Bay killed for industrial use (fertilizers, vitamins, etc.).[6]

1946	Water district started diverting water at the Saticoy Spreading Grounds during the winter months.[7]
1949	107,689 irrigated acres in Ventura County.[1]
Late 1940s	Many farms were under 100 acres.[1]
1950	66,000 acres of orchard land in Ventura County.[1]
1955	Santa Felicia Dam is constructed. [1]
1956	Fillmore WRP comes on-line.[8]
1958	Ventura WRP comes on-line. [8]
Post 1950s	River bed lowering occurred; sand and gravel extraction intensified.[1]
1960s	Surface flow had diminished and use of groundwater replaced earlier sources.[1]
1964	Interstate 5 constructed; Valencia development announced.[1]
1965	SCR surface flows irrigated 2,500 acres because of reduction of surface flow. Same amount irrigated in 1969. [1]
1966	Valencia WRP comes on-line.[8]
1969	Urban use of water along SCR is 39% of local water service.[1]
1969	Largest natural flood on the river.[9]
1970s/80s	A red line was created that limited mining in the river.[1]
Pre-1977	Cool, nutrient-rich ocean phase with high ocean salmon productivity.[10]
Post 1977	Low-production warm ocean phase.[10]
1978	Large flood, over 100, 000 cfs.[9]
1980	UWCD proposes the Pumping-Trough-Pipeline and the permanent Freeman Diversion to solve seawater intrusion problem.[1]
1983	Large flood, over 100, 000 cfs.[9]
1989	Vern Freeman Diversion fish ladder and intake screens installed.[2]
1986	Department of Water Resources – protested that the finding of three adult steelhead did not constitute a “run” and that all water should be diverted from the river to UWCDs percolation grounds.[11]
1991	VFD fish ladder and screen become operational.[12]
1991	Mobil spill. Pipeline ruptured most likely from poor maintenance, oil flowed toward and into the river, in same general area as the later Arco spill. Settlement recently arrived at with Exxon/Mobil. ~$2.7M [1]
1992	Large flood, over 100, 000 cfs.[9]
1992	31.5 miles of the Sespe is designated as Wild and Scenic.[13]
1992	Saugus WRP comes on-line.[8]
1994	Arco spill. Pipeline rupture as result of Northridge Earthquake. Settlement ~7.5M, at $9M as of 1995 due to interest accumulation.[1]
1995	Large flood, over 100, 000 cfs.[9]
As of 1995	There were cattle operations near Piru and in Los Angeles County with occasional cattle drives crossing the river.[1]

References

1. Schwartzberg and Moore 1995
2. National Oceanic and Atmospheric Administration and National Marine Fisheries Service 2000
3. Taylor 1994, as cited in Schwartzberg and Moore 1995
4. Carpanzano 1996
5. Henke 1995
6. Henke 1970
7. Outland 1971
8. Pers. comm. with respective WRP agencies/departments, 2003
9. Santa Clara River Project Steering Committee 1996
10. Reinard 2002
11. Kennedy April 1986
12. Pers. comm. Murray McEachron
13. Blecker 1997

Santa Clara River Watershed Factsheet

Headwaters	**Pacifico Mountain** in the San Gabriel Mountains		
Size	**Watershed Area:** 1,600 square miles		
	Naturally Occurring Waterways: 2623.92 miles		
	Percentage of Free Flowing River Miles: 94		
	Percentage of River Miles in Protected Lands: 21		
Main tributaries	Agua Blanca Creek	Aliso Canyon	Bouquet Canyon
	Canada De Los Alamos	Castaic Creek	Elizabeth Lake Canyon
	Gormon Creek	Lockwood Creek	Mint Canyon
	Piru Creek	Santa Paula Creek	Sespe Creek
	Seymour Creek	Snowy Creek	Hopper Creek
Average annual precipitation	Mean annual precipitation ranges from approximately 8 inches in the easternmost part of the watershed to more than 34 inches near the headwaters of Sespe Creek.		
Land	**Protected Lands:** 20%		
	47 percent, or 480,000 acres of land in the watershed is **publicly owned** (the Los Padres and Angeles National Forests)		
Dams	**7**		
	Vern Freeman, a diversion dam		
	Bouquet Canyon Reservoir (1934; 628 acres)		
	Pyramid and Castaic dams control about 37% of the watershed. **Castaic Lake** is created via an earthen dam across Castaic Creek (324,000 AF)		
	Lake Piru (used for groundwater replenishment)		
	Castaic Lagoon (197 acres)		
	Dry Canyon Reservoir (1,313 AF) is the terminus for the West Branch of the California Aqueduct.		
Species	**Number of Special Status Species:** 26		

Faults	**Santa Clara River Valley Fault Lines:** San Gabriel and Holser
Sea water intrusion	New facilities and management practices introduced in the 1980s and 1990s slowed seawater intrusion
Habitat	**Harbor Blvd. to the U.S. Highway 101 Bridge:** riparian woodland riparian scrub small pockets of *Arundo donax*
	Highway 101 to Saticoy vegetation sparse small pockets of riparian/oak woodland habitat areas infested with *Arundo donax*
	Saticoy to Santa Paula southern willow riparian woodland coastal sage scrub coast live oak woodland large *Arundo donax* infested areas
	Santa Paula to Fillmore vegetation changes to large concentrations of alluvial scrub watercress southern willow scrub large concentrations of *Arundo donax*
	Fillmore to Piru alluvial scrub
	Piru to the Ventura/Los Angeles County line southern willow scrub southern willow riparian woodland
	Los Angeles County line to the upper reaches alluvial scrub southern willow riparian woodland alluvial scrub southern willow scrub

*Main data sources for table were the Southern California Wetlands Recovery Project Information Station on-line at http://www.wrpinfo.scc.ca.gov/, Santa Clara River Enhancement and Management Plan (SCREMP) documents, and the McGrath State Beach Natural Resources Management Plan (April 2003).

Sespe Creek Subwatershed Factsheet

Headwaters	Northwestern corner of the Ojai Ranger District near Ventura/SB County boundary	
Size	207,700 acres	
Major tributaries	Lion Canyon, Hot Springs Canyon, Timber Creek, West Fork Sespe Creek	
Small tributaries	Abadi, Adobe, Cherry, Ladybug, and Burro Creeks	
Average annual volume	Near Wheeler Springs was 10,000 AF from 1947 to 1985. Near Fillmore was 86,220 AF from 1927 to 1985. Sespe Creek contributes 40% of the total natural runoff in the Santa Clara River Basin	
Land uses	Campgrounds	
	Urban (the City of Fillmore) and agricultural development	
Water quality	Affected by the older marine sedimentary rocks. Hot Springs Creek is a major source of fluoride, chlorine, and boron.	
Habitat	Established in 1992, the 219,700-acre Sespe Wilderness Area encompasses 31.5 miles of Sespe Creek and contains a 53,000-acre Sespe Condor Sanctuary. 31.5-mile reach of Sespe Creek from its confluence with Rock Creek and Howard Creek downstream to where Sespe Creek leaves Section 26, Township 5 N., Range 20 W. of the Fillmore USGS Quadrangle map.	
Species	Common wildlife species observed within the subwatershed include black bears, deer, mountain lions, bobcats, coyotes, rattlesnakes, red-tailed hawks, and golden eagles. Black bear populations have maintained their numbers at a relatively constant level over the past few decades.	
	Arroyo toad largest surviving populations: 15 miles of Sespe Creek from the mouth of the Tule Creek downstream to the Hot Springs Canyon vicinity	
	Vireo and Flycatcher recovery: efforts have been focused at the mouth of Sespe Creek near the Fillmore Fish Hatchery	
	Cowbird control: brood parasitism by cowbirds fell to less than 10%, with none detected since 1993	
	Southwestern willow flycatcher: recovery team under leadership of the USFWS.	
Fillmore Wastewater Treatment Plant	Discharges 1.33 million gallons per day of treated domestic and industrial wastewaters, and constitutes a threat to surface water quality in the lower Sespe Creek and Santa Clara River	

*Main data sources for table were the Southern California Wetlands Recovery Project Information Station on-line http://www.wrpinfo.scc.ca.gov/, and Santa Clara River Enhancement and Management Plan (SCREMP) documents.

Santa Paula Creek Subwatershed Factsheet

Headwaters	Springs are on the southern slopes of the Topatopa Mountains in Los Padres National Forest. The headwaters are located near Hines Peak at an elevation of approximately 6,704 feet above MSL
Size	45-square miles or 75,050 acres
Tributaries	Sisar Creek, Mud Creek
Average annual precipitation	17.43 inches
Average annual volume	112 AF from 1927 to 1932
	300 AF from 1949 to 1985.
	No flows were recorded for long periods in most years
Land Uses	Residential development, campgrounds, fishing, swimming, hiking
Surface water quality	Good but not considered potable.
	High amounts of suspended clays, presence of natural oil and sulphur seeps (Sulphur Springs area).
	High biological oxygen demand believed to originate from anthropogenic sources (septic system leacheate and recreational uses at Steckel Park).
Habitat	The natural communities present in the Santa Paula Creek subwatershed include riparian woodland, riparian scrub, coast live oak-walnut woodland, coastal sage scrub-grassland, and chaparral.
Structures	CalTrans bridge for highway 150 near the Thomas Aquinas College. Footings for bridge are in a concrete apron just below the confluence of Santa Paula and Sisar Creeks.
	Harvey Diversion: Santa Paula Water Works, Ltd. Recently sold this diversion to Canyon Irrigation District. The diversion occurs approximately 1,000 feet south of Steckel Park just below a USGS gauging station and just upstream of the confluence with Mud Creek. It is a source of water for the City of Santa Paula. The diversion was built in 1923 and the fish ladder was recently rebuilt in 2000 on the southern wall of the approximately 30-foot dam. Downstream of the dam, the creek is deeply eroded for approximately one mile.
	A flood control channel built and operated by the ACOE. Occurs just prior to the confluence with the mainstem.
	Three road crossings consisting of fill with culverts occur within the streambed of the Santa Paula Creek

*Main data sources for table were the Southern California Wetlands Recovery Project Information Station on-line at http://www.wrpinfo.scc.ca.gov/ and Santa Clara River Enhancement and Management Plan (SCREMP) documents.

Piru Creek Subwatershed Factsheet

Headwaters	Lockwood Valley located northwest Los Angeles and approximately 25 miles northeast of the City of Ventura.
Size	318,000 acres
Tributaries	Lockwood, Alamo, Seymour, Amargosa, San Guillermo, Agua Blanca, and Fish Creeks
Average annual volume	Above Lake Piru, from 1956 – 2001, average annual streamflow: 66.8 cfs
Land uses	Camping, cattle grazing, urban development, citrus, avocado, pasture, small grains, and alfalfa
Water Quality	Threats include waste discharges from the Gorman Water Pollution Control Plant and Pyramid Power Plant; agricultural returns to the Pico Formation near the mouth of Piru Creek. Approximately 60,000 gallons of domestic wastewater is treated and discharged per day to the Peace Valley area.
Habitat	The upper portion of the subwatershed is rugged, undisturbed terrain located in the Los Padres National Forest. Open valleys and steep gorges before the Pyramid Lake Reservoir. Below Pyramid Dam scattered riffle-pool formations.
	Oaks, pines, fir, and juniper species occur above 5,000 feet while cottonwood, and willow communities occur within the streambed and near springs. Seasonal grasses are dominant on the soils formed on finer grained sedimentary rocks and alluvium. Adjacent upland terraces are relatively arid, supporting oaks, grassland and chaparral.
Dams	Pyramid Dam built in 1973; impounds water from the State Water Project (SWP) and subwatershed runoff. Santa Felicia Dam was built in 1955 and impounds runoff from the subwatershed. Approximately 87,000 acre-feet (AF) of water are stored in Lake Piru.
Species	Vegetation throughout lower Piru creek consists of white alders (*Alnus rhombifolia*), California sycamores (*Platanus racemosa*), arroyo willows (*Salix lasiolepis*), coast live oak (*Quercus agrifolia*) and mule fat (*Baccharis salicifolia*). The dominant overstory is alders and sycamores, with some portions being dominated by coast live oaks. The midstory is composed of smaller willows, mule fat, and poison oak (*Toxicodendron diversilobum*), with and understory of the aforementioned species as well as California wild rose (*Rosa californica*), California blackberry (*Rubus californicus*), cattails (*Typha sp*.), and other herbaceous species.
	Middle section of Piru creek (between Pyramid and Lake Piru) contains a wide diversity of aquatic species including abundant rainbow trout. Piru Creek has been stocked by the CDFG with small rainbow trout (*Oncorhynchus mykiss*) since the early 1950s. Stocking of fingerling brown trout (*Salmo trutta*) stopped in the late 1970s.
	Black bear; southwestern willow flycatcher, least Bell's vireo, Cooper's hawk (*Accipiter cooperii*), arroyo toad, and California red-legged frog are either known to occur or potentially occur within subwatershed.
Hydrology	Flow on Piru Creek is controlled by Pyramid and Santa Felicia Dams, which serve as both flood control and water supply reservoirs.

*Main data sources for table were the Southern California Wetlands Recovery Project Information Station on-line http://www.wrpinfo.scc.ca.gov/, the California Department of Water Resources, and Scott, K., J. Ritter, and J. Knott. 1968. *Sedimentation in the Piru Creek Watershed, Southern California*: U.S. Geological Survey, Water-Supply Paper 1798-E, 48 p.

Ecology and Population of Steelhead

Issues

1. Steelhead ecology and biology are poorly known in this river. There is little current data or information on life history, habitat usage, historical numbers, length of time to migrate, etc.
2. The utilization of the estuary by smolts is undocumented. Currently the estuary is shallow, lacks cover, is ¼ of its historical size, and the gravel bed has been covered by silt - removing food sources for smolts.
3. Southern steelhead ocean ecology is virtually unknown.
4. The most likely major cause of steelhead population decline in the SCR was the increase in water diverted at the Vern Freeman Diversion beginning in 1950s when it was operated without a fish screen (i.e. a significant majority of smolts and spawned adults were diverted into the percolation ponds and died) until 1991. Other potential impacts were increased use of water by agriculture and increased aggregate mining.
5. Sespe Creek harbors the largest and highest quality spawning opportunity for steelhead on this river.

Potential Research Questions

- Assess habitat quantity and quality in Santa Paula Creek, Sespe Creek, and Piru Creek including summer water temperatures, oxygen levels, etc.
- Assess carrying capacity of each of the tributaries in terms of food, habitat and water temperature.
- Investigate steelhead tolerances to turbidity, and water temperature.
- Assess historical use of river and estuary by smolts.
  - How has the changing water chemistry in the estuary likely affected smolt utilization?
  - What is the overall condition of the estuary?
  - How much suitable estuarine habitat is available for smolts?
  - How easily and quickly do smolts adapt to the estuary and then to the ocean?
  - How much time do smolts spend in the estuary?
  - What is an optimal size for ocean-going smolts? Do smolts in the SCR reach the necessary size in one year or do they need additional time in the estuary?
  - Is there a beneficial level of freshwater input to the estuary?
- A count at the estuary of the number of smolts making it to the ocean, by size and sex.
- Where in the ocean do steelhead trout go? How well do they survive? What affects their population/survival?
- What is SCR's transportation efficiency? Do adults/juveniles get caught in shallows or hydrologically disconnected reaches and experience high mortality rates?

Section I. Santa Clara River

Fish Counts

- In 1997 there was a high kill of smolts in the out migrant trap at the VFD. UWCD and DFG took scales and used the opportunity to sex fish. There was an extremely skewed sex ratio with females making up 85 - 90%. The normal ratio in other rivers has been 1:1. Similar results to these found at VFD have also been found in Central Valley Coho salmon. It is unclear why the skewness occurred – it could have been an unrepresentative sample, or it could have been some effect of temperature that caused the females to smoltify and emigrate downstream, but not the males, etc. (Robert Titus, California Fish and Game, pers. comm. November 2002)
- Probably more than 1% of smolts make it back to spawn in general (Robert Titus, California Fish and Game, pers. comm. November 2002). Shapovalov and Taft (1954) stated that 3.5% made it back on Waddell Creek.
- Prior to 1954 the DFG required a screen over the VFD headworks to prevent the induction of downstream migrant steelhead. However after Jack White, the DFG warden who worked on the Santa Clara, retired the seasonal installation and maintenance of the screen was allowed to lapse. This change in operations, plus the enlargement of the diversion works, increased groundwater pumping, and the construction of reservoirs on the Piru and Castaic Creek tributaries led to a sharp decline in the SCR steelhead fishery in the late 1950s. (Capelli 1983)
- The size of the SCR drainage has been used to make some run-size estimates. A reasonable estimate is on the order of 1,000s of fish. (Robert Titus, California Fish and Game, pers. comm. November 2002)
- About 1946 the UWCD district started diverting water at the Saticoy Spreading Grounds during the winter months. Local historian Charles Outland never personally saw a native run trout after that time. (Outland 1971).
- 1946 was the beginning of one of the worst droughts on record (Murray McEachron, United Water Conservation District, pers. comm. January 2004).

Migration timing

- In general, upstream migration of adult steelhead occurs from January through March. Downstream emigration of smolts and spawned out adult steelhead occurs from April through June. (Moore 1980c)
- Flow and hydrology are historically inconsistent throughout the SCR watershed. Both upstream and downstream migrating fish have likely developed migration behavior that accounts for the relatively short “migration windows” common to Southern California river systems (Rick Rogers, pers. comm. December 2003)

Return spawners

- It is unknown how likely SCR steelhead are to return to the SCR. Shapovalov and Taft (1954) found 98% of Waddell Creek spawned steelhead returned to their natal creek. However, flows in southern streams like the SCR are less reliable, and make it more likely that these fish seek whatever river openings they can find.

Habitat

- The mainstem of the SCR acts as a fish migratory corridor. Adults swim upstream and do not linger in the mainstem.
- Monitoring-oriented instream habitat surveys are difficult to execute in the SCR because the channel(s) shift(s) from year to year, along the mainstem. Not a static channel. Difficult to monitor. (Matt Carpenter, Entrix, pers. comm. November 2002)
- From above the estuary to the VFD the river is mostly low flows with warm water; lacks instream cover and deep pools. Predominantly sand substrate (Matt Carpenter, Entrix, pers. comm. November 2002).
- Main tributaries on the SCR provided 89 miles of spawning and rearing habitat prior to 1948 (Moore 1980c):

Drainage	SP creek	Sespe Creek	Piru Creek
Mile of historical habitat	11	53	25
Miles of current habitat	2	47	0

Santa Paula Creek

- Due to its smaller watershed size, SP creek was historically a minor contributor in steelhead runs compared to Sespe and Piru. (Rick Rogers, National Marine Fisheries Service, pers. comm. January 2003)
- Adult steelhead still occur but in low numbers. Heavily fished. About 10 – 11 miles of good habitat occurs above the Harvey Dam diversion. East Fork's habitat limiting factor is turbidity due to extensive mass wasting from unstable canyon walls. (The National Oceanic and Atmospheric Administration and the National Marine Fisheries Service 2000)
- ACOE did a wildlife assessment (invertebrates, fish, birds, etc.) from the mouth of SP Creek to Thomas Aquinas College. Pools, riffles, and glides probably not assessed.

Sespe Creek

- Sespe Basin is good rearing and spawning habitat up as far as Cherry Creek. (Buck Yedor, United Water Conservation District, pers. comm. December 2002)
- Sespe is naturally high in total dissolved solids (TDS), which makes for a productive aquatic environment. It is high in calcium and phosphorus. Rich macroinvertebrate community. Stream clears up quickly from a rain.

(Mark Moore, California Department of Fish and Game, pers. comm. December 2002)

- Timber Canyon creek is a cool water addition to Sespe. It has barriers in its middle section. (The National Oceanic and Atmospheric Administration and the National Marine Fisheries Service 2000)
- Coolest tributaries to the Sespe include Pine Canyon, Coldwater, and West Fork Creeks with summer temps generally staying below 64F. (Blecker *et al.* 1997)
- Maintaining migration access to Sespe creek is essential to restoration and recovery of southern California steelhead (Matt Carpenter, Entrix, pers. comm. November 2002). Sespe is the main spawning opportunity and is regarded as the crown jewel of the system (Rick Rogers, National Marine Fisheries Service, pers. comm. January 2003).
- Below Vantrees property, the Lower Sespe is probably only a migration corridor. (Mark Moore, California Department of Fish and Game, pers. comm. December 2002)
- On Sespe Creek, the most suitable steelhead spawning areas are the riffles of the mid to upper section of the Sespe, Lion and Tule Creeks. These areas support the highest trout fry densities. (Blecker *et al.* 1997)
- Sespe creek water chemistry suggests a moderately productive aquatic community with insects in moderate densities. (Blecker *et al.* 1997)
- On the Sespe there is 134,004 m^2 of available spawning habitat, and 242,270 m^2 rearing habitat. Therefore an estimated 94,772 smolts could potentially be supported to smoltification. These fish would equate to approximately 9,472 adults or 2% of the spawning potential of the creek. In drought years rearing capacity would be less. (Blecker *et al.* 1997)
- In the Sespe dead wood does not play a significant role as in-stream fish cover but it does contribute to the erosion potential of floods. (Blecker *et al.* 1997)
- Landslides do not play a long-term beneficial role in supplying the stream with bedload materials. (Blecker *et al.* 1997)
- 1992 – a major section of Sespe was given protection as a federally designated wilderness area, and at the same time a 31.5-mile section was given protected status as a Wild and Scenic River. (Blecker *et al.* 1997)
- Sespe watershed includes an unusually high concentration of perennial creeks and streams for Southern California. (Blecker *et al.* 1997)
- There is currently no active grazing within Sespe. (Blecker *et al.* 1997)
- There are 6 birds, 1 reptile, and 2 amphibian species listed or proposed as threatened, endangered or sensitive, known to potentially occur within the Sespe watershed. (Blecker *et al.* 1997)
- There is a general trend of declining riparian vegetation along the mainstem Sespe as a result of fires, roads, and trails. (Blecker *et al.* 1997)
- Efforts to return the watershed to a more natural or desirable cycle of fire return (i.e., more frequent, less large/hot) may be the most significant contribution to restoration of steelhead habitat. Siltation would be

lessened and hydrology could be improved to lessen the effects of drought and scouring floods. (Blecker *et al.* 1997)

- Water temperatures exceed 60F on the potential steelhead spawning areas approximately 20% of the days in Feb – June. Water temperatures regularly rise above 68F during July – September. Riparian canopies are not adequate to moderate summer water temperatures. (Blecker *et al.* 1997)
- Large boulder material frequently plays the role of large woody debris, and water temperatures are locally influenced by upwelling of cooler spring water. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- Sespe creek and its tributaries (Dvorsky 2000):
    - The dominant habitat variable in the nine subwatersheds influencing fish densities was pool depth, and to a certain degree, pool volume.
    - Some Sespe tributaries may produce a large number of fry but show very few large individuals suggesting the spawning quality of the creek is good but other habitat characteristics are poor such as food production or temperature.
    - Alder Creek for example has low densities for the smaller trout sizes indicating that spawning success was relatively low yet densities for higher classes were fairly high suggesting that habitat is able to support adult rainbow trout populations in Alder Creek but that production of fry and juveniles is low. Creeks lined by alder trees are often associated with year-round surface flow, but sediment storage characteristics may limit the supply of gravel creating insufficient spawning habitat.
    - In Trout Creek small trout densities are relatively high, yet the larger size classes have small amounts of representation. This suggests that Trout Creek provides adequate spawning habitat as indicated by its sediment storage characteristics but may provide poor rearing and adult habitat.
- The middle reach of the Sespe is a demanding area to survey because of its very ruggedness and inaccessibility. Hasn't been done utilizing systematic survey methods such as the Habitat Suitability Index method. Middle reach is the main spawning area, from above and below Alder Creek downstream to Devil's Gate. Big water, deep ponds. May require diving. Smolt population is high. (Maurice Cardenas, California Department of Fish and Game, pers. comm. December 2002; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- Bear Canyon Creek -1979 - Good habitat (summer nursery) and trout numbers in the lower river. (The National Oceanic and Atmospheric Administration and the National Marine Fisheries Service 2000)
- Lion Creek -1979 - rainbow trout abundant. (The National Oceanic and Atmospheric Administration and the National Marine Fisheries Service 2000)

Pole Creek

- Natural impassable 30 ft waterfall 3.9 miles upstream of Fillmore city limits. Potential artificial barrier 0.8 miles above Hwy 126. No fish observed in 1992 survey. (The National Oceanic and Atmospheric Administration and the National Marine Fisheries Service 2000)

Hopper Canyon Creek

- RT observed 1992. Fair to good spawning and rearing habitat throughout upper portions (The National Oceanic and Atmospheric Administration and the National Marine Fisheries Service 2000)
- Hopper Canyon has great wildlife habitat. Hopper Creek is a good creek, but there's no size to it. However, the creek has good potential to support trout and smolts. (Maurice Cardenas, California Department of Fish and Game, pers. comm. December 2002)

Piru Creek

- No steelhead were found below Santa Felicia Dam in 1978 seining survey. Abundance of naturally-reproduced RT found in 1987 in reaches near old Hwy 99. (The National Oceanic and Atmospheric Administration and the National Marine Fisheries Service 2000)
- Historical data on Piru Creek is spotty at best, but the current headwaters (above both Piru and Pyramid Lakes) contain stretches of suitable steelhead spawning and rearing habitat. (Rick Rogers, National Marine Fisheries Service, pers. comm. January 2003)
- Piru Creek contains approximately 30% of the total amount of historic steelhead spawning and rearing habitat in the Santa Clara River watershed. (Moore 1980c)

Estuary

- Estuary is shallow due to siltation; recent seining found no steelhead; lack of cover minimizes chances of a successful out-migration of smolts (National Oceanic and Atmospheric Administration and National Marine Fisheries Service 2000). Estuarine conditions in the SCR lagoon have changed dramatically over the past fifty years (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004). In particular the natural frequency of lagoon breaching has been disrupted. Levees, decreased river flows, and pollution have impacted the lagoon environment (Comstock 1992).
- The Santa Clara River Estuary formerly consisted of a series of shifting river mouths that have now been restricted by development to a single location and reduced to approximately 1/4 of its previous aerial extent. Prior to the late 1940s when upstream diversions altered the flow regime in the lower river, smolts were commonly seen in the estuary waiting for the sand bar to breach and allow their emigration to the ocean. The estuary bottom consisted of more coarse sediments than today, which

provided a suitable substrate for benthic organisms upon which smolts could feed. Currently, the silt-covered bottom of the estuary provides more suitable habitat for marine species of fish such as stripped mullet, which were not common before, but are now seen more frequently and in increasing numbers. (Mark Capelli, National Marine Fisheries Service, pers. comm. October 2003)

- Estuary lost part of its earthen levee on the east bank in 1995, and the rest of it is eroding back. Sediment is building up along the east (downcoast) bank. (Virginia Gardner, California State Parks, pers. comm., October 2003).
- Currently there is no authorized, artificial breaching of the levee by either California State Parks or the City of Ventura. (Virginia Gardner, California State Parks, pers. comm., October 2003)
- The Army Corps of Engineers has rejected McGrath Farms' claim that they have a right to breach the estuary. The Ventura County Resource Management Agency's Environmental Health Department has suggested artificial breaching of the sandbar as a means of mosquito control, however the California Department of Parks and Recreation manages the majority of the estuary as a Natural Preserve and does not support the practice. (Waln 2004)
- The City of Ventura's wastewater treatment plant's effluent is currently in violation of the copper limits established for a saltwater environment (i.e., for the estuary). The City commissioned a study of the estuary that showed that the majority of the species in this environment were either freshwater species tolerant of brackish conditions or brackish water species. (Entrix 2002)
- The Santa Clara River estuary is unique among other estuaries found in the Southern California Bight (Point Conception south to the California/Mexico border). Published information on invertebrate communities and hydrologic conditions was found on seven estuaries of similar size to the Santa Clara River estuary within the Southern California Bight. Among these estuaries, the SCR estuary is unique in that it receives constant year-round freshwater flows and does not have its mouth manually dredged for water quality purposes. The seven estuaries examined generally share many benthic invertebrate taxa in common. With the exception of San Dieguito Lagoon, the Santa Clara River estuary shares very few invertebrate taxa with these other estuaries. The species compositions of the other estuaries are in general more estuarine and marine than the SCR estuary. (Entrix 2002)
- During a recent water quality profile of the estuary, low salinities (1 to 4ppt) were observed near the discharge channel and upper estuary, where the Santa Clara River flows in. Brackish conditions (5 to 10 ppt) were observed in the middle of the Estuary. More marine-like (>10 ppt) conditions were isolated to the area near the mouth and far southwestern portion of the estuary, the highest salinity measurement being 30 ppt. (Entrix 2002)

- The temperature of the reclaimed water discharge (treatment plant effluent) is essentially identical to the temperature of upstream river flows. The city of Ventura has available extensive temperature, nutrient and chlorophyll A data that they have collected for upstream flow, estuary waters, and reclaimed water discharge. The upstream sampling sites for the City of Ventura are at the Harbor Blvd. bridge and 0.5 miles upstream of the Harbor Blvd. bridge. There are also four sampling sites within the estuary. (Waln 2004; Don Davis, City of Ventura, pers. comm. March 2004)
- UWCD no longer releases smolts near the outfall for the City of Ventura's wastewater treatment plant. Sampling from February through April of 2001 revealed the outfall water temperature to be 5°C warmer than that at the Vern Freeman Diversion. (Buck Yedor and Murray McEachron, United Water Conservation District, pers. comm. March 2004)
- The City of Ventura WRP's discharge directly to the Santa Clara River estuary has substantially altered the water chemistry and quality of the estuary. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)

Aggregate Mining

- During the time when poorly-regulated, active gravel mining occurred in the active river channel and for as long as excavations remained, fish perished as a result of mining operations. Mining would disrupt surface flow continuity creating holes into which the surface water (and fish) would disappear. (Mark Moore, California Department of Fish and Game, pers. comm. December 2002)

Climate

- The Upper Santa Clara River is characterized by semi-arid Mediterranean-type climate and temperature ranges from 100° F to 30° F. Eighty percent of the average annual precipitation occurs between November and March. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Lower Santa Clara River temperature ranges from 69° F near the coast to 61° F inland. Most precipitation occurs between December and March. Average annual rainfall from 1950 – 1992 was from 13.7 inches to 18.7 inches. (United Water Conservation District and Castaic Lake Water Agency 1996)

Section II. General Information

Southern Steelhead

- South of Point Conception the climate is much more hostile to steelhead. It is generally hotter, drier, and more variable, etc. Most habitat criteria developed for steelhead (i.e., temperature, instream shelter, etc.) are not always applicable to streams south of Point Conception. (Matt Carpenter, Entrix, pers. comm. November 2002)

- Steelhead were listed before systematic population and habitat monitoring studies were able to begin on southern steelhead, thus our ability to understand and recover the population is diminished due to a lack of long term monitoring data (Matt Carpenter, Entrix, pers. comm. November 2002).
- Southern steelhead show unique genetic characteristics as well as high genetic diversity, suggesting that they developed from a population that survived in a Baja California refuge during the Pleistocene and that has recently come into contact with steelhead of more northern origin (Nielsen 1999). This ESU's high diversity may help to explain its remarkable capacity to persist in seemingly unfavorable environments.
- Due to drought and/or human-related activities, southern steelhead are often impeded or blocked from accessing their natal streams due to low-flow conditions. It appears that when faced with this prospect southern steelhead adapt, and either delay their upstream spawning migration until adequate flows exist or enter and ascend another suitable stream nearby. This action of straying from their stream of birth appears to be an important survival technique for a species whose freshwater habitat is characterized by extremely variable climatic conditions and human competition for resources, which may effectively eliminate upstream migration for a number of years. (Stoecker 2002)
- Studies by Moore (1980b) and others have shown that length of residency decreases in the more southern drainages. This variety in time to reach the smolting stage is probably related directly to growth rates, which in turn are influence by the length of the growing season, water temperatures, and the abundance of aquatic food materials. Moore's (1980b) study on the Ventura River indicated that a juvenile steelhead might reach the smolting stage in a single growing season. (Capelli 1983; Moore 1980b).
- Biologically and genetically we don't know how resilient these fish are. Migration windows are tiny. (Mark Moore, California Department of Fish and Game, pers. comm. December 2002)
- In 1999 on the Santa Ynez River eight adult steelhead were counted below Bradbury Dam. While there are few rivers monitoring the number of steelhead that run each year, steelhead have been sighted in rivers ranging from the Santa Maria southward into Orange County.

Regulation

- In 1989 both the genus name and species name of the rainbow trout were changed from *Salmo gairdneri* to *Oncorhynchus mykiss*.
- Southern ESU declared endangered in 1997 (National Oceanic and Atmospheric Administration and National Marine Fisheries Service 2000).

Habitat Qualities

- Escape cover can exist in the form of boulders, logs, undercut banks and trees, root wads, and overhead riparian vegetation (Hager 2001). In southern California rivers, boulder debris can serve the same function as large woody debris in providing refugia for migrating and rearing steelhead (Mark Capelli, National Marine Fisheries Service, pers. comm, January 2004)
- Loss of riparian vegetation reduces shade, cover, food supply, and streambank stability. Vegetation provides habitat for insects upon which steelhead feed, nutrients to streams via detritus, and cover for predator avoidance. Vegetation also prevents erosion by slowing runoff rates and reducing soil loss. (Hager 2001)
- Habitats with increased current speeds and turbulence usually contain higher dissolved oxygen and food levels, and when steelhead have access they preferred such habitat, particularly under conditions of oxygen stress at higher temperatures. (White 1991, as cited in Stoecker 2002; Hill and Grossman 1993, as cited in Stoecker 2002)
- Juvenile steelhead require living space (different combinations of water depth and velocity), shelter from predators and harsh environmental conditions, food resources, and suitable water quality and quantity for development and survival. (Lent 2001)
- Wetlands, estuaries and lagoons provide critical nursery habitat for all juvenile salmonids migrating to the ocean, as a feeding area and in their acclimatization to higher salinities. The ocean survival for juvenile salmonids is greatly increased if rearing fish are able to attain larger size for an extended period in the estuary. (Bryant and Lynch 1996)
- In other southern California rivers, sewer treatment plant effluent has been noted to supply more surface water than was available historically. The water is often much warmer than natural waters emerging from underground sources. Its high nutrient load encourages a different suite of species and can put the native fauna (and flora) at a competitive disadvantage (Swift *et al.* 1993; Morris 1991 as cited in Swift *et al.* 1993).

Migration and Spawning

- Migration and life history patterns of southern California steelhead depend more strongly on rainfall and stream flow than is the case for steelhead populations further north (Moore 1980, as cited in Lent 2001).
- The CFG Salmonid Stream Habitat Restoration Manual (Flosi *et al.* 1998) reports that an adult steelhead can maintain a maximum swim speed of 6.0 ft/sec. for 30 minutes until exhaustion and a maximum burst speed of 10.0 ft/sec. For 5 seconds until exhaustion. The maximum leap, or jump, speed is listed as 12 ft/sec. Jumping upstream of a structure becomes difficult or impossible when the jump pool depth becomes less than 1.25 times the jump height of the structure from the pool surface.
- When migrating upstream, steelhead use up to 80% of their energy reserve. Any major changes in steelhead energy expenditure, such as

overcoming barriers, may prevent the success of migration and spawning. Steelhead are capable of leaping 6 to 10 feet, however this requires adequate pools for resting above and below the obstacle. (Hager 2001)

- Shapovalov and Taft (1954) caught steelhead with four age type combinations at maturity. The relative abundance of these types varies from river to river, but Shapovalov and Taft's abundances were:

Years in fresh water	Years in salt water	% of fish
2	1	30
2	2	27
3	1	11
1	2	8

- Waddell Creek in Santa Cruz County (Shapovalov and Taft 1954):
  - 82.8% = 1st time spawners
  - 15.0% = 2nd time spawners
  - 2.1% = 3rd time spawners
  - 0.1% = 4th time spawners
- Adult males predominate in the early portions of the run while females predominate in the latter portions.
- After spawning spent steelhead often move gradually downstream and hang out in pools for periods of time during the downstream migration.

Feeding

- After steelhead leave their home streams they feed on estuarine invertebrates and marine krill, but as they increase in size, fish gradually become more important to their diet (Moyle 2002).
- Spent adult steelhead typically do not resume feeding while in fresh water (Shapovalov and Taft 1954).

Native fish and hatchery stock

- Native fish are less susceptible to disease than hatchery fish (Bryant and Lynch 1996)
- Steward and Bjornn (1990, as cited in Bryant and Lynch 1996) found that hatchery stocks might produce fewer smolts and returning adults.

Effects of sediment and turbidity

- Effects of increased sedimentation include: clogging and abrasion of gills and other respiratory surfaces; adherence of grains to the chorion of eggs; increase in conditions conducive to entry and persistence of disease-related organisms; the inducement of behavioral modifications; the entombing of different life stages; alteration of water chemistry by the adsorption of chemicals; degradation of useable habitat by scouring and filling of pools and riffles and changing bedload composition; reduction in photosynthetic growth and primary production; and an affect on intergravel permeability and dissolved oxygen. (Bryant and Lynch 1996; Cordone and Kelley 1961; Walters 1995)

- Turbidity reduces drift feeding (Barrett *et al.* 1992).
- In a small coastal California stream, Cross (1975, as cited in Stoecker 2002) found that 67%-96% of young-of-the-year steelhead resided in pools. Similar results were reported by Spina (2003). Loss of pools due to excessive sediment input and filling can greatly reduce a streams capacity to rear steelhead to smolt size. Barnhart and Parson (1986) observed that dissolved oxygen be, at least, 80% of saturation for successful spawning to occur. Embryonic and alevin survival is highly dependent on intragravel, dissolved oxygen and concentrations of less than 7.2 mg/L can cause total mortality.
- Turbidity can reduce aquatic plant life by limiting photosynthetic growth, therefore reducing the number of aquatic invertebrates which are the primary food source for steelhead. An excess of sediment in spawning gravel can fill the interstitial spaces preventing water and oxygen from entering the redd. Egg survival increases with permeability. Sediment concentrations greater than 4,000 mg/L have been found to cause migration to cease. (Hager 2001)
- Sigler *et al*. (1984, as cited in Stoecker 2002) observed that chronic turbidity in streams during emergence and rearing of steelhead negatively affects the number and quality of fish produced. Suspended sediments can cause physiological damage to steelhead at concentrations of 3,000 parts per million or greater; when sediments settle out of suspension they frequently cover essential spawning sites, cover eggs, prevent emergence of recently hatched young, and decrease the amount of shelter available to fry that were able to hatch. Deposited sediment also reduces the production of aquatic insects that are essential prey to steelhead survival (Mark Capelli, National Marine Fisheries Service, pers. comm. 2004).

Ocean Life

- Southern steelhead are rarely caught by commercial or recreational fishers in the ocean, principally because adults do not tend to swim in large schools as do other pacific salmonids (Mark Capelli, National Marine Fisheries Service, pers. comm. 2004). However, high seas driftnet fishing has been implicated as a cause for decline of steelhead from coastal streams along the Pacific Coast since high seas steelhead distribution and driftnet fisheries overlap. Unauthorized high seas driftnet fisheries harvest between 2 percent (32,000) and 28 percent (448,000) of the steelhead that are destined to return to the Pacific Coast. Even the combined authorized and unauthorized take of steelhead in the open seas, at the highest estimate of 31%, cannot account for the greater than 50% decline observed in North American steelhead runs from 1986 – 1991. (Bryant and Lynch 1996)
- When northern steelhead smolts enter the Pacific Ocean they begin a directed movement into offshore waters of the Gulf of Alaska. California

steelhead stocks may have more restricted western migrations than do more northerly stocks due to sea surface isotherm temperatures. (Bryant and Lynch 1996).

- Steelhead experience most of their marine phase mortality soon after they enter the ocean. Ocean mortality is poorly understood however because few studies have been conducted. Predation is likely the primary cause of mortality among juveniles. (McEwan and Jackson 1996)
- There may be a tendency for populations of steelhead in the Southern California ESU to remain in close proximity to their natal streams within nearshore waters, which are vulnerable to upland runoff (Capelli 1999)

Ocean Climate

- El Nino is an environmental condition often cited as a cause for the decline of west coast salmonids. El Nino is an unusual warming of the Pacific Ocean off South America caused by atmospheric changes in the tropical Pacific Ocean (Southern Oscillation-ENSO). El Nino events occur when there is a decrease in the surface atmospheric pressure gradient from the normal-steady trade winds, there is a drop in pressure in the east off South America and a rise in the pressure in the western Pacific. The resulting decrease in the pressure gradient across the Pacific Ocean causes the easterly trade winds to relax, and even reverse in some years. When the trade winds weaken, sea level in the western Pacific Ocean drops, and a plume of warm sea water flows from west to east toward South America. Coast currents are changed as is upwelling. (Bryant and Lynch 1996)
- Good fish catches in Alaska generally reflect poor catches for the west coast of the U.S. and vice versa. One set of ocean conditions here, different from those in Alaska, persist 20 to 30 years. Then the conditions become reversed. The entire process of these cycling events is called the Pacific Decadal Oscillation. The abrupt reversal in a short time period is called a regime shift. (Reinard 2002)
- Before a 1977 regime shift occurred, the U.S. had a cool, nutrient-rich ocean phase with high ocean salmon productivity. The 1977 shift brought the low-production warm ocean phase to us. Meanwhile, pristine Alaska suffered alarmingly low salmon populations before the 1977 shift, after that, salmon productivity prospered. (Reinard 2002)

Fish surveys and counts on the Santa Clara River

Smolt Counts

Month	Year	# of days	Count	Source	Pub.	Notes
Apr - May	1981	12	21	CFG	1981	3 month survey on lower SCR; June 1981
May	1981	2	30	CFG	1981	Same study as above but at UWCD spreading grounds
Jan - June	1983	150	1	Puckett and Villa	1985	-
Feb - Apr	1984	60	1	Puckett and Villa	1985	-
Feb - May	1994	74	81	Entrix	1994	Vern Freeman Diversion; partial count
Jan - June	1995	141	111	Entrix	1995	Vern Freeman Diversion; partial count
Mar - Apr	1996	33	82	Entrix	1996	Vern Freeman Diversion; partial count
Nov - June	1997	187	414	Entrix	1999	Vern Freeman Diversion; partial count
Apr - July	1998	88	2	Entrix	2000	Vern Freeman Diversion; partial count
-	1999	-	5	UWCD	-	Vern Freeman Diversion; partial count
-	2000	-	876	UWCD	-	Vern Freeman Diversion; partial count
Nov - June	2003	-	35	UWCD	-	Vern Freeman Diversion; partial count

Adult Counts

Month	Year	# of days	Count	Source	Pub.	Notes
-	1978	-	0	Titus	2002	Bell 1978; mainstem only
May	1980	14	0	Titus	2002	Areta and Willsrud, 1980; mainstem only; sampling was done in backwaters, side streams, pools, etc. i.e., habitats that steelhead do not frequent.
Apr - May	1981	12	0	CFG	1981	3 month survey on lower SCR; June 1981
Jan - June	1983	150	2	Puckett and Villa	1985	Sespe creek: weir and hook and line
Nov - Apr	1983 - 84	152	1	Puckett and Villa	1985	weir
Apr	1986	?	0	McEwan	-	Sespe Canyon. Phone interview.
March	1987	-	2	Titus	2002	USFWS electrofishing survey SP creek
-	1987 - 1988	-	several	Comstock	1992	Kaufman 1989
Mar - Apr	1991	7	0	Entrix	1994	SCR didn't open to ocean until March
June	1992	30	0	Parmenter & McEwan	1999	Hopper, Pole and Santa Paula Creeks
Dec - Jan	1992	3	0	Entrix	1994	at Vern Freeman Diversion
Feb - May	1993	90	0	Entrix	1994	at Vern Freeman Diversion
Feb - Apr	1994	32	1	Entrix	1994	at Vern Freeman Diversion
Jan - May	1995	135	1	Entrix	1995	at Vern Freeman Diversion
Feb - Mar	1996	25	2	Entrix	1996	at Vern Freeman Diversion
Nov - Feb	1997	51	0	Entrix	1999	at Vern Freeman Diversion
-	1998	0	0	Entrix	2000	Upstream trap not operated
April	1999	-	1	UWCD	-	seen in bay area at Vern Freeman
March	2000	-	2	UWCD	-	seen in fish ladder
April	2001	-	2	UWCD	-	seen in fish ladder
-	2002	-	-	UWCD	-	too dry
-	2003	-	-	UWCD	-	fish counter operational

Mainstem: Hydrology and Human Impacts

Issues

1. Artificially altered surface flow is most likely the principal problem for steelhead in the Santa Clara River. It is probable that steelhead do not have an adequate opportunity to complete their upstream and downstream migrations.
2. There is no control over wells along the Santa Clara River or its tributaries, or how much water is removed through them. Nor is the total amount of surface water diverted from the river known, in part due to illegal diversions (though the amount is believed to be small).

Potential Research Questions

- How much water is being diverted (rates and timing) and by whom?
- An accurate accounting is needed of the amount of permitted water that is being removed, by both major and minor diverters, and an estimate of how much non-permittees are drawing from the river.
- How could discharges from Santa Felicia be modified to benefit the migration, spawning, and rearing of steelhead in both the Santa Clara River and Piru Creek?

Section I. Santa Clara River

Diverted Water

- UWCD is mandated by the State Water Resources Control Board to divert the maximum flow available for groundwater augmentation and to mitigate seawater intrusion into aquifers on the Oxnard Plain that are pumped for agricultural, industrial, and municipal uses. UWCD can also divert SCR flows during the winter months, notwithstanding requirements to maintain migration continuity, pursuant to approval/agreements with CFG and NMFS. (Matt Carpenter, Entrix, pers. comm. November 2002)
- The UWCD operates Santa Felicia Dam on Piru Creek conjunctively with the VFD. Generally water is only temporarily stored in the reservoir during winter, spring and summer months, and then released during the fall in a manner which allows the released water to either naturally percolate into the Santa Clara River aquifers, or be diverted through the VFD for percolation via the series of percolation ponds at Saticoy. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- The highest average daily amount diverted at VFD for the years shown (Moore 1980c):

Years	Cfs/day
1932 - 1954	32
1955 - 1974	112

- The 1999 water year: 49,591 acre-feet of water was released from Lake Piru. The Piru spreading grounds received 3.5% of the released water. The upper basins of Piru, Fillmore and Santa Paula received 33.6% of the release water, which was naturally recharged, and the remaining 62.9% flowed to the VFD. (United Water Conservation District 2000)

<u>*In-stream Flow*</u>

- Annual mean outflow at the County Line gauging station has increased from 25,700 acre feet in 1972 (20 year mean) to 35,360 acre feet in 1988 (36 year mean). A difference of 9,660 acre-feet. Most likely all of it is from WRP effluent. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Effluent from the Saugus and Valencia WRPs comprise a majority of the total flow in the upper SCR during summer months. Forty years of stream data indicate that effluent accounts for 40% of total stream flow during the wet season and 90% during the dry season. (United Water Conservation District and Castaic Lake Water Agency 1996)
- No record of streamflow was recorded at Montalvo during 1933 – 1950 (Taylor *et al.* 1977). This was due to the gauging station being inoperative, or non-existent; this time period experienced some record flood flows, e.g., 1938, (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004).
- Five cfs or natural stream inflow to Lake Piru, whichever is less, is required to outflow from Lake Piru (Murrray McEachron, United Water Conservation District, pers. comm. January 2004).
- Generally the channel of the SCR upstream from Bouquet Junction is dry except following storms. Downstream from Bouquet Junction, the combination of shallow bedrock, a reduced cross-sectional flow area and wastewater discharge to the streambed from two water reclamation plants creates a perennial flow condition in the river westward from the Saugus water reclamation plant past the LA – Ventura County Line. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Castaic Dam seems to have little effect in reducing the annual flow at Montalvo due to percolation between Castaic Reservoir and Saticoy Taylor *et al.* 1977).
- Bouquet Dam is used primarily for storage of imported water. It controls less than 1% of the total drainage area and its influence on the streamflow at Montalvo has been considered negligible. (Taylor *et al.* 1977)
- The cumulative effects of the combined operation of Pyramid, Castaic, Bouquet, and Santa Felicia dams on the natural pattern of surface flows (level, duration, frequency, and timing) on the mainstem of the Santa

Clara River has not be investigated, or modeled. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)

- Opinion differs on the flow available to the mainstem with the construction of the Santa Felicia dam. Taylor et al. (1977) state that all inflow to Lake Piru has been prevented from reaching Montalvo (with rare exceptions such as 1969 water year). UWCD states that on average Santa Felicia has spilled every six years (1969, 1978, 1979, 1980, 1983, 1993, 1995, 1998, and 2001 - essentially during big water years) (Murray McEachron, United Water Conservation District, pers. comm. January 2004).

<u>Groundwater Basins</u>

- The groundwater basins of the Santa Clara River starting in Los Angeles County and moving west into Ventura County are: Acton, Eastern, Piru, Fillmore, Santa Paula and Mound Basins. Moving south from the Santa Paula and Mound Basins are the Montalvo, Oxnard Plain and Pleasant Valley Basins. (United Water Conservation District and Castaic Lake Water Agency 1996; United Water Conservation District 1999)

<u>Rising Groundwater</u>

- Rising groundwater occurs at several points along the SCR. Rising groundwater is an area where groundwater is forced to the surface by some type of flow barrier and thus becomes surface water flow. Rising areas of groundwater are (United Water Conservation District and Castaic Lake Water Agency 1996 United Water Conservation District 1999):
  - At the mouth of Soledad Canyon caused by buried bedrock highs in the alluvium
  - Just west of the Los Angeles/Ventura County line
  - Just east of Fillmore at the Fillmore Fish Hatchery; considered to be the boundary between the Piru and Fillmore groundwater basins.
  - Just east of the city of Santa Paula in the vicinity of Willard Road
  - East of the unincorporated area of Saticoy near the toe of South Mountain.

<u>How groundwater basins get replenished</u>

- Acton Basin – deep percolation of rainfall and infiltration of surface water runoff; lawn and agricultural runoff; septic tank and leachfield system percolation. (United Water Conservation District and Castaic Lake Water Agency 1996; United Water Conservation District 1999)
- Eastern Basin – surface water runoff from SCR; rainfall; tributaries.
- Piru Basin – percolation of surface flows; rainfall; irrigation returns; spreading grounds located adjacent to Piru Creek just upstream of the confluence of Piru Creek and the Santa Clara River; water conservation releases from Santa Felicia Dam by UWCD. (United Water Conservation

District and Castaic Lake Water Agency 1996; United Water Conservation District 1999)

- Fillmore Basin - percolation of surface water from SCR and Sespe Creek and releases from Santa Felicia Dam; rainfall penetration; irrigation returns; effluent from sewage treatment plants. (United Water Conservation District and Castaic Lake Water Agency 1996; United Water Conservation District 1999)
- Santa Paula Basin – percolation of surface flows of SCR (including releases from Santa Felicia Dam), Santa Paula Creek and other tributaries; underflow from the Fillmore Groundwater Basin; agriculture returns. (United Water Conservation District and Castaic Lake Water Agency 1996; United Water Conservation District 1999)
- Montalvo Basin – UWCD's spreading grounds at Saticoy and El Rio; percolation of SCR flows; underflow from the Santa Paula Basin; rainfall; irrigation returns. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Oxnard Plain Basin – Montalvo Basin. (United Water Conservation District and Castaic Lake Water Agency 1996; United Water Conservation District 1999)

Groundwater in the Oxnard Plain

- The Fox Canyon Groundwater Management Agency was established in the 1970s to deal with the problem of high chloride levels in Oxnard Plain groundwater. The solution chosen was additional yield from Vern Freeman Diversion supplied via the Pumping Trough Pipeline, and shifting pumping to the lower aquifer system from the upper aquifer system, which is determined to have 100 years of supply. A moratorium was established on new upper aquifer system wells, meters were installed on wells, rolling cutbacks were implemented of 25% over 20 years, and waivers or credits were established for cutbacks. The cutbacks started in the early 1990's and are in 5% increments every 5 years. If a users pumpage exceeds the cutback amount, there is a tiered penalty structure of up to $600/AF. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Groundwater aquifers in the Oxnard Plain are in critical state of overdraft. Over the last 50 years, groundwater pumping from these aquifers has exceeded natural and artificial recharge. (Lent 2001)

Groundwater Overdrafts

- Annual overdraft = how much more water is taken out than put in during one water year. (United Water Conservation District Groundwater Department 2001)
- Accumulated overdraft = amount of water necessary to prevent seawater intrusion, or subsidence of land. (United Water Conservation District Groundwater Department 2001)

- For the eight groundwater basins that lie wholly or partially within UWCDs jurisdiction, and for the water year 2001, the (United Water Conservation District Groundwater Department 2001):
  - Average annual overdraft for prior 10 years was 600 AF.
  - Annual overdraft for 2002 was estimated to be 0 – 600 AF.
  - Accumulated overdraft is 30,000 – 35,000 AF.
  - Water needed to replenish the groundwater basins is estimated to be 846,000 AF.

Groundwater Usage

- Agriculture was estimated to use 155,300 AF in 2002 (United Water Conservation District Groundwater Department 2001).
- The concept of "safe yield" was discussed with Santa Clara River water agencies during the SCREMP process. Safe yield of an aquifer is the amount of water, usually expressed in acre-feet that may safely be withdrawn annually from an aquifer without causing depletion or long-term harm to the aquifer. However, water agencies would not agree to a safe yield level. (Ron Bottorff, Friends of the Santa Clara River, pers. comm. December 2002)

Geomorphology

- The upper river has typical braided stream deposits and a relatively wide floodplain area. The particle sizes of sediment in the streambed generally range from coarse sand sizes to gravel (pebble, cobble and boulder size). (United Water Conservation District and Castaic Lake Water Agency 1996)
- The SCR along its entire course consists of typical braided stream geomorphological characteristics such as point bar deposits, gravelly stream bottoms, and broad, wide washes. (United Water Conservation District and Castaic Lake Water Agency 1996)
- The SCR has been formed largely by stormwater flows emanating from highland areas caused by storms of short duration but great rainfall intensity. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Where the SCR runs adjacent to South Mountain and has cut into sedimentary formations scour pools have formed with retain water through sub-surface flows during the during periods where continuous surface flows is otherwise non-existent. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)

Water Use and Availability

- Nearly 10.7 million gallons of water are pumped through the raceways daily from the Fillmore Fish Hatchery's four wells. Some of the water is cycled back through the facility, and some is piped out and used for crop irrigation. (Whitnall 2003)

- FOSCR is in disagreement with several water agencies over the actual amount of water that is available to cities and those agencies. The agencies and cities claim there is more water available than FOSCR believes there is. (Ron Bottorff, Friends of the Santa Clara River, pers. comm. December 2002)
- There is no enforceable regulatory mechanism over how much water gets pumped out of the SCR aquifers by wells, nor is there monitoring of the level of groundwater extraction. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- Trailer and RV parks along the river engage in unregulated or illegal activities that no agency oversees such as damming the river for swimming holes, etc. (Ron Bottorff, Friends of the Santa Clara River, pers. comm. December 2002; (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004).
- It is unknown how much water is taken from the upper SCR. UWCD has some information on water withdrawals from the lower river.
- The County of Ventura has transferred it long-term State Water Project (SWP) water supply contract for 20,000 acre-feet of water annually to the Casitas Municipal Water District. This water is available to UWCD (5,000 acre-feet), Casitas Municipal Water District (5,000 acre-feet), and the City of San Buenaventura (10,000 acre-feet). Only UWCD has taken delivery of SWP water. (United Water Conservation District and Castaic Lake Water Agency 1996; Ventura County Resource Management Agency 1994)
- Before the drilling of wells and production of underground water, the valley ground water basins were full to overflowing, resulting in a perennial surface flow in the river channel throughout the valley (Henke 1995). Other sources have noted that the flow was in some sections of the river channel, or below the Sespe Creek confluence (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004; Murray McEachron, United Water Conservation District, pers. comm. January 2004).

Urbanization Effects

- Impervious surfaces increase runoff, creating a greater flood hazard.
- Flood control and land drainage schemes may increase the flood risk downstream by concentrating runoff. A flashy discharge pattern results in increased bank erosion with subsequent loss of riparian vegetation, undercut banks and stream channel widening. (Bryant and Lynch 1996)
- Sediments washed from the urban areas and deposited in river waters include trace metals such as copper, cadmium, zinc and lead, as well as pesticides, herbicides, fertilizers, gasoline and other petroleum products. (Bryant and Lynch 1996)

- CSWRCB (1991, as cited in Bryant and Lynch 1996) reported that NPS (non point source) pollution is the cause of 50 – 80 percent of impairment of water bodies in CA.
- Increases in urban development are expected to result in an approximate 10 percent increase in peak discharges in the Santa Clara River (Ventura County Flood Control District and Los Angeles County Department of Public Works 1996).
- Proposed major projects as of 1996 (United Water Conservation District and Castaic Lake Water Agency 1996):
    - Newhall Ranch – 25,000 homes. Includes new wastewater treatment facility. Wastewater will be used to irrigate the golf course and other landscaped areas.
    - Tesoro del Valle – master planned community of 3,000 units. North of the City of Santa Clarita and south of the Angeles National Forest. Castaic Lake is to the northwest of the site. Consumption will be 2,800 AF per year.
    - Chiquita Canyon Landfill Expansion – near city of Santa Clarita. 154 acres. Located on Newhall property and operated by Laidlaw.
    - Reclaimed water system by Castaic Lake Water Assn. That will be used to serve Magic Mountain, golf courses and misc. irrigation uses. 1,700 less gallons of effluent will go into the SCR per year.
    - Aggregate mining and reclamation of a site known as Sycamore Ranch. Would enable continued operation of S.P. Milling's processing plant. Simultaneous agricultural, mining and reclamation activities. North of SCR at confluence with Sespe.
    - Toland Road Landfill Expansion – unincorporated area of Ventura County between Santa Paula and Fillmore. Serves the SC valley, which includes the communities of Santa Paula, Fillmore, Piru and other unincorporated areas of the county. Would increase capacity from 2.5 million tons of solid waste to 15 million tons. Would expand service to Oxnard, Port Hueneme, Ventura, Camarillo and Ojai.
    - Expansion of Valencia WRP

Agricultural Effects

- Citrus and irrigated agriculture in the SCR valley have overtaken earlier crops that required less water. Higher profits and yields come from irrigated crops (Schwartzberg and Moore 1995). Farmers are currently losing money on citrus. Some are switching over to avocado orchards.
- Fields were "tiled" starting at the turn of the century to deal with the problem of alkali accumulation. Tiling provides improved drainage and now underlies a vast portion of the Oxnard Plain and part of the river valley. Many ditches drain into the Pacific Ocean or McGrath Lake but a number runoff into the SCR. The nature/quality of this run-off differs from the river's water. (Schwartzberg and Moore 1995)

- Some agriculture like watercress farming and gathering is done within the riverbed itself. (Schwartzberg and Moore 1995)
- The harvesting of the exotic, invasive species *Arundo donax* is another use of river bottomland. The SCR is reputed to contain the finest reed source in the United States. (Gilday 1994, as cited in Schwartzberg and Moore 1995)
- The area generally referred to as the Oxnard Plain is actually part of a large marine deltaic formation which has been created by the periodic shift of the lower Santa Clara River channel, and the deposition sediments in the river's lower reaches and at its mouth at the Pacific Ocean. The arcuate shaped marine face of the Santa Clara River Delta extends along the coast between the Santa Monica Mountains on the east to the Ventura Foothills on the west, while the apex of the delta extends inland to the area around Saticoy. (Mark Capelli, National Marine Fisheries Service, pers. comm. October 2003)
- Primarily as a result of agricultural return waters there has been a general increase in TDS in groundwater basins. Few groundwaters in the Piru, Fillmore, Santa Paula, and Montalvo basins are now less than 1000 parts per million total dissolved solids, the maximum concentration permitted under United States Public Health Service Drinking Water Standards. (Mann 1975)
- The aquifers for the Santa Clara River Valley are marine deposits so we would always expect to see a certain concentration of TDS. Other potential causes for an increase of TDS could include an increase in the outfall of the sewage treatment plants along the river. (Murray McEachron, United Water Conservation District, pers. comm. February 2004)

Effects of Recreation

- Recreational use has included fishing, duck ponds/clubs, birding, hiking, golf courses, RV parks, ATVs in the river bottom and on surrounding lands, motocross racing at Indian Dunes on Newhall land took place in the river bottom, trail rides, and fishing/boating/camping/swimming at reservoirs. (Schwartzberg and Moore 1995; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)

Homelessness

- The riverbed has been a de facto housing community for many years for the homeless. (Schwartzberg and Moore 1995)

Aggregate Mining Effects

- The river produces the best aggregate material in the county and much of the county's roads and other structures were built out of materials extracted from the river. (Schwartzberg and Moore 1995)
- Aerial photos of the river in the 1960s demonstrate the extent of mining in the Santa Clara River. Evidence of roads crossing the river bottom is pervasive, trucks are often present in the river bottom and extraction operations are clearly visible. (Schwartzberg and Moore 1995)
- Curtis Sand and Gravel has an in-river mining operation east of Santa Clarita. There is one inactive in-river operation in the Saugus-Newhall section of the Santa Clara River, and eight inactive in-river operations in western Ventura County. P. W. Gillibrand has an active out-of-river mining operation in the Saugus-Newhall area. (AMEC 2003)
- CEMEX, a giant cement company in Mexico recently purchased Southdown Corporation. Southdown's subsidiary Transit Mixed Concrete is planning to open an aggregate strip mine on 460 acres of public land just east of Santa Clarita's city limits in Soledad Canyon. Part of this mine project site is within the 500-year floodplain of the River. The proposed mining operation is planned to span 20 years in its initial phase and process 78 million tons of material. Excavation is planned to be six days a week, sixteen hours a day. Blasting is planned to occur twice a week for 10 years, then double for the subsequent 10 years. Materials transport is an estimated 694 trips per day mostly via the 14 Freeway. Currently there are about 9,600 residential units within a five-mile radius of the site. (AMEC 2003)

Section II. General Information

Habitat and water flow

- In California, diversion and transfer of water has resulted in depleted river flows necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of large woody debris. (Bryant and Lynch 1996)
- It has been reported that 7 inches is the minimum depth required for successful migration of adult steelhead (Thompson 1972, as cited in McEwan 2001), although the distance fish must travel through shallow water areas is also critical.
- A primary characteristic of high quality aquatic ecosystems is an abundance of large pool habitats (particularly important for over-summering juvenile steelhead). Loss occurs by: filling by sediments, loss of pool-forming structures such as boulders and large wood, and loss of sinuosity by channelization. (Stoecker 2002; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- Stream depth provides steelhead with shelter from extreme water temperatures, excessive water velocities, and predation. Southern California streams are often subjected to low flow conditions due to

drought, water extractions, and the annual summer-fall dry season. Survival during dry season stream conditions is believed to be a major limitation to steelhead and adequate depth is essential for survival (Douglas 1995, as cited in Stoecker 2002). Pools provide depth and habitat that is critical to steelhead survival during the dry season. An abundance of large pools has been shown to be an important characteristic in healthy aquatic ecosystems. (Stoecker 2002)

- Warmer water temperatures due to water diversion, water development and habitat modification may affect steelhead mortality from predation directly or indirectly through stress and disease associated with wounds inflicted by pinnipeds or piscivorous predators. (Bryant and Lynch 1996)
- Agricultural practices in general have contributed to the degradation of salmonid habitat through irrigation diversions, overgrazing in riparian areas, sedimentation, loss of riparian vegetation, loss of habitat complexity (Bryant and Lynch 1996).

List of Major Water users along the Santa Clara River

(United Water Conservation District and Castaic Lake Water Agency 1996)

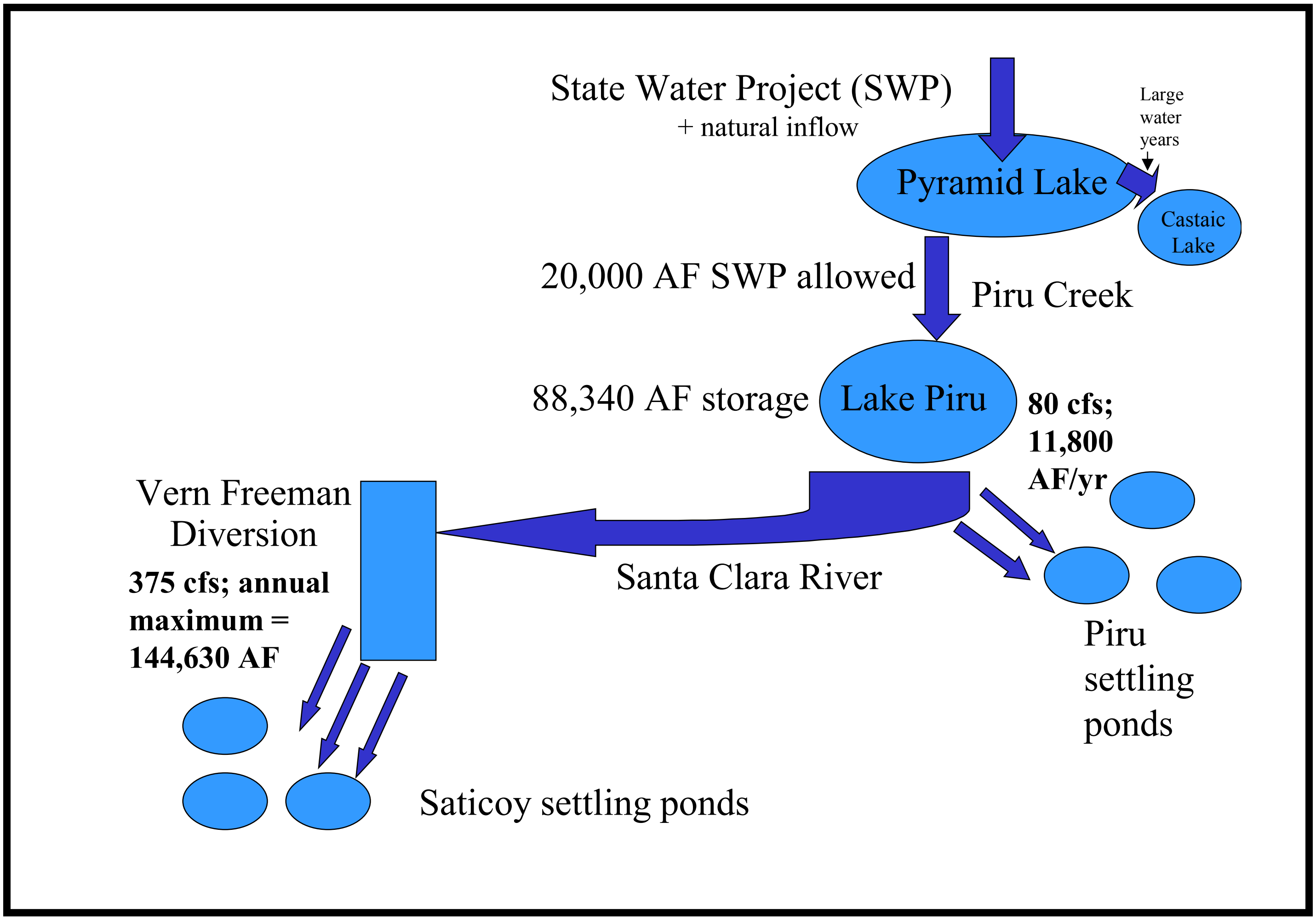
- California Watercress, Inc.
- Camulos Ranch
- Fillmore Irrigation Company
- Newhall Blue Cut and Isola Diversions
- Piru Mutual
- Ray and Elizabeth Billet
- Rio Dulce Ranch
- Santa Clarita Water Company
- Santa Paula Water Works
- Southside Improvement
- Transit Mixed Concrete Co
- Turner/Richardson Ditch
- United Water Conservation District

Smaller Diversions

(United Water Conservation District and Castaic Lake Water Agency 1996)

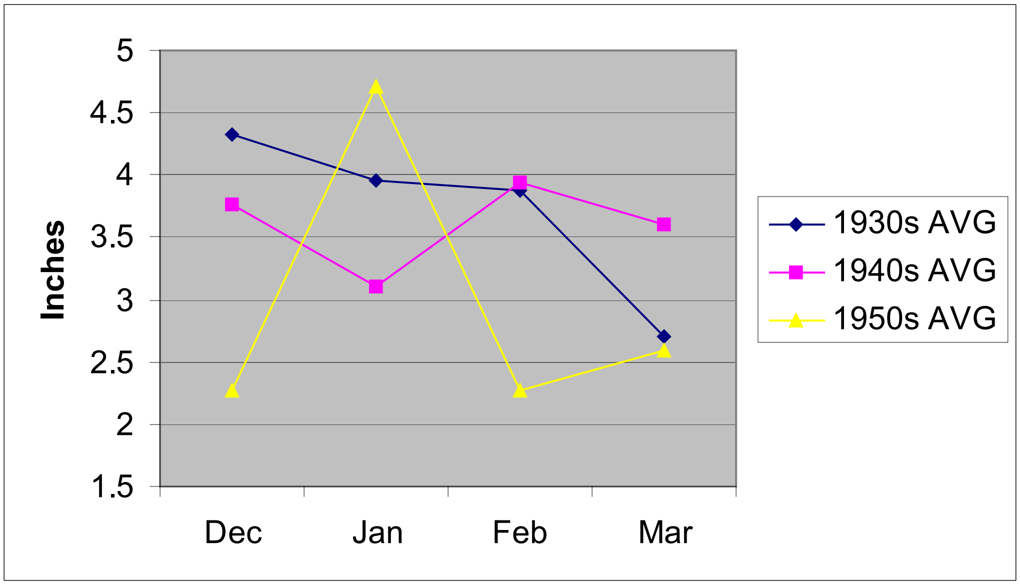
- Alfred and Francis Martinez, Pole Creek
- Central Coast Production Credit Assn., SCR
- CF&G, SCR
- Flying A Ranch, Pole Creek
- Pajaro Partners Inc, Santa Paula Creek
- Robert Asimow, Hopper Creek
- Sanford Drucker, Sespe Creek
- Santa Clara Water and Irr. District, SCR
- Steven and Robin Smith, Santa Paula Creek
- The Nature Conservancy, Hopper Creek

Graphic of Lower Santa Clara Flow of Water



Amount of rainfall in the Lower Santa Clara River

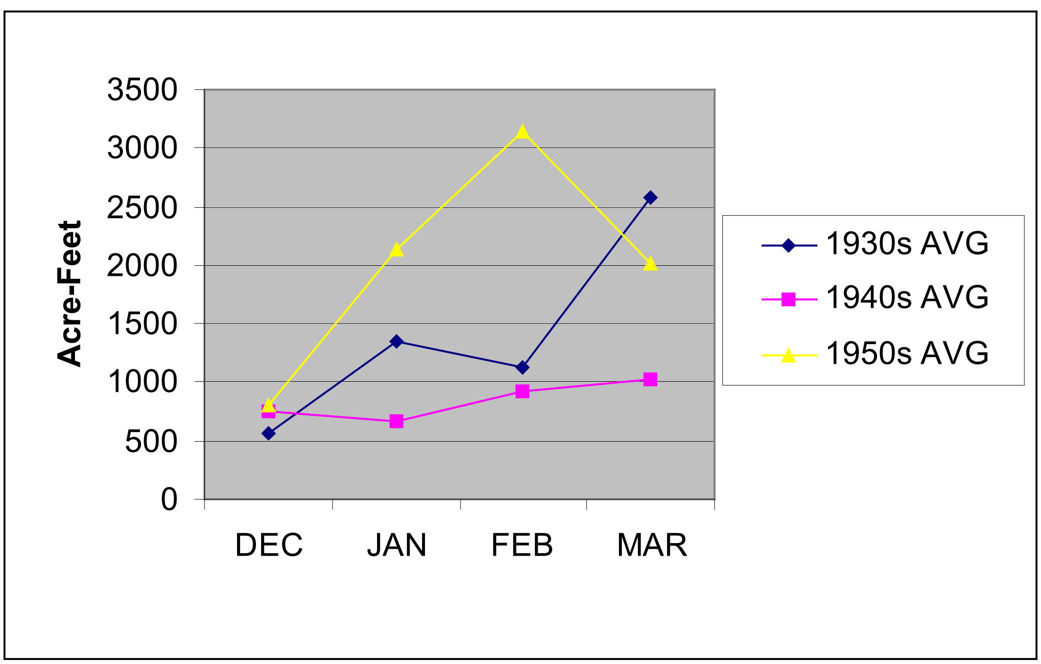
December through March, by decade



*Date source: United Water Conservation District

Amount of water diverted at the Vern Freeman Diversion

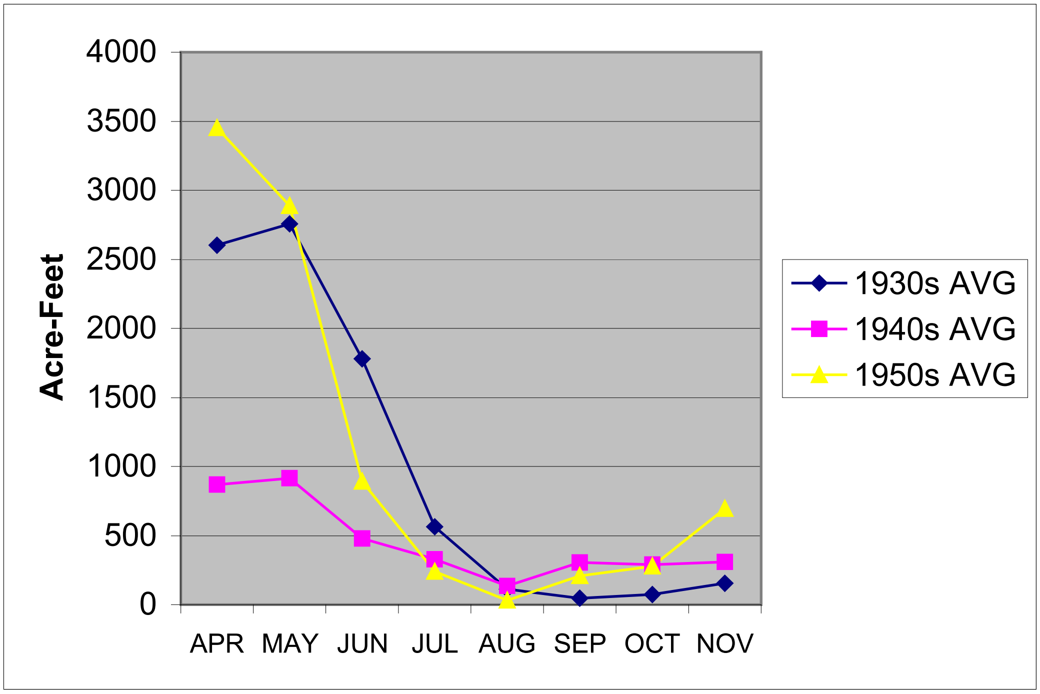
December through March, by decade



*Date source: United Water Conservation District

Average Acre-Feet diverted at VFD

April through November, by decade



*Date source: United Water Conservation District

Fish Passage

Issues

1. It is unclear how steelhead passage into and out of the tributaries from the mainstem is affected by flow regulation, flood control project/activities, or other types development.
2. There is no independent evaluation or assessment of the fish passage structures on the mainstem or tributaries. Opinions conflict regarding how well the fish ladder at VFD operates or how easily fish find the ladder, but the number of adult steelhead detected over the last 10 years since the commencement of the operation of the ladder is extremely low (<10).

Potential Research Questions

- What are the fish passage problems in the mainstem, between the mainstem and the tributaries, into the tributaries, and within the tributaries?
  - Do transverse bars occur in the river? What is the impact of multiple ladders or passage difficulties on reproduction? What can be done to minimize the number of days it takes for fish to get up or down river? In what condition do fish arrive at the spawning areas after passing problem areas?
- For how long after storm flow do Santa Paula and Sespe creeks maintain a passable steelhead connection with the mainstem of the Santa Clara River?

Section I. Santa Clara River

The Vern Freeman Diversion Fish Ladder

- Discharge from VFD in the recent past has been 40 cfs for the 1st 24 hours and 20 cfs for the 2nd 24 hours post-storm. However, the National Marine Fisheries Services has indicated that increased levels and duration of flows are necessary to provide adequate opportunities for steelhead to reach the VFD and pass to upstream spawning and rearing areas. (Mark Capelli, National Marine Fisheries Service, pers. comm 2004.
- The VFD ladder incorporates a denil design, which operates at a maximum flow of approximately 40 cfs, with an additional artificial attraction flow capacity of approximately 80 cfs. As a consequence of these design limitations, the ladder operates over a relatively narrow range of natural river flows (approximately 200 to 1,200 cfs), based upon the attraction flow criteria used by the California Department of Fish and Game and the National Marine Fisheries Service (i.e., attraction flow associated with a ladder should not be less than 10% of the natural river flows). Its design does not allow for good trapping method, and the trap

that was used in the late 1990s caused problems. Currently, velocities can drop out and sediment can get into ladder shutting it down during the most critical time. (Maurice Cardenas, California Department of Fish and Game, pers comm. December 2002; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)

- There are varying opinions on issues and/or functionality of the Vern Freeman diversion and the location of the ladder. Two of those opinions are:
    - VFD is a wide structure. Main channel tends to stick to opposite side of the river from the ladder. The fish swim up the opposite side and then have to traverse the face of the dam to get to the fish ladder. A second ladder or a fish ramp usable by fish during higher flow events may provide a means of supplementing the limited fish passage opportunities afforded by the current ladder. Problems with installing a second ladder are a productive marsh area that has been established above the VFD. (Rick Rogers, National Marine Fisheries Service, pers. comm. January 2003; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
    - The main channel above the Vern Freeman has always been on the fish ladder side. Only storms great than 50,000 cfs have caused water to go to the other side. Downstream of the diversion the main channel was almost in the middle prior to the Freeman, but has since moved to the fish ladder side. (Murray McEachron, United Water Conservation District, pers. comm. January 2004).

Santa Paula Creek

- DFG actively assisted ACOE in development of a fish passage at the transition between the upper end of the Santa Paula Creek Flood Control Project, and the unimproved portion of lower Santa Paula Creek. In general there are adequate jump pools, but the 1st jump pool is too shallow and needs to be fixed. A large boulder could block one of the low flow passage channels. (Mary Larson, California Department of Fish and Game, pers. comm.; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- Harvey Diversion was built prior to 1910, the original fish ladder was built in 1939 and effective until 1969 floods made it unusable. The Canyon Irrigation District built a new fish ladder on the Harvey Diversion in the late 1990s. This second ladder requires a lot of maintenance. The area located directly downstream of the Harvey Diversion has highly erosive conditions and scoured out in 2000 - 2002. To keep the downstream entrance of the fish ladder in place and functioning properly, it has been anchored, and large boulders have been placed along the downstream bank to reduce scouring. "Rock glue", drill, and cable were used to keep rocks in place. The bank underneath the fish ladder would be undermined

without this. DFG helped design and pay for the diversion ladder. A fish counter was installed on the ladder in 2003. (Rick Rogers, National Marine Fisheries Service, pers. comm. January 2003; Mary Larson, California Department of Fish and Game, pers. comm.; Buck Yedor, United Water Conservation District, pers. comm. December 2002; National Oceanic and Atmospheric Administration and National Marine Fisheries Service, 2000)

- The Highway 150 Bridge near Thomas Aquinas College presents steelhead passage problems. The supports are in a concrete apron. There are steps in the apron, and the modifications necessary are minor. The free-flowing oil seeps need to be channeled around the step pools. Some exposed rebar needs to be removed, an interim step pool needs to be built to correct one large jump, and the shape of another bowl needs to be changed so a deep pool is formed. (Mary Larson, California Department of Fish and Game, pers. comm.)
- DFG wants the city of Santa Paula to develop a restoration plan for the area from the debris basin upstream to the top of the Harvey diversion. (Mary Larson, California Department of Fish and Game, pers. comm.)

Sespe Creek

- Sespe has tremendous potential for steelhead production. There are no dams. The main obstacle is the correct management of the "window of opportunity" (i.e., sufficient duration and volume of streamflow) for adult steelhead to migrate between the estuary and the Vern Freeman Fish Ladder; and the control of introduced aquatic species (fish and amphibians) that prey upon juvenile steelhead. (Rick Rogers, National Marine Fisheries Service, pers. comm. January 2003; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- Surface flow from Sespe Creek doesn't reach the mainstem during normal, baseflow (summer and fall) conditions. Water coming out of the Sespe usually disappears into a porous flood plain before it reaches the mainstem. There is a lack of connectivity between the Sespe and the mainstem, and Santa Paula Creek and the mainstem, except during storm events. (Steve Lee, University of California at Los Angeles, pers. comm. November 2002)
- Fillmore Diversion may impound juveniles in artificial pond, but its significance to adult passage is unknown. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- There is a gravel operator on the lower Sespe who as of early 2003 was interested in extracting from the creek; this operation has the potential to further reduce steelhead passage from the mainstem to Sespe Creek (Rick Rogers, National Marine Fisheries Service, pers. comm. January 2003; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004). However, this operator would need to obtain a new permit from Ventura County, with adequate CEQA review (Ron Bottoroff, Friends of the Santa Clara River, pers. comm. January 2004).

Piru Creek

- Owner of the lower section, Rancho Temescal, bought the property in 2000 and is developing it for agriculture and other commercial uses, e.g. an Equestrian Center for thoroughbred training and racing. The value of the 5cfs which is currently released from Santa Felicia Dam to protect aquatic resources in the lower two miles of Piru Creek from the dam to the confluence of the Santa Clara River may be compromised by proposed development and related activities. (Rick Rogers, National Marine Fisheries Service, pers. comm. January 2003; Mark Capellli, National Marine Fisheries Service, pers. comm. January 2004)

Section II. General Information

Dams/Barriers

- Dams can result in increased water temperatures, changes in fish community structure, and increased travel time by migrating adult and juvenile salmonids. (Bryant and Lynch 1996)
- Types of barriers include dams, culverts, diversions, flood control channels, flow dynamics, water quality, and natural features such as waterfalls (Stoecker 2002).

Exotic Species Predation and Competition

Issues

1. The impact of exotic species on different life stages of steelhead has been poorly documented.
2. Green sunfish and black bullhead catfish are known to prey on steelhead fry and eggs.

Potential Research Questions

- How many exotic species exist and what are their population numbers?
- What likely impact are they having on the different life stages of steelhead?
- What overall/accumulative effect do exotic species have? What are the impacts of predation and competition?

Section I. Santa Clara River

- Bullheads can be extremely voracious egg eaters. Bullheads are in high abundance in the middle Sespe from Timber to Lion Creeks and appear to be rapidly expanding in population and distribution into the lower Sespe; within the last 5 years black bullheads have spread down through the Sespe Gorge to Devils gate, and now dominate many of the shallow pools. (Blecker *et al.* 1997; Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)

Section II. General Information

Predation

- Low flow conditions in southern California streams can enhance predation opportunities where adult steelhead may congregate at the mouth of streams waiting for high flows. (Bryant and Lynch 1996)
- Most investigators believe that marine predation is a minor factor in steelhead declines. (Bryant and Lynch 1996)
- Two striped garter snakes (a native species) are highly effective predators, taking juvenile salmonids of up to 5 inches in length. Their impacts on local fish populations can be substantial. (Blecker *et al.* 1997)
- Bullfrogs (a non-native species) may also prey upon young trout and steelhead. (Blecker *et al.* 1997)
- During drought years green sunfish densities seem to increase and trout densities decline. Sunfish are better able to withstand higher temperatures and will prey upon large numbers of trout fry if they are crowded into the same habitat. (Blecker *et al.* 1997)

Competition

- Green sunfish are likely competitors with trout and juvenile steelhead, feeding on the limited caddisflies and terrestrial insects. The may also feed on salmonid eggs and very young fry. (Blecker *et al.* 1997)

Water Quality

Issues

1. The Stormwater program has found that copper, lead, nickel, selenium, and fecal coliform exceed allowable limits in the SCR.
2. The LA-RWQCB is establishing TMDLs (Total Maximum Daily Loads) for the Santa Clara River. A chloride TMDL of 100 mg/L, has been established for the upper river. Other TMDLS scheduled are: toxaphene, fecal coliform, and nitrate.
3. Many of the smaller communities in this watershed remain unsewered. In particular in the Auga Dulce area of the upper watershed and near the city of Acton.
4. Increase in urban areas has led communities to build sewage treatment plants along the river, adding flood protection structures and effluent to the river.
5. There are eight Wastewater Treatment Plants (or Water Reclamation Plants) along the river that are releasing at least 25 million gallons per day of effluent into the river or nearby percolation basins.
6. Over time there have been 14 landfills/dumps both legal and illegal associated with the river. It is unknown if contaminants are leaching into the surface or ground water.

Potential Research Questions

- How significant a problem is pollution in the Santa Clara River?
- What is the impact of agricultural chemicals on the river? How much is released into the river?
- Which WRPs are contributing excessive pollution to the river?
- What are the impacts of the WRPs impact on the estuarine environment at the mouth of the Santa Clara River?
- Are there pollutants/runoff in the tributaries?
- How do different pollutants impact steelhead adults, smolts, fry, and eggs?
- Are landfills contaminating surface and groundwater? What and how much?

Section I. Santa Clara River

<u>*Mainstem*</u>

- In the past LA-RWQCB considered the designation of the SCR as a Significant Natural Resource. This category would be similar to the unique natural resource designation at the federal level that declares a resource unlike any other in the region. A major component of the designation would be limiting the hydrologic and water quality impacts of further urbanization in the watershed. However, the LA Sanitation District said that LA-RWQCB didn't go through sufficient legal processes that such a designation would require more legal development of the category, and established strong adversarial legal challenge. Continuing this effort is beyond the staffing capabilities that LA-RWQCB has now. To make this happen the category would have to be adopted by the regional board, then the state board. They would also have to go through the process of a new beneficial use designation at the federal level.

Tributaries

- Since 1971, Piru Creek (between Pyramid Reservoir and Santa Felicia Reservoir) has shown improvements in water quality as a result of discharges from Pyramid Reservoir. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Sespe Creek has a lower overall Total Dissolved Solids (TDS) and is a good source of higher quality water. (United Water Conservation District and Castaic Lake Water Agency 1996)

Estuary

- Water quality issues within the estuary are (United Water Conservation District and Castaic Lake Water Agency 1996):
    - Water level management – the estuary has been mechanically breached when it reaches 9 ft above sea level. Questions remain whether natural breaching is sufficient to avoid water quality problems at other times.
    - Eutrophication – high nutrient levels entering estuary from point source and non point source discharges could cause algal blooms and lead to eutrophication [not clear if this has actually happened].
    - Coliform bacteria – bacteria levels exceeding recreational standards have been recorded at receiving stations in the estuary and nearby ocean monitoring stations. High levels appear to be associated with non-point sources.
    - Pesticides – Agricultural activities may result in contamination of sediments in the estuary. Further investigation is needed. Agricultural runoff can alter chemistry of the water and may destroy aquatic life by adding pesticides, herbicides and fertilizers to the water.
- Wastewater treatment plant effluent is not a source of coliform bacteria in the estuary. Populations of native and migrating birds who use the estuary for feeding, resting, and breeding are a potential source of coliform. (Waln 2004)

Surface water quality monitoring occurs

- At the Vern Freeman Diversion for Ventura County Stormwater Program (the SCR receives municipal storm drain discharges from Fillmore, Oxnard, Ventura, Santa Paula and unincorporated Ventura County). (Darla Wise, Ventura County Flood Control District, pers. comm.)
- In the upper SCR by LA Sanitation District for Saugus and Valencia treatment plants. (Los Angeles Regional Water Quality Control Board date unavailable)
- Between Piru and Saticoy by UWCD. (Los Angeles Regional Water Quality Control Board date unavailable)
- At Santa Paula, for mid-river receiving water. (Los Angeles Regional Water Quality Control Board date unavailable)
- At Fillmore when they discharge to surface waters. (Los Angeles Regional Water Quality Control Board date unavailable)

Discharge Permits granted by the Los Angeles RWQCB

(Los Angeles Regional Water Quality Control Board date unavailable):

- 47 NPDES discharges – 33 go into mainstem, 14 go into tributaries
- 4 major discharges (POTWs, one discharging to estuary, one to middle reaches, two into upper watershed.
- 13 minor discharges
- 30 discharges covered under general permits
- 72 dischargers covered under an industrial storm water permit. Largest number of dischargers is located in the cities of Santa Paula and Valencia. Many of these businesses are involved with auto wrecking and food packing.
- 188 dischargers are covered under a construction storm water permit. The majority of these are located in the upper watershed especially within Santa Clarita and Valencia.

Pollution/contamination

- Natural oil seeps discharge significant amounts of oil into Santa Paula Creek. (Los Angeles Regional Water Quality Control Board date unavailable)
- In 1997, ammonium perchlorate was discovered in four Saugus Aquifer wells (Castaic Lake Water Agency 1997). Ammonium perchlorate is an inorganic chemical that is used in solid rocket propellants, fireworks and explosives (Castaic Lake Water Agency 1997). All currently contaminated Saugus wells are located south of the San Gabriel fault, many near the location of the former Whittaker-Bermite site where the perchlorate contamination originated (Castaic Lake Water Agency 1997). The five shut wells are located along San Fernando Road, Magic Mountain Parkway, and Soledad Canyon Road in the Santa Clarita Valley (Worden 2003).

- An oil spill occurred in Lake McGrath in 1993. Subsequent sampling after cleanup revealed no residual oil contamination remaining in the lake. Water sampling has demonstrated however, that pesticides are a problem particularly historically used pesticides such as DDT. California State Parks is the lead trustee agency for restoration planning efforts related to the oil spill settlement from the 1993 spill. (Denise Steurer, U.S. Fish and Wildlife Service, pers. comm. January 2004)
- Nitrates in specific areas (El Rio, Bardsdale near Fillmore and an area west of Fillmore) are in excess of the state drinking water standard of 45 mg/l. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Higher water quality is present with higher in-stream flows, and lower water quality with lower in-stream flows. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Potential sources of water quality problems in the lower Santa Clara River are: natural oil seeps in the Santa Paula Area, impacts from urbanization, impacts from agriculture, and effects of imported and reclaimed water. (United Water Conservation District and Castaic Lake Water Agency 1996)

Stormwater program

- On August 22, 1994 the California Regional Water Quality Control Board (RWQCB), Los Angeles Region, issued a NPDES permit to the Ventura County Flood Control District (VCFCD), the County of Ventura, and the cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks as Co-permittees, for discharges of stormwater and urban runoff into the receiving waters of the Santa Clara River. (Ventura County Flood Control District 2002)
- The presence of the following constituents are measured as part of the stormwater program (Ventura County Flood Control District 2002). Tables are shown as they appear in the 2003 mid-year monitoring report:

Table 37: Bacteriological Results from the Mass Emission Station (ME-SCR)

Constituent	Units	11/7/2002	12/16/2002	2/11/2003
E. Coli	MPN/100ml	18600	26020	17930
Enterococcus	MPN - 1:100 Dilution	11840	14450	20050
Total Coliform	MPN/100ml	980400	488400	>241920

Table 34: Organics Results from the Mass Emission Station (ME-SCR)

Date			11/7/2002	12/16/2002	2/11/2003
Method	**Constituent**	**Units**			
EPA 8081	Endrin Ketone	ug/L	<0.01	<0.01	0.07
SM5310C	TOC	mg/L	6.8	7.6	7.3
Remaining EPA methods 8141/8151A, 8081, 8270C, 547, 418.1 are non-detect.					

Table 28: Conventional and Nutrient Results from Mass Emission Station (ME-SCR)

Date			11/7/2002	12/16/2002	2/11/2003
Constituent	**Fraction**	**Units**			
Ammonia-N	Total	mg/L	0.3	<0.2	0.5
BOD	Total	mg/L	6	4.8	5
Bromide	Total	mg/L	0.8 *	0.2	0.2
Chloride	Total	mg/L	75 *	56	44
Conductivity	Total	umhos/cm	1070	1000	797
Hardness	Dissolved	mg/L	565	457	N/A
Hardness	Total	mg/L	675	684	388
Nitrate Nitrogen	Total	mg/L	2.7	1.8	1.9
Nitrate+Nitrite as N	Total	mg/L	3.1	1.8	2
Nitrite Nitrogen	Total	mg/L	0.34	0.1 *	<0.1
Oil and Grease	Total	mg/L	<3	<3	<3
pH	Total	units	7.7	7.8	8
Phosphate	Total	mg/L	0.6	0.9	0.5
Phosphorus	Dissolved	mg/L	1.1	2.5	1.4
Phosphorus	Total	mg/L	3.4	5.5	3
TKN	Total	mg/L	3.1 *	4.2	2.3 *
Total Dissolved Solids	Total	mg/L	1210	870	750
Total Suspended Solids	Total	mg/L	420	2340	990

Table 31: Metals Results from the Mass Emission Station (ME-SCR)

Date			11/7/2002	12/16/2002	2/11/2003
Constituent	Fraction	Units			
Arsenic	Total	mg/L	0.011	0.028	<0.002
Cadmium	Total	mg/L	0.0012	<0.0002	0.0005
Calcium	Total	mg/L	155	157	96
Chromium	Total	mg/L	0.051 *	<0.001	0.018
Copper	Total	mg/L	0.041 *	0.005 *	0.021
Lead	Total	mg/L	0.0147	0.0578 *	0.009
Magnesium	Total	mg/L	70	71	36
Mercury	Total	ng/L	43	122	10.8
Nickel	Total	mg/L	0.035 *	0.003 *	0.015
Selenium	Total	mg/L	0.007	0.008	0.005
Silver	Total	mg/L	<0.001 *	<0.001 *	<0.001
Thallium	Total	mg/L	0.0005	0.0007	<0.0002
Zinc	Total	mg/L	0.12 *	0.04 *	0.09 *
Arsenic	Dissolved	mg/L	<0.002	<0.002	<0.002
Cadmium	Dissolved	mg/L	<0.0002	<0.0002	<0.0002
Calcium	Dissolved	mg/L	139	114	N/A
Chromium	Dissolved	mg/L	0.003 *	0.002	<0.001
Copper	Dissolved	mg/L	0.014 *	0.005 *	0.012
Lead	Dissolved	mg/L	<0.0002	<0.0002 *	<0.0002
Magnesium	Dissolved	mg/L	53	42	N/A
Mercury	Dissolved	ng/L	1.28	1.19	1.44
Nickel	Dissolved	mg/L	0.005 *	0.003 *	0.004
Selenium	Dissolved	mg/L	0.009	<0.002	0.006
Silver	Dissolved	mg/L	<0.001 *	<0.001 *	<0.001
Thallium	Dissolved	mg/L	<0.0002	<0.0002	<0.0002
Zinc	Dissolved	mg/L	<0.01 *	<0.01 *	<0.01 *

Constituents that exceeded water quality objectives under either dry or wet conditions in 2003 are:

Constituent	Most Likely Sources
Copper	WRPs (residential plumbing materials)
Lead and Nickel	Urban storm water runoff, industrial, or domestic wastewater discharges, oil and gas production, mining or farming.
Selenium	?
Fecal Coliform	Unknown. Possible sources include poorly functioning wastewater treatment plants, ranches (with horses, cattle or hogs), dogs, cats, wildlife (raccoons, coyotes, birds, etc.).
Total Dissolved Solids	Can have both natural and anthropogenic sources.
Chromium	Urban storm water runoff, industrial, or domestic wastewater discharges, oil and gas production, mining or farming.
Zinc	Urban storm water runoff, industrial, or domestic wastewater discharges, oil and gas production, mining or farming.

TMDLs

- The LA-RWQCB is establishing TMDLs for the Santa Clara River (Los Angeles Regional Water Quality Control Board date unavailable). A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The schedule for setting TMDLs is listed below though it is subject to change:

Constituent	Area Affected	Standard or scheduled year	Probable Source	Most Likely Cause
Chloride	Upper SCR	100 mg/l	Saugus and Valencia WRPs	Residential water softeners
Toxaphene	Estuary	2007	Historical pesticide	
Fecal Coliform	Upper SCR and Estuary	2006	Unknown	
Nitrate	Upper and Lower SCR	2004	Unknown	WRPs, livestock, fertilizers
Eutrophication, fish kills, algae, trash	Lakes Elizabeth, Hughes, Munz	2004	Unknown	Recreational users. Other.

Sewage

- Sewage alters dissolved oxygen concentrations leading to near anaerobic conditions. (Hager 2001)
- Secondary water source usually sewer treatment plant effluent provide more surface water than was available historically. This water is often detrimental. It is much warmer than natural waters emerging from underground sources. Its high nutrient load encourages a different suite of species and can put the native fauna and flora at a competitive disadvantage. These conditions favor introduced aquatic vertebrates like red shiners, grass carp, goldfish, and clawed frogs. (Swift *et al.* 1993)
- Many of the smaller communities in this watershed remain unsewered. In particular, in the Auga Dulce area of the upper watershed, and near the city of Acton. (Los Angeles Regional Water Quality Control Board date unavailable)
- The effects of septic system use in the Oxnard Forebay area is also of concern. (Los Angeles Regional Water Quality Control Board date unavailable)
- Increase in urban areas has led communities to build sewage treatment plants along the river, adding flood protection structures and effluent to the river. (Schwartzberg and Moore 1995)

- The amount of sewage that plants along the river are capable of treating and releasing as effluent are (United Water Conservation District 2000; pers. comm. with respective facilities):

Location of Plant	Capacity
Saugus	5.43 million gallons per day (MGD)
Fillmore	0.15 MGD
Piru	0.11 MGD
Valencia	10.56 MGD. Expansion planned as of 1996.
Ventura	10.3 MGD. Significant upgrades are underway to increase capacity to14 MGD
Santa Paula	2.55 MGD
Newhall (proposed)	6.90 MGD

- Piru, Fillmore and Montalvo percolate secondary treated effluent into the ground near the Santa Clara riverbed (United Water Conservation District and Castaic Lake Water Agency 1996). Fillmore also has an NDPES permit to discharge directly into the river.
- Saticoy percolates primary treated effluent from a community septic tank. (United Water Conservation District and Castaic Lake Water Agency 1996)
- Santa Paula discharges tertiary treated water directly to the SCR. (United Water Conservation District and Castaic Lake Water Agency 1996)

Landfills/Dumps

- There have been huge landfills associated with the river (see following landfill table).

Table of present and past landfills located on or near the Santa Clara River
(Schwartzberg and Moore 1995; United Water Conservation District 2000)

Name	Present	Historic	Location	Serves/served/notes
Chiquita Canyon	X		Near Santa Clarita	Valencia, Newhall and eastern Ventura County
Elkins Ranch	X			
Toland Rd	X		Between Santa Paula and Fillmore	SC valley: Santa Paula, Fillmore, Piru and other unincorporated areas of the county. Oxnard, Port Hueneme, Ventura, Camarillo and Ojai.
Illegal dump site	X		South Mountain Road	A large amount of trash, including cars, boats and trailers have been found in the river's bed
Illegal dump site	X		Between Bailard Landfill and Ventura Marina	Casual dumping of trash on both sides of the river.
Torrey Rd		X	Piru	Piru
Highway 23		X	Near Fillmore	
12th St. and South Mountain		X	Santa Paula	Santa Paula
Saticoy Avenue		X	Saticoy	Saticoy
Wagon Wheel		X	Wagon Wheel	Oxnard, Ventura
Southern California Coastal landfill		X	Ventura Road to the Victoria/ River Ridge Golf Course	Ventura? Oxnard?
Borchard dump		X	Victoria Ave	Ventura? Oxnard?
Bailard Landfill		X	South of the SCR, approx. 1,500 feet west of Victoria Ave.	Ventura Regional Sanitation District
Sears-Walker		X	Site of Ventura Marina	Sea burn dump where trash was often bulldozed into the ocean.

Sediment Regime

Issues

1. Santa Felicia Dam has had the greatest impact on altering the SCR sediment regime and preventing delivery of sediment to beaches.
2. Total reduction in sand transport to the coast from 1928 – 1975 is estimated to be 15 million tonnes.

Section II. Santa Clara River

<u>*Sediment*</u>

- From 1928 to 1955 suspended sediment delivery to the ocean was reduced by only 6% due to anthropogenic influences. Since 1956 annual deliveries of sand sized material by have been reduce by about 37% or 15 million metric tonnes due to man-made upstream control structures. The Lower River Diversion Dam built in 1929, and Santa Felicia Dam built in 1956 on Piru Creek are the structures whose operations have been primarily responsible for this reduced shoreline sediment delivery. (Taylor *et al.* 1977)
- Total sediment discharge of the basin computed from records of SCR at Montalvo for water years 1968 – 75 was 63.5 million tons of which 59.5 million tons was carried in suspension. (Williams 1979)
- Total reduction in suspended sediment transport to the coast from 1928 – 1975 has been on the order of 50M tonnes. A ballpark estimate of the total reduction in sand transport to the coast during this period can be made as 30% of the suspended load, for a total of 15M tonnes. (Taylor *et al.* 1977)
- The major difference between natural and actual sediment discharges of the Santa Clara River Basin is the sediment intercepted upstream from Lake Piru behind the Santa Felicia Dam. The combined trap efficiency of Lake Piru and Pyramid Lake approaches 100 percent. Sediment deposited in these reservoirs resulted in about a 12 percent reduction of sediment to the SCR basin during the period 1953 – 75. (Williams 1979)
- VFD and the Santa Felicia dam are the main structures that reduce delivery of sediment to the beach. (Taylor *et al.* 1977)
- Sediment losses by gravel mining, diversion of flows and interception of sediment in the Castaic Creek basin resulted in additional reductions of 4 percent during the period 1953 – 75. (Williams 1979)
- Most of the sediment from the SCR was transported during only a few days of floodflow. The long-term average annual sediment discharge of the SCR is estimated at 3.67 million tons. (Williams 1979)

- Development on steep slopes (residential, industrial, and agricultural) can elevate the background levels of fine sediments in tributaries, particularly, Santa Paula, Pole, Hopper, and lower Piru Creeks, affecting steelhead spawning and rearing success. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)
- Forest fires can have temporary, but substantial effects on sediment regimes in tributaries, particularly the Sespe and Santa Paula Creeks; their frequency and intensity have been significantly modified by forest management practices. (Mark Capelli, National Marine Fisheries Service, pers. comm. January 2004)

Section II. General Information

- Excessive sedimentation alters the entire hydrology of a watershed leading to channel widening, loss of the pool-riffle sequence, reduced pool depth, and decreased stability of substrate and banks. (Barnhart 1986, as cited in Stoecker 2002; Cordone and Kelley 1961; Walters 1995)

A partial list of Santa Clara River Species

Birds

Common Name	*Genus*	*Species*	Native?	Special Status?
California least tern	*Sterna*	*antillarum browni*	Y	Y
Least Bell's vireo	*Vireo*	*bellii pusillus*	Y	Y
Loggerhead shrike	*Lanius*	*ludovicianus*	Y	Y
Southwestern willow flycatcher	*Empidonax*	*trailii extimus*	Y	Y
Western least bittern	*Ixobrychus*	*exilis hesperis*	Y	Y
Western snowy plover	*Charadrius*	*alexandrinus nivosus*	Y	Y
Yellow warbler	*Dendroica*	*petechia breshteri*	Y	Y
Brown-headed cowbird			N	-

Fish

Common Name	*Genus*	*Species*	Native?	Special Status?
Pacific Lamprey	*Lampetra*	*tridentata*	Y	
Pacific staghorn sculpin	*Leptocottus*	*armatus*	Y	
Prickly sculpin	*Cottus*	*asper*		
Rainbow trout	*Salmo*	*gairdneri*	Y	N
Santa Ana sucker	*Catostomus*	*santaanae*	Y but invasive	Y
Southern steelhead trout	*Oncorhynchus*	*mykiss*	Y	Y
Tidewater goby	*Eucyclogobius*	*newberryi*	Y	Y
Unarmored threespine stickleback	*Gasterosteus*	*aculeatus williamsoni*	Y	Y
Black Bullhead	*Ameiurus*	*melas*	N	
Sacramento sucker	*Catostomus*	*occidentalis*	N	
Green sunfish	*Lepomis*	*cyanellus*		
Largemouth bass	*Micropterus*	*salmoides*		
Owens sucker	*Catostomus*	*fumeiventris*		
Threadfin shad	*Dorosoma*	*peteneses*		

Plants

Common Name	*Genus*	*Species*	Native?	Special Status?
Mule fat	*Baccharis*	*salicifolia*	Y	
Nevin's barberry	*Berberis*	*nevinii*	Y	Y
Ojai fritillary	*Fritillaria*	*ojaiensis*	Y	Y
Slender-horned spineflower	*Dodecahema*	*leptoceras*	Y	Y
Ventura marsh milkvetch	*Astragalus*	*pycnostchyus*	Y	Y
Bull Thistle			N	-
Castor Bean	*Ricinus*	*communis*	N	-
Fennel			N	-
Giant Cane	*Arundo*	*donax*	N	-
Pampas grass			N	-
Tamarisk	*Tamarix*	*sp.*	N	-

Reptiles and Amphibians

Common Name	*Genus*	*Species*	Native?	Special Status?
Arroyo toad	*Bufo*	*microscaphus californicus*	Y	Y
California red-legged frog	*Rana*	*aurora draytonii*	Y	Y
South coast garter snake	*Thamnophis*	*sirtalis sp.*	Y	Y
Southwestern pond turtle	*Clemmys*	*marmorata pallida*	Y	Y
Two striped garter snake	*Thamnnophis*	*hammondii*	Y	N
African clawed frog	*Xenopus*	*laevis*	N	-
Bullfrog	*Rana*	*catesbiana*	N	

Current Santa Clara River Studies

Name	Org	Date Begin	Date End	Summary
Watershed Plan	ACOE	Jan-04	Jan-07	Also referred to as the Feasibility study. Approximately ½ of the cost is being paid by ACOE with Ventura and Los Angeles Counties paying the other ½ mostly with in-kind services. Major components of the study include: surveys and mapping of the watershed; hydrologic, hydraulic, sediment, water quality, and coastal investigations; engineering and design analysis to identify flood control, erosion, sedimentation and environmental restoration projects; socioeconomic studies; environmental studies; and cultural resource studies. The six planning steps are: 1) specify problems and opportunities, 2) inventory and forecast conditions, 3) formulate alternative plans, 4) evaluate effects of alternative plans, 5) compare alternative plans, and 6) select recommended plan. The study will take 3 years to complete.
SCREMP	Ventura County			A management plan for the river up to the 500 year floodplain. Covers from the 500 - 25 year flood line for bank improvements and stabilization.
SCR EIR and Mapping	Arundo Task Force			EIR and mapping to match $1.3M Prop 13 funding that was given to the LA portion of the SCR for EIR, mapping and *Arundo* removal.
Steelhead Recovery Plan	NMFS			An endangered species recovery plan that will encompass the Southern California ESU and will address restoring southern steelhead trout.
Regional Wetlands and Watershed Management Plan for Southern California	Environment Now/ Wetlands Recovery Project	Apr 02	Nov 04	Funded by Environment Now. Watershed Coordinators, hired under the Wetlands Recovery Project Local Assistance Program, are focusing on project management and assistance for projects that are already on the Wetlands Recovery Project workplan. They will also promote the contribution of local resources to the development of watershed management planning tools under development by the Wetlands Recovery Project.
Steelhead Habitat and Barriers Assessment	UC Santa Barbara and The Nature Conservancy	Oct 03	Sept 05	Assessing steelhead habitats, populations, and barriers to migration. Evaluating and modeling hydrology as it relates to steelhead migration.

A partial list of potential funding sources

Sources of funding	Title	Contact	Type of funding	Amt	Notes
CA Water Quality Control Board	NPS				Prop 40.
CA Water Quality Control Board	Stormwater				Prop 40. Dry weather flow; diversions, acquisition and development of wetlands, implementation of BMPs
CA Wildlife Conservation Board	Habitat Enhancement and Restoration Program				
CFG	Fisheries Restoration Grant Program	Mary Larson	Barrier modification and removal, fish ladders, monitoring, education, demo projects.		Very competitive. Funding is not provided until the following summer, i.e. approved proposals from May 2003 will receive funds in summer 2004. $$ needs to be spent in 1 - 2 years.
Dept of Water Resources	Flood protection Corridor Program		Buy land, flood control		
National Fish and Wildlife foundation	Bring back the Natives	Don Glaser	Restoration Projects		On the ground habitat restoration projects for natives
National Fish and Wildlife foundation	Challenge Grants	Anna Weinstein	Cooperative parnerships		To conserve fish, wildlife, plants and their habitats.
National Fish and Wildlife foundation	Native Plant Conservation Initiative	Beth deCarolis	Conservation Projects		On the ground conservation projects that protect, enhance or restore native plant communities.
NOAA	Community Based Restoration Program		Cooperative		

Sources of funding	Title	Contact	Type of funding	Amt	Notes
NRCS	Wetlands Reserve Program	Alan Forkey	Wetland restoration		To establish long-term conservation practices and protection. Private landowners only.
NRCS	Wildlife Habitat Incentives Program (WHIP)	Lisa Roberts	Wildlife Habitat		Develop and improve habitat. 75% cost-share assistance. Like to fund multiple partner projects.
USFWS	ARCO oil spill	Denise Steurer	For land acquisition, invasive non-native species control, restoration projects, information and education, and watershed evaluation and monitoring	$7.1M	
USFWS	Private Stewardship		On the ground conservation projects	$10K	
USFWS	Partners for Fish and Wildlife	Kate Symonds	Projects		Conserve/protect fish and wildlife and their habitats

Bibliography

Aggregate Resources Subcommittee. 1996. *Aggregate Resources Report Los Angeles and Ventura Counties - Subcommittee Working Draft. The Santa Clara River Enhancement and Management Plan*. Ventura, CA.

AMEC Earth & Environmental. 2003. *Santa Clara River Enhancement and Management Plan - Stakeholder Review Draft*.

Areta, G. and T. Willsrud. 1980. *The proposed improved Freeman Diversion Facility: Impact on fishes and fisheries of the Santa Clara River*. United Water Conservation District.

Barnhart, R. A. and J. Parson. 1986. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest). Steelhead. Biological Report 82*. Fish and Wildlife Service; Coastal Ecology Group; U.S. Army Corps of Engineers.

Barrett, J.C., G.D. Grossman, J. Rosenfield. 1992. *Turbidity-induced changes in reactive distance of rainbow trout*. Trans. Am. Fish Society. 121: 437-443.

Bednarek, A.T. 2001. *Undamming Rivers: A review of the Ecological Impacts of Dam Removal*. Environmental Management. 27: 803-814.

Bell, M. A. 1978. *Fishes of the Santa Clara River System, Southern California*. Natural History Museum of Los Angeles County. Los Angeles, CA.

Betz, M. South Central Coast Regional Commission, California Coastal Commission. October 10, 1978. Memo to Eric Metz. Subject: Santa Clara River. 2 pages.

Blecker, R., S. Chubb, B. Cohn, A. King, G. Garcia, T. Austin, A. Marx, J. Garcia, B. Peckham, J. Dvorsky, C. Carpanzo, I. Ilander, and G. Kouns. 1997 . *Sespe Watershed Analysis. Ojai Ranger District. Los Padres National Forest.* U.S. Dept of Agriculture. Forest Service. Pacific Southwest Region.

Bryant, G. J. and J. Lynch. 1996. *Factors for Steelhead Decline*. National Marine Fisheries Service. Portland, OR and Long Beach, CA.

California Fish Passage Workshop. For the Sake of the Salmon, California Department of Fish and Game, FishNet 4C, California Trout, National Marine Fisheries Service. Ventura, CA.

California Regional Water Quality Control Board, Los Angeles Region. 1994. *Water Quality Control Plan Los Angeles Region. Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties.* California Regional Water Quality Control Board, Los Angeles Region. Montery Park, CA.

California Sportfishing Protection Alliance and Santa Barbara Urban Creeks Council. 1996. *Public Trust Protest to CALMAT Water Right Application 30498.* State Water Resources Control Board.

Capelli, M. H. 1976. *An annotated list of the fishes associated with the Santa Clara River Lagoon*.

----- March 29, 1983. Letter to Jack Coe. 7 pages.

----- 1998. *Restoring the Southern California Steelhead*. University of California, Extension. University of California, Santa Barbara.

----- July 3, 1999. Santa Barbara, CA. Letter to Branch Chief. 12 pages.

Cardenas, M. Department of Fish and Game. June 6, 1996. Memo to Dwayne Maxwell and Dennis McEwan. Subject: Freeman Diversion, Ventura County.

Carpanzano, C. M. 1996. *Distributions and habitat associations of different age classes and mitochondrial genotypes of Oncorhynchus mykiss in streams in southern California*. Master's thesis. University of California, Santa Barbara.

Castaic Lake Water Agency. 1997. *The Saugus Formation and Perchlorate - Fact Sheet*. http://www.clwa.org/perchlorate_information.htm.

CH2MHILL. 1993. *Santa Clara River Enhancement and Management Plan: Bibliography*. Santa Ana, CA.

Coe, J. J., R. E. Angelos, R. Y. D. Chun, O. V. Holquin, D. Tong, G. Valenzuela, J. Akiyama, S. Johanson, P. Yates, M. Apante, D. Wilson, and M. Sato. 1981. *Alternative Water Requirements and Costs for Migration of Steelhead Smolts in Santa Clara River*. State of California, The Resources Agency, Department of Water Resources, Southern District. Los Angeles, CA.

Comstock, R. 1992. *Santa Clara River Steelhead: Restoration Assessment*. U.S.F.W.S., Western Washington Fishery Resource Office. Olympia, Washington.

Cooper, Lt. K. G. Department of Fish and Game. March 12, 1976. Memo to Mark Capelli. Subject: Santa Clara River Steelhead.

Cordone, Almo J. and Don W. Kelley. 1961. The Influence of Inorganic Sediment on the Aquatic Life of Streams. Vol. 47. Number 2, April 1961. California Fish and Game.

Cramer, S., D. W. Alley, J. E. Baldrige, K. Barnard, D. B. Demko, D. H. Dettman, B. Farrell, J. Hagar, T. P. Keegan, A. Laird, W. T. Mitchell, R. C. Nuzum, R. Orton, J. J. Smith, T. L. Taylor, P. A. Unger, and E. S. Van Dyke. 1995. *The status of steelhead populations in California in regards to the Endangered Species Act*. S.P. Cramer and Associates, Inc. and the Association of California Water Agencies. Gresham, OR.

Cross, P.D. 1975. *Early life history of steelhead trout in a small coastal stream*. M.S. Thesis. Humbolt State Univ., Arcata, Calif.

Department of Fish and Game. 1981. *Three month steelhead survey on the lower Santa Clara River and tributaries*. Long Beach, CA.

Dettman, D. H. and D. W. Kelley. 1986. *Assessment of the Carmel River Steelhead Resource. Volume I. Biological Investigations*. D.S. Kelley and Associates. Newcastle, CA.

Douglas, Paul L. 1995. *Habitat Relationships of Oversummering Rainbow Trout in the Santa Ynez River Drainage*. M.S. Thesis. University of Calif., Santa Barbara, Calif.

Dvorsky, J. R. 2000. *The influence of valley morphology and coarse sediment distribution on rainbow trout populations in Sespe Creek, California at the landscape scale*. Masters Thesis. University of California, Santa Barbara.

Entrix, Inc. 1993. *Results of fish passage monitoring at the Vern Freeman Diversion Facility, Santa Clara River, 1993*. Entrix, Inc. Walnut Creek, CA.

----- 1994. *Results of fish passage monitoring at the Vern Freeman Diversion Facility, Santa Clara River, 1994*. Entrix, Inc. Walnut Creek, CA.

----- 1995. *Results of fish passage monitoring at the Vern Freeman Diversion Facility, Santa Clara River, 1995*. Entrix, Inc. Walnut Creek, CA.

----- 1996. *Results of fish passage monitoring at the Vern Freeman Diversion Facility, Santa Clara River, 1996*. Entrix, Inc. Walnut Creek, CA.

----- 1999. *Results of fish passage monitoring at the Vern Freeman Diversion Facility, Santa Clara River, 1997*. Entrix, Inc. Walnut Creek, CA.

----- 2002. *Resident Species Study - Santa Clara River Estuary*. City of San Buenaventura. Ventura, CA.

ESI Environmental. Date unavailable. *Review of National Geographic's Article "Earth's Fresh Water Under Pressure"*. www.ewire.com/wires/ 438BD761-5CF0-442C-A0C72124C8AE5CFE.htm.

Faber, P. M., E. Keller, A. Sands, and B. M. Massey. 1989. *The Ecology of Riparian Habitats of the Southern California Coastal Region: A Community Profile*. U.S. Fish and Wildlife Service. Mill Valley, CA.

Farrell, J. and W. K. Fox. Date unavailable. *Environmental Inventory and Assessment for Proposed Saticoy Diversion and Silt Pond*.

Finney, K. and J. Edmondson. Date unavailable. *Swimming Upstream: Restoring the Rivers and Streams of Coastal Southern California for Southern Steelhead and other Fishes*. Southern California Steelhead Coalition. http://www.socalsteelhead.org/frames/steelhead.pdf.

Florsheim, J.L., E.A. Keller, D.W. Best. 1991. *Fluvial sediment transport in response to moderate storm flows following chaparral wildfire, Ventura county, southern California.* Geological Society of America Bulletin. 103: 504-511.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. *California Salmonid Stream Habitat Restoration Manual*. State of California, The Resources Agency, California Department of Fish and Game, Inland Fisheries Division.

Hager, J. 2001. *An Evaluation of Steelhead Habitat and Population in the Gabilan Creek Watershed*. Undergraduate thesis. California State University, Monterey Bay.

Hawthorne, J. G. 1981. *Cultural resource reconnaissance and impact evaluation of a 14+ mile route for the proposed pumping trough pipeline an lower aquifer system wells, County of Ventura, California*. California State University, Northridge.

Henke, E. April 20, 1970. Mountain View, CA. Letter to James Roads. 16 pages.

----- 1995. *Response by Ed Henke, Historical Research. Comments to the U.S. Forest Service - Los Padres National Forest of the U.S. Department of Agriculture, U.S. Department of the Interior on the Public's Invitation to Respond to a Specific Segment of Its Jurisdiction Involving Historical Southern Steelhead (Oncorhynchus mykiss) Habitat Found Within the Sespe Creek/River Watershed Area*. Ashland, OR.

Hill, J., and G.D. Grossman. 1993. *An energetic model of microhabitat use for rainbow trout and rosyside dace*. Ecology. 74(3).

Jordan, W.R. III, M.E. Gilpin, and J.D. Aber. 1987. *Restoration Ecology: A synthetic approach to ecological research*. Cambridge University Press, Cambridge, UK.

Kennedy, D. N. January, 1986. Letter to Jack C. Parnell. 3 pages.

----- Department of Water Resources. April 30, 1986. Memo to Darlene C. Ruiz. Subject: Lower Santa Clara River Fish Study.

Klassen, H. D. Date unavailable. *Rehabilitating spawning and rearing habitat in a destabilized stream by placing gabion weirs*.

Labinger, Z. and J. Greaves. 2001. *Summary Report of Avian Studies (1994 - 1999) following the ARCO/Four Corner January 17, 1994 oil spill on the Santa Clara River, California. Draft.* Bio Logic Consulting. Valley Glen, California.

Laurent, B. and L. A. K. Mertes. 1998. *Comparing Fine Resolution IFSARE Radar DEMS to USGS DEMS, Santa Clara River Watershed, California*. University of California, Santa Barbara.

Lecky, J. H. October 26, 2001. Long Beach, CA. Letter to James Kentosh. 4 pages.

Lent, R. 2001. Letter to David Castanon. 17 pages including biological opinion.

Lisle, T.E. and S. Hilton. 1999. *Fine bed material in pools of natural gravel bed channels.* Water Resources Research. 35: 1291-1304.

Los Angeles Regional Water Quality Control Board. Date unavailable. California Environmental Protection Agency. www.swrcb.ca.gov/rwqcb4/.

Los Angeles Regional Water Quality Control Board. Date unavailable. *Santa Clara River Watershed 303(d) listed waters*. www.swrcb.ca.gov/rwqcb4/.

Mann, John F., Jr. 1975. *History of ground water management in the United Water Conservation District*. Paper presented at the Tenth Biennial Conference on Ground Water. Ventura, CA.

Matthews, K.R. and N.H. Berg. 1997 . *Rainbow trout responses to water temperature and dissolved oxygen stress in two southern California stream pools.* Journal of Fish Biology. 50: 50-67.

McEwan, D.R. 2001. *Central Valley steelhead.* In: Brown, R.L. (Ed.)., California Department of Fish and Game Fish Bulletin. 1(179): pp. 1-43.

McEwan, D.R. and T. A. Jackson. 1996 . *Steelhead Restoration and Management Plan for California*. State of California, The Resources Agency, Department of Fish and Game.

Moore, M. R. 1980a. *Stream Survey: Ojai Ranger District*. Los Padres National Forest. Ventura, CA.

----- 1980b. *Factors Influencing the Survival of Juvenile Steelhead Rainbow Trout (Salmo gairdneri gairdneri) in the Ventura River, California*.

----- 1980c. *An assessment of the impacts of the proposed improvements to the Vern Freeman Diversion on anadromous fishes of the Santa Clara River System, Ventura County, California*.

Moyle, P.B. 2002. *Inland Fishes of California*. University of California Press, Berkeley, CA.

Nash, L. 1993. *Impacts and implications for aquatic and riparian resources*. Pacific Institute for Studies in Development, Environment and Security.

National Marine Fisheries Service. 2000. *Biological Opinion. Endangered Species Act. Section 7 Consultation. U.S. Bureau of Reclamation operation and maintenance of the Cachuma Project on the Santa Ynez River in Santa Barbara County, California*.

National Oceanic and Atmospheric Administration. Date unavailable. *Status Review of West Coast Steelhead from Washington, Idaho, Oregon and California. NOAA Technical Memorandum NMFS-NWFSC-27*.

National Oceanic and Atmospheric Administration and National Marine Fisheries Service. 2000. *NMFS California Anadromous Fish Distributions. Southern California Steelhead ESU. Current Stream Habitat Distribution Table.* Southern California Steelhead ESU Region Habitat Distribution Source Book, prepared by Sari Sommarstrom, Ph.D., Principal; Andrew Eller, Research Assistant. U.S. Department of Commerce Reference Order No. 40ABNF901259. http://swr.ucsd.edu/hcd/soCalDistrib.htm

Neeley, D. 1994. *The Relation between Oceanic Factors and California Steelhead Survival*. S.P. Cramer and Associated, Inc. Gresham, OR.

Nielsen, J.L. 1999. *The evolutionary history of steelhead (Oncorhynchus mykiss) along the U.W. Pacific Coast: developing a conservation strategy using genetic diversity*. Marine Science. 56: 449-458.

Nielsen, J., M. Sherwood, R. Almy, J. Baldrige, and J. Gray. 1998. *Restoring the Southern California Steelhead*. UCSB Extension Business Management and Law. Santa Barbara, CA.

Nielsen, J. L., C. Carpanzano, M. C. Fountain, and C. A. Gan. 1996. *Mitochondrial DNA and nuclear microsatellite diversity in hatchery and wild Oncorhynchus mykiss from freshwater habitats in southern California*. Manuscript.

Odeh, M. 1999. *Innovations in Fish Passage Tehnology*. American Fisheries Society, Bethesda, MD.

Outland, C. F. November 18, 1971. Santa Paula, CA. Letter to Mark Moore. 1 page.

Parmenter, S. and D. McEwan. 1999. *1992 Stream Surveys of Several Ventura and Los Angeles County Streams*. California Department of Fish and Game.

Powers, P. D. and J. F. Orsborn. 1985. *Analysis of Barriers to Upstream Fish Migration*. Albrook Hydraulics Laboratory, Washington State University. Pullman, Washington.

Puckett, L. K. and N. A. Villa. 1984. *Lower Santa Clara River Steelhead Study*. State of California, Department of Fish and Game.

Reinard, B. July 12, 2002. *Ignorance Hinders Salmon Recovery.* Capital Press.

Santa Clara River Enhancement and Management Plan. Date unavailable. *GIS mapping layers*. Ventura, CA.

Santa Clara River Project Steering Committee. 1996. *Santa Clara River Enhancement and Management Plan Study: Biological Resources. Volume I*. Ventura, CA.

The Santa Clara River Trustee Council. 2002. *Restoration Plan and Environmental Assessment for the Santa Clara River Arco Oil Spill*. United States Fish and Wildlife Service, California Department of Fish and Game, and the Office of Oil Spill Prevention and Response.

Schwartzberg, B. J. and P. A. Moore. 1995. *A history of the Santa Clara River - Subcommittee working draft. The Santa Clara River Enhancement and Management Plan.* Ventura, CA.

Shapovalov, L. and A.C. Taft. 1954. *The Life Histories of the Steelhead Rainbow Trout (Salmo gairdneri gairdneri) and Silver Salmon (Oncorhynchus kisutch)*. Department of Fish and Game, State of California.

Sigler, J.W., T.C. Bjornn and F.R. Everest. 1984. *Effects of chronic turbidity on density and growth of steelhead and coho salmon*. Transactions of the American Fisheries Society. 113: 142-150.

Spina, Anthony P. 2003. Habitat Associations of Steelhead Trout Near the Southern Extent of their Range. Vol 89, No. 1. California Fish and Game, State of California.

State Water Resources Control Board. 1987. *Permitted Applications 25988 and 26058 of the Department of Water Resources and permitted application 26434 of United Water Conservation District: Santa Clara River System*.

State Water Resources Control Board, State of California. October 19, 1986. *In the Matter of Water Right Permits 18709 and 18710, Applications 25988 and 26058 of Department of Water Resources and Permit 18909, Application 26434 of United Water Conservation District. Santa Clara River, Ventura County.* State Water Resources Control Board, State of California.

Stoecker, M. W. 2002. *Steelhead Assessment and Recovery Opportunities in Southern Santa Barbara County, California*. Conception Coast Project. Santa Barbara, CA.

Swift, C.C., T.R. Haglund, M. Ruiz, R.N. Fisher. 1993. *The Status and Distribution of the Freshwater Fishes of Southern California.* Bulletin of the Southern California Academy of Sciences. 92: 101-167.

Taylor, B. D., W. M. Brown, and W. R. Brownlie. 1977. *Progress Report No. 3 on sediment management for southern California mountains, coastal plains, and shoreline*. Environmental Quality Laboratory California Institute of Technology, and Shore Processes Laboratory Scripps Institution of Oceanography.

Taylor, G. and B. Quelvog. 1975. *Sespe Creek Study*. Department of the Interior, Los Padres National Forest.

Titus, R. G., D. C. Erman, and W. M. Snider. 2002. *History and Status of Steelhead in California Coastal Drainages south of San Francisco Bay*. California Department of Fish and Game.

U.S. Bureau of Reclamation. 1999. *Biological Assessment for Cachuma Project Operations and the Lower Santa Ynez River*.

United Water Conservation District. 1985. *Draft Environmental Impact Statement/Environmental Impact Report. Freeman Diversion Improvement Project*. United Water Conservation District. Santa Paula, CA.

----- 1999. Surface and Groundwater Conditions Report: Water Year 1998. Prepared by Groundwater Resources Department, United Water Conservation District.

----- 2000. *Piru and Fillmore Basins Groundwater Conditions Report Water Year 2000*. United Water Conservation District. Santa Paula, CA.

United Water Conservation District and Castaic Lake Water Agency. 1996. *Water Resources Report on the Santa Clara River. The Santa Clara River Enhancement and Management Plan*. Ventura, CA.

United Water Conservation District Groundwater Department. 2001. *Annual Investigation and Report of Groundwater Conditions within United Water Conservation District*. United Water Conservation District.

Vadas, R.L.Jr. 2000. *Instream-flow needs for anadromous salmonids and lamprey on the Pacific Coast, with special reference to the Pacific Southwest.* Environmental Monitoring and Assessment. 64: 331-358.

Ventura County Flood Control District. 1995. *Final Wetlands Mitigation Plan and Exotics Control Program for Arroyo Las Posas Sediment Control Project, Unit 4*. Ventura County Flood Control District. Ventura, CA.

----- 2002. *Ventura Countywide Stormwater Quality Management Report. Annual Report for Permit Year 2, Reporting Year 8*. Ventura County Flood Control District. Ventura, California.

Ventura County Flood Control District and Los Angles County Department of Public Works. 1996. *Flood Protection Report. Santa Clara River Enhancement and Management Plan.* Ventura, CA.

Ventura County Resource Management Agency. 1994. Ventura County Water Management Plan. Vol.1 Goals, Policies and Program; Vol. 2. Technical Appendix; Vol. 3 Public Comment and Response to July 1993 Draft. County of Ventura.

Waln, Karen. January 6, 2004. City of Ventura. Ventura, CA. Letter to Elise Kelley. 3 pages.

Walters, Thomas E. 1995. Sediment In Streams: Source, Biological Effects and Control. Monograph 7. American Fisheries Society.

Wells, A. W. and J. S. Diana. Date unavailable. *Survey of the freshwater fishes and their habitats in the coastal drainages of southern California*. Natural History Museum of Los Angeles County Foundation.

White, R.J. 1991. *Resisted lateral scour in streams- its special importance to salmonid habitatmanagement*. Fisheries-Bioengineering Symposium. Colt, J., R. J. White, eds. American Fisheries Society. no. 10.

Whitnall, R. September 26, 2003. *Fillmore Fish Hatchery has been educating generations of kids* . The Ventura County Star. http://www.staronline.com/vcs/county_news/article/0,1375,VCS_226_2300373,00.html

Williams, R. P. 1979. *Sediment Discharge in the Santa Clara River Basin, Ventura and Los Angeles Counties, California*. U.S. Geological Survey.

Wisehart, D. November 7, 2001. Santa Paula, CA. Letter to Elton Gallegly. 1 page.

Worden, L. June 8, 2003. *Un-Well Water: The Problem of Perchlorate*. The Signal. http://www.scvhistory.com/scvhistory/sg060803.htm.